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Open File Report 19

Geology and Geomorphology of Levy County, Florida

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Frank R. Rupert

Florida Geological Survey
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GEOMORPHOLOGY

Levy County lies near the northern edge of the Mid-peninsular Zone of White (1970). This zone spans the Florida peninsula from the lower edge of the topographically higher Northern Highlands southward to approximately the Caloosahatchee River. The Mid-peninsular zone is partitioned into a series of elevationally-differentiated geomorphic subzones. Two of these subzones occur within Levy County, the Central Highlands and the Gulf Coastal Lowlands (White, 1970).

Central Highlands

The Central Highlands geomorphic province includes a series of localized highlands and ridges punctuated by topographically lower valleys, all of which trend generally coast-parallel down the central Florida peninsula. Two geomorphic subdivisions of the Central Highlands occur in eastern Levy County, the Western Valley and the Brooksville Ridge.

The Western Valley

The Western Valley geomorphic subzone (White, 1970) borders the eastern edge of Levy County, and locally includes the Williston Limestone Plain of Vernon (1951). The terrain is characteristically a gently-rolling limestone plain covered by a thin blanket of Pleistocene (1.8 million years to 10,000 years before present) sands and containing localized pockets of phosphatic Alachua Formation sediments. Outcrops of the underlying Eocene (54 to 36 million years before present)

limestones are common. Elevations on the Williston Limestone Plain in Levy County generally range from 60 to 90 feet above mean sea level (MSL).

Brooksville Ridge

The Brooksville Ridge is a topographic highland extending from northeastern Gilchrist County southward through eastern Levy County, terminating 110 miles to the south in Pasco County. In Levy County, the ridge sediments rest on highly karstic, Eocene limestone. The core of the ridge is largely comprised of Pleistocene siliciclastics and is capped by a depression-pocked rolling plain of Pleistocene marine terrace sands. Surface elevations range from 60 feet MSL at the western edge of the Ridge, to approximately 135 feet MSL along portions of the crest.

Gulf Coastal Lowlands

The Gulf Coastal Lowlands geomorphic province parallels the present Gulf Coast of Florida from Ft. Myers northward, then westward around the Big Bend to the Alabama line. In the vicinity of Levy County, the Gulf Coastal Lowlands extend inland from the modern Gulf of Mexico shoreline distances of between 15 and 30 miles, terminating at the western edge of the Brooksville Ridge (see Figure 1). The Gulf Coastal Lowlands in Levy County are characterized by broad, flat marine erosional plains, underlain by Eocene limestones, and blanketed by thin Pleistocene sands deposited by the regressing Gulf of Mexico. Elevations within this province vary from 0 feet MSL at the Gulf shoreline, to about 60 feet MSL near the Brooksville Ridge. Several geomorphic subdivisions, based on topography, punctuate the Gulf

Coastal Lowlands zone in Levy County. These include the Waccasassa Flats, the Limestone Shelf and Hammocks, the Chiefland Limestone Plain, the Suwannee River Valley Lowlands, and the Coastal Marsh Belt (Vernon, 1951).

Waccasassa Flats

Vernon (1951) proposed the name Waccasassa Flats for the low, swampy area averaging about five miles wide and 25 miles long, trending from the Santa Fe River in Gilchrist County, southeastward into central Levy County. Land surface elevations over most of the "Flats" average about 55 feet MSL, although isolated sand hills, possibly associated with Wicomico marine terrace deposits and the Brooksville Ridge, reach elevations of nearly 70 feet MSL. At the southern terminus of the Waccasassa Flats, the zone broadens to about 14 miles wide, and elevations decrease to 30 feet MSL as the "Flats" merge into the hammocks of southwestern Levy County. The Waccasassa River, which originates as a poorly-defined channel in the swamps, lakes, and tyty ponds in northern Levy County, drains the lower reaches of the Waccasassa Flats. It flows southwestward and empties into the Gulf of Mexico. The upper portion of the Waccasassa River flows in a poorly-defined channel in sandy alluvium. South of U.S. 98, the river is incised in a limestone channel. A narrow Holocene floodplain of muds and sand occurs near the coast, where the river merges with the coastal swamps.

The origin of the Waccasassa Flats is uncertain. Vernon (1951) believed that the "Flats" are either a remnant stream valley, possibly of ancestral Suwannee River, or are of erosional

marine origin. Due to the predominance of relict marine features throughout the area of the flats, Puri et al. (1967) consider this feature to be marine in origin.

Limestone Shelf and Hammocks

The Limestone Shelf and Hammocks subzone, as used in this report, includes the Pamlico Terrace of Vernon (1951). This zone is characterized by a highly karstic, erosional limestone plain overlain by sand dunes, ridges, and coast-parallel paleo-shoreline sand belts associated with the Pleistocene-age Pamlico marine terrace (approximately 10 to 25 feet MSL). The irregular, highly solutioned Eocene limestone underlying this area is masked by a blanket of Pleistocene sands. Near the modern coast, the limestone shelf is drowned by the coastal marshes. Inland, the limestone rises gently to an elevation of about 20 feet MSL, and is heavily forested. Numerous artesian springs flow from the near-surface limestone, and during periods of heavy rainfall, much of the area floods to form a shallow swamp. Drainage from the coastal hammocks occurs through numerous small creeks and sloughs, which empty into the coastal marshes.

Chiefland Limestone Plain

The flat, karstic limestone shelf in northwestern Levy County associated with the Pleistocene-age Wicomico Terrace is named the Chiefland Limestone Plain (Vernon, 1951). This plain extends from Gilchrist County southward into Levy County, terminating against the Limestone Plain and Hammocks zone, and bounded by the Waccasassa Flats on the east. The terrain is generally flat to rolling, characterized by a veneer of well-

drained Pleistocene sands, generally less than 30 feet thick, overlying the solutioned Eocene limestones. Elevations range from 25 feet MSL at the southern edge of the plain, to nearly 50 feet MSL at the Levy-Gilchrist County line.

Suwannee River Valley Lowlands

The Suwannee River forms the northwestern boundary of Levy County, and empties into the Gulf of Mexico. This river flows in a solution valley, formed in the near-surface Eocene limestones. The lowlands immediately adjacent to the river, floored by a thin veneer of Holocene alluvium and exposed limestone, comprise the Suwannee River Valley Lowlands geomorphic subzone (Vernon, 1951). The broadly-meandering valley is less than one mile wide over most of its course, broadening to about two and a half miles wide just northwest of Chiefland; valley floor elevations average about five feet MSL. Along its lower stretch, the river valley is drowned and obscured by marshes of the Coastal Marsh Belt zone.

Coastal Marsh Belt

The Coastal Marsh Belt is situated on the drowned, seaward edge of the Eocene limestone shelf underlying Levy County. Elevations are less than five feet MSL. The gentle slope of the limestone plain results in a very broad shallow continental shelf off the Florida Big Bend. Sediments are predominantly muds and alluvial sands. Due to the "zero-energy" nature of the shoreline and lack of an adequate sand supply, beaches are vitrually absent (Tanner, 1960). Marshes of Juncus and Spartina grasses fringe

the modern coastline, and a series of small islets or keys, comprised of limestone pinnacles or alluvial sand, are common offshore of the modern coast.

STRATIGRAPHY

The oldest rock commonly penetrated by water wells in Levy County is marine limestone of the Eocene age Avon Park Formation. Undifferentiated Pleistocene to Holocene age surficial sands, clayey sands, and alluvium are the youngest sediments present. The Avon Park Formation and the younger overlying limestone units are important freshwater aquifers, and this discussion of the geology of Levy County is confined to these Eocene age and younger sediments.

Eocene Series

Avon Park Formation

The Avon Park Formation (Miller, 1986) is a lithologically variable Middle Eocene carbonate unit underlying all of Levy County. It is typically a tan to buff to brown dolomite, frequently interbedded with white to light cream to yellowish gray limestones and dolomitic limestones, and containing varying amounts of peat, lignite, and plant remains (Vernon, 1951, and Florida Geological Survey in-house lithologic files). Mollusks, echinoids, and foraminifera, where preserved, are the principal fossils present. The top of the Avon Park Formation varies in depth from surface outcrop along the crest of the Ocala Platform, to nearly 150 feet deep in northern and eastern Levy County. Surface exposures occur in two large areas, one around and west of the town of Gulf Hammock, and a second extending from just

south of Lebanon Station southeastward into Citrus County. Oil test wells which have penetrated the entire Avon Park Formation section under Levy County reveal a total thickness for this unit of approximately 800 to 1100 feet (Florida Geological Survey in-house well files).

Ocala Group

Marine limestones of the Ocala Group (Puri, 1957) unconformibly overlie the Avon Park Formation under all of Levy County except along the crest of the Ocala Platform, where the younger limestones erosionally pinchout against the Avon Park Formation (Vernon, 1951). The Ocala Group is comprised of three Formations; in ascending order, they are the Inglis Formation, the Williston Formation, and the Crystal River Formation. These formations are differentiated on the basis of lithology and fossil content. Typically, the lithology of the Ocala Group grades upward from alternating hard and soft, white to tan to gray fossiliferous limestone and dolomitic limestone of the Inglis and lower Williston Formations into white to cream colored, abundantly fossiliferous, chalky limestones of the upper Williston and Crystal River Formations. Foraminifera, mollusks, bryozoans, and echinoids are the most abundant fossils occurring in the Ocala Group. Thickness of the Ocala Group sediments under Levy County averages about 100 feet. In the vicinity of Gulf Hammock, and south of Lebanon Station, the Ocala Group thins and pinches out against the structurally high Avon Park Formation (see cross section A-A'). Depth to the irregular and highly solutioned top of the Ocala Group is generally less than 50 feet.

In western Levy County, and offshore of the modern coast, a thin blanket of sand covers the limestone and exposures in the form of limestone boulders and pinnacles are common. Surface exposures are also common east of the Brooksville Ridge on the Williston Limestone Plain.

The permeable and cavernous nature of the Ocala Group limestones make them important freshwater bearing units of the Floridan aquifer system. Many drinking water wells in Levy County withdraw water from the upper units of this group.

Miocene to Pleistocene Series

Alachua formation (?)

The Alachua formation is a complex and little understood unit. Originally defined to include only the sand and clay infillings in older karst depressions or stream channels (Dall and Harris, 1892), the Alachua formation was later considered to be a mixture of discontinuous interbedded clay, sand, and sandy clay, including commercially important phosphatic sand and gravel deposits (Vernon, 1951; Puri and Vernon, 1964). In Levy County, the Alachua formation underlies portions of the Brooksville Ridge and sporadic remnants occupy depressions in the Williston Limestone Plain and possibly along the northeast edge of the Chiefland Limestone Plain (Vernon, 1951). The lithology is highly diverse. On a regional basis, the base of the formation contains the mineable ore, and is a rubble of phosphatic rock, silicified limestone float, silicified wood and occassional vertebrate fossils in a matrix of cream to gray to greenish gray clays and phosphatic clays (Vernon, 1951); overlying this bed is

a variably thick section of quartz sandy phosphatic clay.

The phosphate rock is a minor constituent of the Alachua formation, but was economically feasible to mine for many years. Its mode of occurrence ranges from clay to boulder size clasts as well as in the form of replacements of limestone and laminated-phosphate (platerock). Since the Alachua formation was deposited on the eroded, highly karstic and possibly faulted surface of the Ocala Group limestones, its thickness varies considerably over short distances. The mineable deposits are, for the most part, situated on the eastern flank of the Brooksville Ridge.

Both the origin and age of the Alachua formation are uncertain. Cooke (1945) considered it an in-situ accumulation of weathered Hawthorn Group (Miocene) sediments. Puri and Vernon (1964) believed it originated as a largely terrestrial deposit, with lacustrine and fluviatile components, and Brooks (1966) suggested that is was deposited in an estuarine environment. More recently, Scott (1988, in press) considers the Alachua formation to be weathered and possibly reworked Hawthorn Group sediments, although he does not consider it part of the Hawthorn Group.

An age range of Miocene to Pleistocene, based primarily on contained vertebrate fossils, has been postulated for the Alachua formation. This wide age range tends to support the concept of the Alachua formation being composed of time-transgressive, reworked sediments, with each successive depositional event incorporating a younger vertebrate fauna into the sediments.

Plio-Pleistocene Series

Much of the core of the Brooksville Ridge in Levy County is comprised of reddish, clayey coarse sands, lithologically similar to the Citronelle Formation of the panhandle, and the Cypresshead Formation of peninsular Florida; both considered to be Late Pliocene to Early Pleistocene in age. For the purposes of this report, these variably-colored red, orange, and pink siliciclastics, some containing fossil burrows, are placed in the category of undifferentiated Plio-Pleistocene sediments.

Undifferentiated Pleistocene marine quartz sands and clayey sands form a thin veneer over all of Levy County. In the western part of the county and on the Williston Limestone Plain, these sands are generally less than 20 feet thick, and overlie the Ocala Group limestone directly; in east central Levy County, they cap the reddish coarse clastics and where present, the Alachua Formation. Many of the larger and higher sand bodies in the county are relict dunes, bars, and barrier islands associated with various Pleistocene sea level stands. The higher crests on the Brooksville Ridge, above 100 feet MSL, are associated with the Sunderland/Okefenokee Terraces (Healy, 1975). With the exception of the Suwannee River Valley Lowlands, which are part of the Pamlico and Silver Bluff Terraces, and the Limestone Shelf and Plain, which contains Penholoway, Talbot, and Pamlico terrace deposits, the surficial siliciclastic sediments occurring over the remainder of Levy County are Wicomico terrace deposits (Vernon, 1951; Healy, 1975).

Holocene Series

Unnamed Freshwater Marl and Alluvium

A white to gray, fossiliferous freshwater marl commonly occurs along the banks and in the valleys of the Withlacoochee and Suwannee Rivers. This marl generally contains an abundant Holocene freshwater mollusk fauna, and may attain three to four feet in thickness (Vernon, 1951; Puri et al., 1967). Holocene quartz sand and mud alluvium form bars and floor the valleys of most major streams in Levy County.

GROUNDWATER

Groundwater is water that fills the pore spaces in subsurface rocks and sediments. This water is derived principally from precipitation within Levy and adjoining counties. The bulk of Levy County's consumptive water is withdrawn from groundwater aquifers. Two main aquifer systems are present under Levy County, the surficial aquifer system and the underlying Floridan aquifer system.

Surficial aquifer system

The surficial aquifer system is the uppermost freshwater aquifer in Levy County. This non-artesian aquifer is contained within the interbedded sands and clays of the Alachua formation and the overlying Plio-Pleistocene siliciclastics and marine terrace sands in east-central Levy County. In western Levy County, the surficial aquifer system is thin or absent, occurring only in locally thick Pleistocene sands immediately overlying the Ocala Group limestone. On average, the surficial aquifer system

ranges from 10 to 50 feet thick, with the thicker portions located under the higher geomorphic sand ridges of central and eastern Levy County. The surficial aquifer system is unconfined, and its upper surface is the water table. In general, the water table elevation fluctuates with precipitation rate and conforms to the topography of the land surface. Recharge to the surficial aquifer system is largely through rainfall percolating downward through the loose surficial siliciclastic sediments, and to a lesser extent, by upward seepage from the underlying Floridan aquifer system. Water naturally discharges from the aquifer by evaporation, transpiration, spring flow, and by downward seepage into the Floridan aquifer system. The surficial aquifer system may yield quantities of water suitable for consumptive use, but in some areas the concentration of iron and/or tannic acid impart a poor taste and color to the water.

Floridan aquifer system

The Floridan aquifer system is comprised of thousands of feet of Eocene marine limestones, including the Avon Park Formation and the Ocala Group. It is the principle source of drinking water in Levy County. The Floridan aquifer system exists as an unconfined, non-artesian aquifer in portions of western, northern, and eastern Levy County, where porous Pleistocene quartz sand directly overlies the limestone. In areas of east-central and eastern Levy County, where clay beds in the Alachua Formation and undifferentiated Pleistocene siliciclastics form low-permeability confining units, the Floridan may function as an artesian aquifer. Depth to the top

of the Floridan aquifer generally corresponds to the depth of limestone, and varies from less than five feet in the Coastal Marshes and Suwannee and Santa Fe River valleys, to nearly 50 feet under the Brooksville Ridge. The potentiometric gradient is generally west-southwestward.

Recharge to the Floridan aquifer system in Levy County is obtained from local rainfall percolating through the permeable surficial sands in the northwestern and eastern portions of the county. Low permeability siliciclastics under the Waccasassa Flats retard downward percolation, resulting in only low to moderate recharge in this area (Stewart, 1980). In the Limestone Shelf and Hammocks and in the Coastal Marshes, the potentiometric surface of the Floridan aquifer system is at or near land surface, resulting in discharge. Water leaves the Floridan aquifer system through natural movement downgradient and subsequent discharge through numerous springs and seeps along the river valley lowlands and in the hammocks and coastal marsh belt.

MINERAL RESOURCES

The following discussion of mineral commodities is intended to provide an overview of the extent and mining potential for each mineral. In Levy County, the principal mineral commodities are sand, phosphate limestone, dolomite, and clay.

Sand

A number of shallow private pits in Levy County are worked for fill sand and aggregate. Pleistocene sand deposits occur as thin veneers over the limestone plains, and in thicker concentrations in the marine terrace deposits on and adjacent to

the Brooksville Ridge. Since there is insufficient local demand for sand products, the potential for commercial mining is low at this time.

Phosphate

The phosphatic sands, clays, and limestones of the Alachua formation deposits along the Brooksville Ridge have been mined since the 1900's. Hard rock phosphate, a calcium fluorapatite mixture, occurs as a replacement of limestone float contained in basal Alachua Formation sediments and on top of the Ocala Group. The clays within the Alachua Formation contain collodial phosphate and comprise what is termed soft rock phosphate.

In Levy County, hard-rock phosphate mining has historically been concentrated along the Brooksville Ridge, and in localized areas of the Williston Limestone Plain (Vernon, 1951). There are presently no active mines in the county. While potential deposits probably still exist under the Brooksville Ridge, future exploitation of phosphate in Levy County will depend largely on phosphate market prices and the economic health of the phosphate industry.

Limestone and Dolomite

Avon Park Formation dolomite occurs near the surface in the vicinity of Gulf Hammock and southward to near the Levy/Citrus County line. Two companies currently operate pits near the town of Gulf Hammock, and the extracted dolomite is used as concrete aggregate, soil conditioner, and as filler in bituminous mixes Lane et al., 1988 in press).

Ocala Group limestones occur near the surface under most of

Levy County. High purity, road base quality rock, is concentrated in the Chiefland and Williston Limestone Plains. Aggregate and secondary road base grades floor the Limestone Shelf and Hammocks, and the Coastal Marshes of western Levy County. Three companies currently operate quarries in the Williston area, and the Levy County Road Department extracts road base material from small, local pits, on an "as needed" basis. Due to the extensive deposits of limestone in the county, future potential for this commodity remains high.

Clay

Localized deposits of clay and sandy clay are associated with Wicomico and Pamlico Terrace deposits in Levy County (Vernon, 1951). Most of these deposits are contained in and interbedded with other sediments, usually on a very irregular limestone surface. As a result, the clay deposits can vary considerably in lithology and thickness. Vernon (1951) tested clays from two locations in Levy County, and reports that both showed poor strength characteristics, precluding their use in structural products. However, by mixing the two samples and adding fluxes, a pottery-grade clay was produced. Reserve estimates have not been made, and the future exploitation of Levy County clay deposits will depend largely on more extensive exploration and testing, as well as market demand.

Limonite

An extensive deposit of Limonite, an iron-oxide mineral, occupies solution depressions in the Ocala Group limestones in an area northeast of Chiefland. Vernon (1951) reports a 20-foot

thick section of limonite nodules in a pit east of Chiefland, and estimates that a reserve of about 50,000 tons is available in the area. The most feasible use would be as ochre pigment in paint. Local residents claim that the Confederates operated a smelting furnace in the area during the Civil War and produced iron from the deposit (Vernon, 1951).

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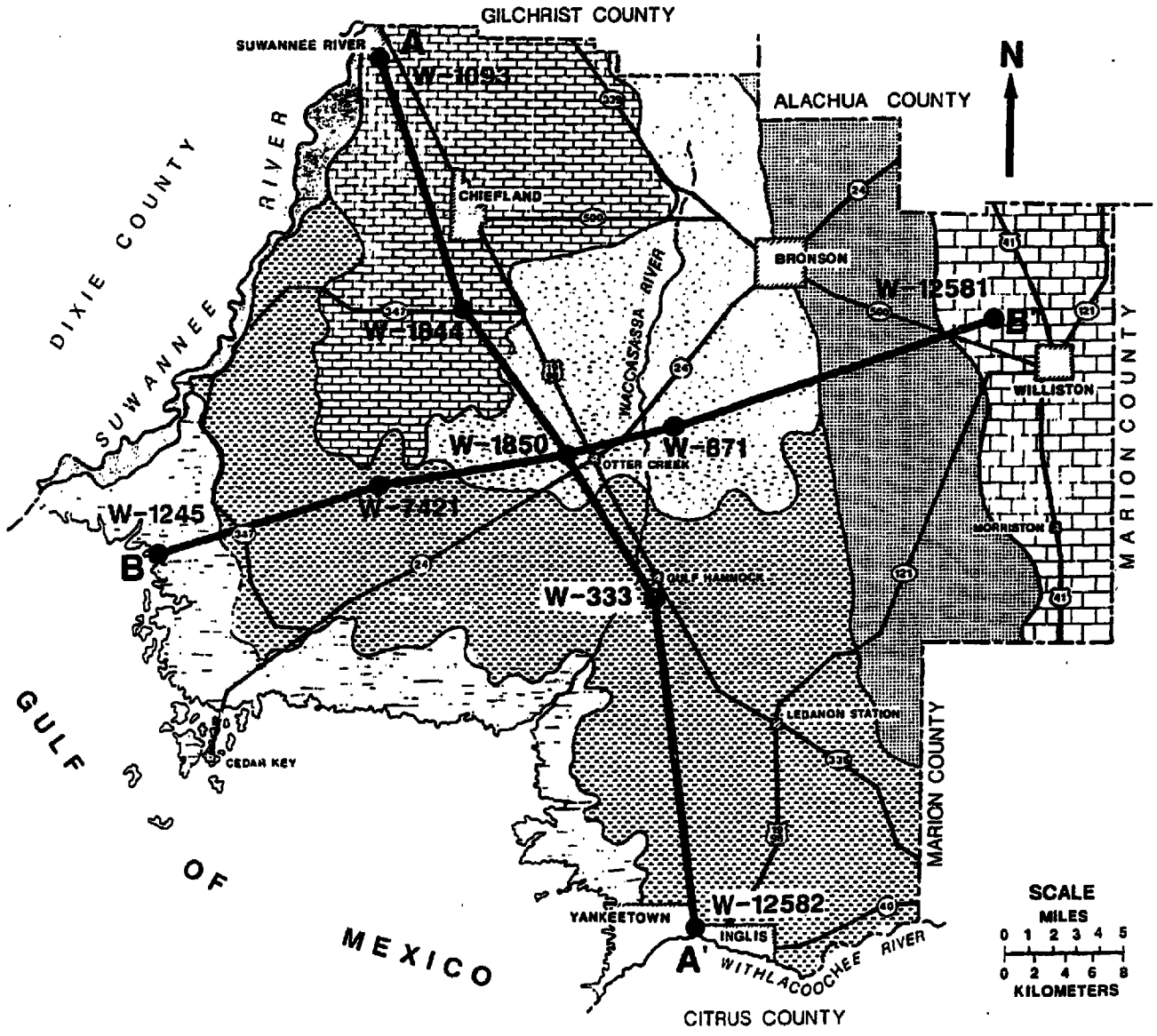


EXPLANATION

- TOWN
- U.S. HIGHWAY
- STATE/COUNTY ROAD
- WELL LOCATION
- CROSS SECTION LOCATION

GEOMORPHIC ZONES

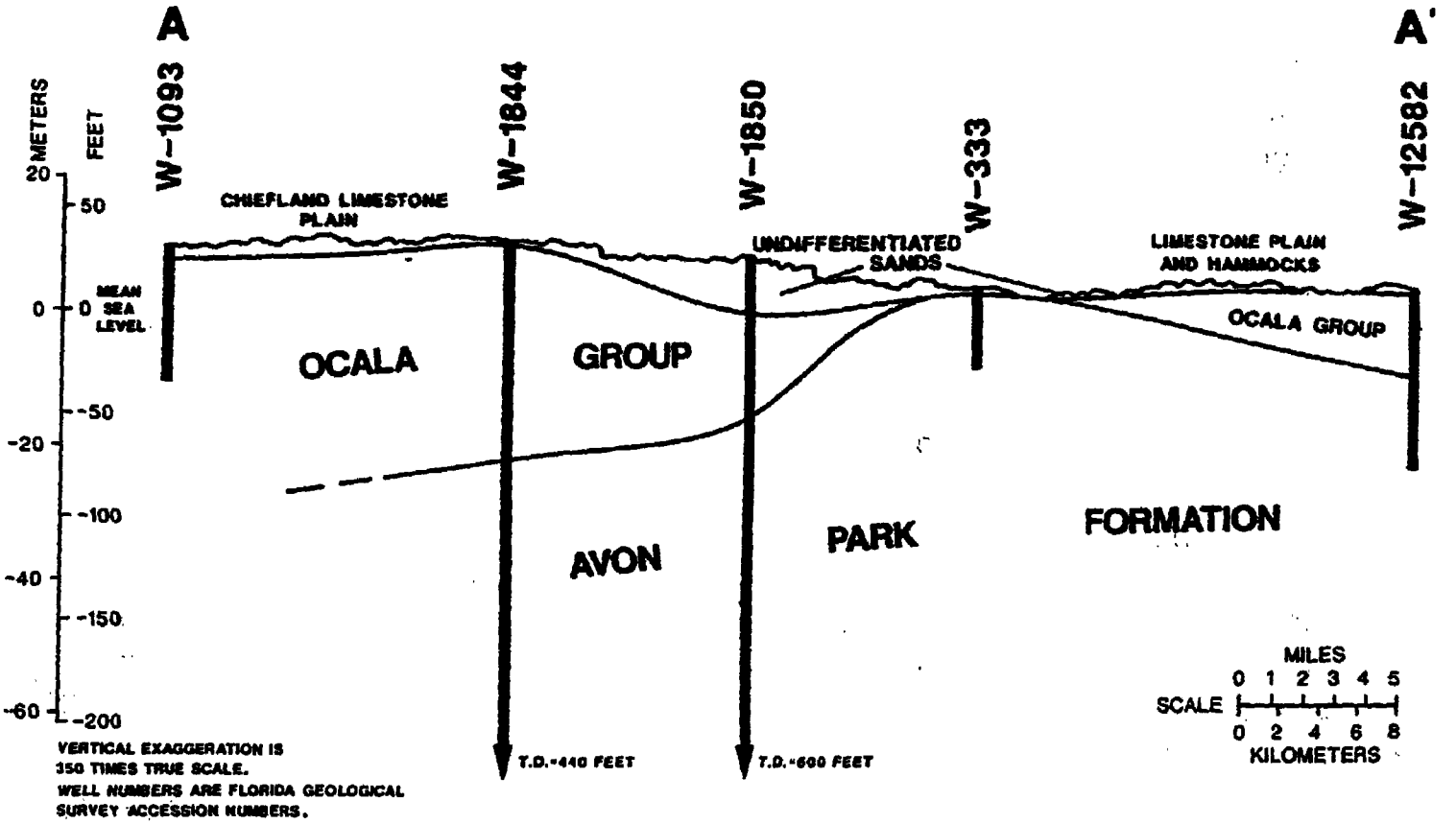
MODIFIED AFTER VERNON(1951) AND WHITE(1970).

CENTRAL HIGHLANDS

- WESTERN VALLEY – WILLISTON LIMESTONE PLAIN
- BROOKSVILLE RIDGE

GULF COASTAL LOWLANDS

- WACCASASSA FLATS
- LIMESTONE SHELF AND HAMMOCKS
- CHIEFLAND LIMESTONE PLAIN
- SUWANNEE RIVER VALLEY LOWLANDS
- COASTAL MARSHES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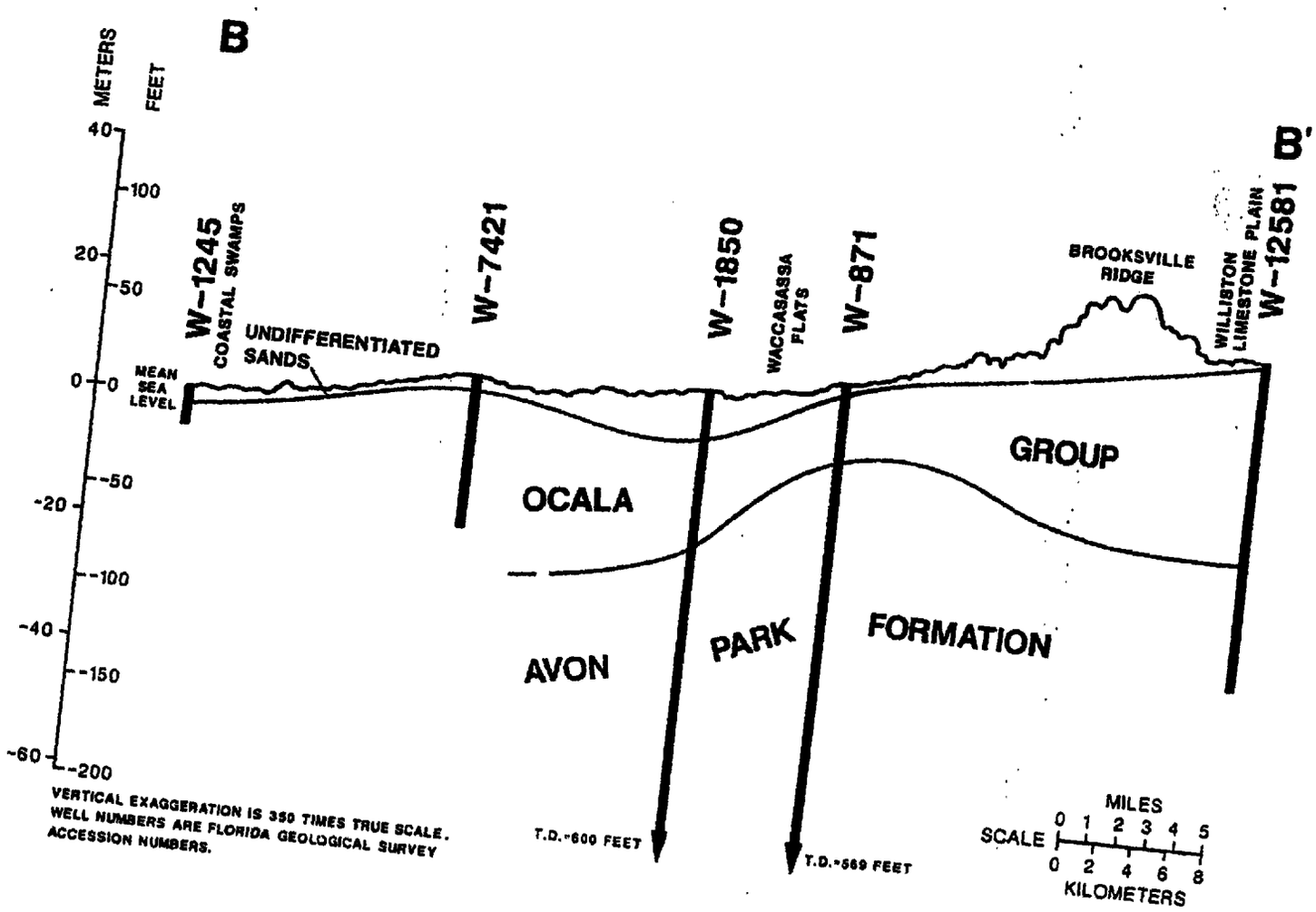
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WILLISTON LIMESTONE PLAIN
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