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The geomorphology and geology of Escambia County, Florida

by

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GEOMORPHOLOGY

Escambia County is situated at the western end of the Northern or Proximal geomorphic zone of White (1970). This zone includes the northernmost Florida peninsula, and all of the panhandle. Locally, the Northern Zone is subdivided into two geomorphic provinces: the Western Highlands and the Gulf Coastal Lowlands (Figure 1).

Western Highlands

The Western Highlands comprise the northern three-quarters of Escambia County. They are the western extension of the series of topographic highlands which span northern Florida. These highlands are thought to be the stream-dissected remnants of an extensive delta plain that covered southern Alabama, southern Georgia, and northern Florida. The terrain is characteristically comprised of gently rolling clayey-sand hills and ridges, punctuated by a series of deeply-incised dendritic streams. Land surface elevations range from 280 feet above mean sealevel (MSL) in northern Escambia County, near the Florida - Alabama state line, to approximately 100 feet above MSL at the southern edge of the highlands.

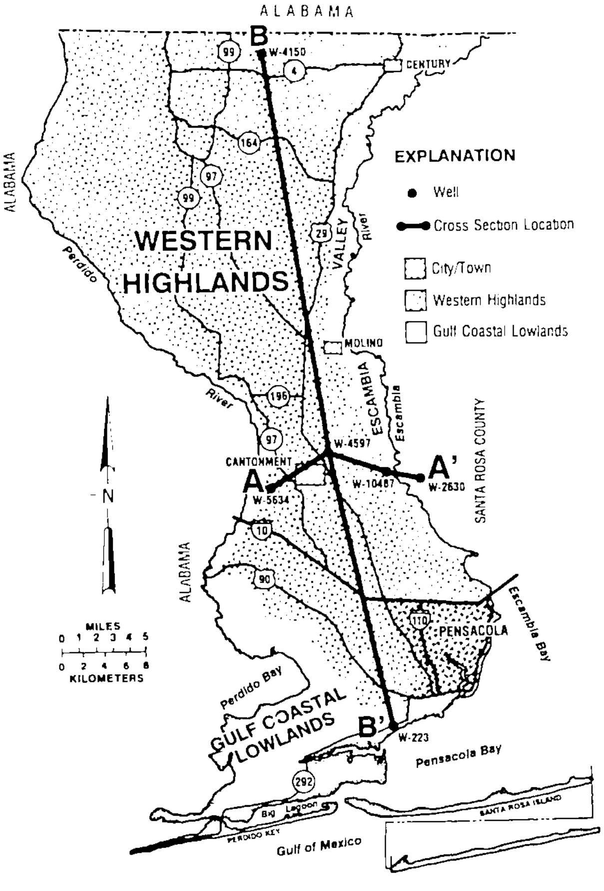

Figure 1. Geomorphic and cross section location map.

Large surface water bodies are rare in the Western Highlands. A number of small ponds are perched on low-permeability layers with the clayey sand sediments comprising the highlands.

As with most of Florida, the Western Highlands have been modified by marine erosion. Healy (1976) identified three marine terrace elevation zones in the Western Highlands:the Sunderland/Okeefenokee Terrace, which extends from the southern edge of the zone (approximately 100 feet MSL) to 170 feet above MSL; the Coharie Terrace (170 to 215 feet above MSL); and the Hazelhurst Terrace (215 to 320 feet above MSL), which includes the highest elevations in Escambia County.

Gulf Coastal Lowlands

The Gulf Coastal Lowlands zone covers the southern one-quarter of Escambia County. It extends from the base of the Western Highlands southward to the present coastline, and includes the Escambia River Valley and the modern coastal barrier islands. The boundary between the Gulf Coastal Lowlands and the uplands to the north is marked by a relict marine escarpment, lying at an elevation of approximately 100 to 120 feet above MSL.

The terrain in the Gulf Coastal Lowlands is generally flat and sandy, reflecting erosion and subsequent deposition by high-standing Pleistocene seas. Healy (1976) recognized four marine terrace elevation zones comprising portions of the Gulf Coastal Lowlands: the Silver Bluff Terrace (0 to 10 feet above MSL), the

Pamlico Terrace (10 to 25 feet above MSL), the Talbot Terrace (25 to 42 feet above MSL), the Penholoway Terrace (42 to 70 feet above MSL), and the Wicomico Terrace (70 to 100 feet above MSL).

The land surface in the Gulf Coastal Lowlands slopes gently from an elevation of about 100 feet above MSL at the northern edge of the lowlands to 0 feet MSL near the coast. Much of the land adjacent to Perdido Bay and landward of the Gulf coastal barrier islands is swampy, and is drained by small sluggish creeks. Relict Pleistocene sand beach ridges and dunes are situated on the mainland and the landward edge of Perdido Key, just west of Big Lagoon.

Perdido Key and Santa Rosa Island are Holocene barrier islands, comprised of quartz sand and shell beds, and supporting a series of coast-parallel sand dune and beach ridge systems. The larger of these dunes attain elevations of up to 45 feet above MSL, but are continually vulnerable to erosion by storm surges. Low swales positioned between the dunes may contain standing fresh water, and commonly accumulate organics.

Escambia Valley

The valley of the Escambia River forms a broad extension of the Gulf Coastal Lowlands which straddles the river northward to the Florida-Alabama state line (White et al., 1964). It begins at sea level where the river enters the northwestern edge of Escambia Bay through a 4-mile-wide swampy delta. From here it extends northward to the Alabama state line, following the 1.5 to 2 mile wide floodplain of the Escambia River. The elevation in the valley gradually rises to an elevation of about 50 feet above MSL at the point where it enters Alabama.

STRATIGRAPHY

Escambia County is underlain by thousands of feet of Mesozoic and Cenozoic sedimentary rocks. The oldest known sediments encountered by drilling, consisting of Jurassic quartzitic sandstone and gray shale, were penetrated at a depth of 17,950 feet in an oil test well in the north-central part of the county. These sediments are part of the Smackover Formation, which yields petroleum in wells situated in the Jay field in adjacent Santa Rosa County. The youngest sediments are Pleistocene and Holocene undifferentiated sands, clayey sands, and alluvium. Figure 1 shows the locations of the shallow geologic cross sections illustrated in Figures 2 and 3.

The rock strata underlying Escambia County dip and thicken gently to the southwest in a homoclinal structure. This structure is produced by the thickening and downwarping of sediments as they dip into the large sedimentary basins of the Gulf of Mexico sedimentary basin and the Mississippi Embayment, situated west and south of the county respectively (Marsh, 1966). The majority of the vast thickness of Tertiary sediments underlying the county are continental siliciclastics and marginal marine units.

Locally, the thick sequence of Miocene and younger siliciclastic rock units function as fresh water aquifer systems, and are a source of non-petroleum economic mineral commodities. The following discussion of the geology of Escambia County is therefore restricted to the Middle Miocene and younger strata. All stratigraphic nomenclature follows Braunstein et al.(1988), and the areal extent of units is taken from Scott (1993).

Middle and Upper Miocene Series
Pensacola Clay

The Pensacola Clay (Marsh, 1966) is a dark to light gray to brownish-gray, silty, variably sandy clay and quartz sand unit underlying central and southern Escambia County. This formation characteristically contains a prolific benthic foraminifera assemblage, as well as marine molluscs and ostracods. The Pensacola Clay consists of three members in this area - a lower clay member, a thin sand member named the Escambia Sand, and an upper clay member. The formation ranges from approximately 380 feet thick in the east-central part of the county to over 1000 feet thick just north of Pensacola and under Perdido Bay. It unconformably overlies Oligocene carbonates of the Chickasawhay Formation.

The Pensacola Clay is generally absent in the northern portion of the county. Here it grades into the Coarse Clastics or is truncated by the overlying Citronelle Formation. The top of the formation varies in depth from approximately 250 feet below land surface (bls) near Cantonment, to nearly 800 feet bls under Perdido Bay in southwestern Escambia County.

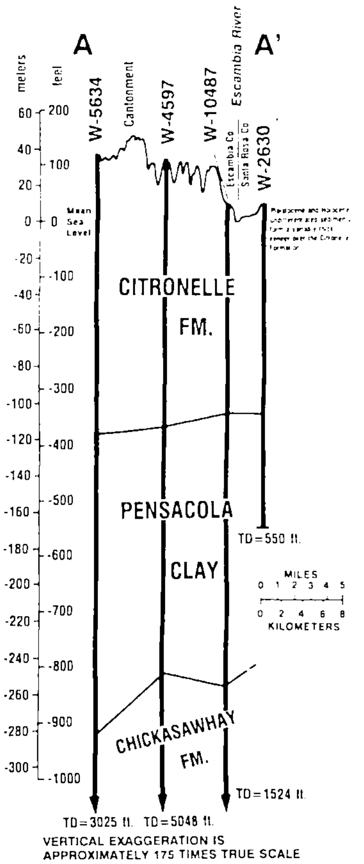

Figure 2. Cross section A - A'.

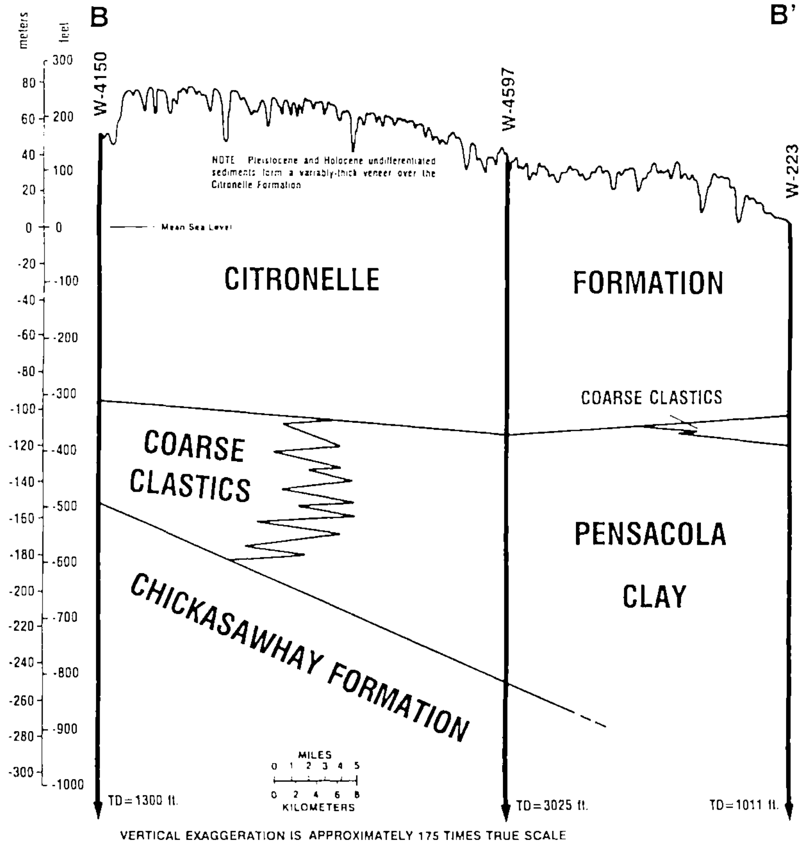

Figure 3. Cross section B - B'.

Miocene-Pliocene Series
Coarse Clastics

Marsh (1966) coined the name Miocene Coarse Clastics for the extensive beds of light-brown to light-gray, poorly sorted fine to very coarse sand, granules, and small quartz pebbles and mollusc shells underlying the western-most Florida panhandle. These beds most likely transgress the Miocene-Pliocene age boundary, and the general name Coarse Clastics has been adopted (Braunstein et al., 1988). The mineral muscovite is common as an accessory throughout the unit. Perhaps the most distinctive feature of the Coarse Clastics, and that which differentiates them form the overlying Citronelle Formation, is the presence of abundant small marine molluscs. In some well samples, these fossils comprise 5 to 50 percent of the sample.

Thickness of the Coarse Clastics is variable. It is about 70 feet thick in north-central Escambia County, from where it generally thickens to the southeast and southwest, attaining a maximum thickness of nearly 500 feet just southeast of Cantonment. Depth to the top of the unit varies from approximately 280 feet bls beneath Pensacola Bay, to nearly 650 feet bls in northwestern Escambia County near the Florida-Alabama state line.

The Coarse Clastics interfinger with the Pensacola Clay in south central Escambia County, and are in turn unconformably overlain by the Pleistocene age Citronelle Formation and undifferentiated terrace deposits.

Pliocene Series
Citronelle Formation

The Citronelle Formation (Matson, 1916) is predominantly a light yellowish-brown to reddish-brown to light-gray to white quartz sand unit, containing lenses and beds of clay and chert and quartz gravel. It forms the stream-incised hills of the Western Highlands Zone, and forms a distinct bluff at Bay Bluff, along the western shore of Escambia Bay. Analyses by Coe (1979) suggest that the Citronelle Formation sediments are largely deltaic in origin. Clay beds within the Citronelle Formation may reach 60 feet in thickness, and a few, such as one at Molino, are of suitable economic grade for brick making (Marsh, 1966). Fossils are generally rare, but scattered molluscs, foraminifera, shrimp burrows, fossil pollen and wood remains have been reported from Citronelle sediments in various parts of Escambia County (Marsh, 1966).

The abundant iron oxide in the Citronelle Formation lends a reddish color to many of the sediments, and may concentrate in sand beds forming hardpan layers. These hardpan layers vary from less than an inch to several feet thick. Owing to their resistant nature and low permeability, small ponds may form over hardpan layers as well as over clay beds. Ground water percolating downward through the sediments will commonly reach a hardpan layer, and be diverted laterally. When this lateral flow intersects a surface stream gully, bluff, or hillside, the exiting flow may undermine the overlying sediments, causing a semicircular collapse feature called a steephead. As erosion continues, the steephead migrates away from the water seepage point, cutting a stream gully as it progresses. Steepheads are most common in the deeply-incised terrain of the Western Highlands.

The thickness of the Citronelle Formation varies considerably. Because of the difficulty in differentiating Citronelle sediments from the overlying terrace deposits, there is some uncertainty in the overall thickness range. However, the Citronelle Formation generally varies from about 200 feet thick at the southern edge of the county to almost 800 feet thick in the northwestern corner of Escambia County (Marsh, 1966).

Pleistocene and Holocene Series Undifferentiated sand and clay

A series of undifferentiated, commonly unconsolidated quartz sands and clays overlie the Citronelle Formation in much of Escambia County. These sediments are deposited in a series of elevational marine terraces. The younger terraces near the modern coast contain still-discernable relict shoreline features, such as clean quartz sand dunes and beach ridges. In many areas, particularly in the central and northern portions of the county, these sediments are difficult to differentiate from the underlying Citronelle Formation. They cap the hills of the Western Highlands, and accumulate as alluvium in stream channels. These sediments consist primarily of clean to slightly clayey quartz sands, generally containing less clay and quartz pebbles than the older Citronelle sediments.

The unconsolidated sediments, along with Holocene alluvium and shoreline sands, are grouped into the undifferentiated sand and clay unit. Because of the difficultly in differentiating them from the underlying Citronelle Formation sediments, the undifferentiated sediments are not depicted on the geologic cross sections (Figures 2 and 3).

GROUND WATER

Ground water, or water that fills the pore spaces in subsurface rocks and sediments, is the principal source of potable water in Escambia County. It is derived primarily from precipitation within Escambia and neighboring counties.

The primary aquifer systems present under Escambia County are the surficial aquifer, also called the Sand and Gravel Aquifer, and the deeper Floridan aquifer system. These units are separated by an aquiclude, commonly containing water-bearing units, named the intermediate aquifer/confining unit. Data on the extent and thickness of each aquifer system is taken from Musgrove et al. (1961, 1965), Marsh (1966), and Scott et al. (1991).

Sand and Gravel Aquifer

The majority of water wells in Escambia County draw water from the Sand and Gravel Aquifer. This aquifer is formed in the porous siliciclastic sediments of the Coarse Clastics, the Citronelle Formation, and the surficial undifferentiated sand and clay units. It extends under the entire county, overlying Oligocene carbonate in the northern part of the county, and overlying the Pensacola Clay in the southern portion of the county. It is variable in thickness, ranging from the surface down to depths of 200 to 500 feet bls. Unlike the carbonate aquifer system in much of Florida, water from the Sand and Gravel Aquifer is low in mineral content due to the predominantly insoluble quartz sand and gravel composition of the water-bearing sediments. As such, it makes an economical industrial water source for manufacturing processes requiring low mineral content water.

Intermediate aquifer/confining unit

Locally, the Sand and Gravel Aquifer is separated from the underlying Floridan aquifer system by an intermediate confining unit comprised of the Pensacola Clay. This low-permeability unit is variable in thickness, generally ranging from 380 to 1000 feet thick. It acts as an aquiclude and effectively isolates the two aquifer systems. The Escambia Sand member, situated within the Pensacola Clay, may contain freshwater but is not utilized as a water source in Escambia County.

Floridan aquifer system

The Floridan aquifer system is composed of porous carbonate rocks of Miocene and Eocene age. The top of the unit lies at depths generally in excess of 600 feet under Escambia County. Water within the Floridan aquifer system is harder, with a higher dissolved mineral content than the overlying Sand and Gravel Aquifer water. The chloride content increases substantially downdip, under the Perdido Bay area in southwestern Escambia County.

Although the Floridan aquifer system is the primary fresh water source in much of Florida, it is not used extensively in the western panhandle. The availability of high quality water at shallower depths in the Sand and Gravel Aquifer precludes the need to drill deeper wells to reach the Floridan aquifer system.

MINERAL RESOURCES

The principal near-surface, non-energy mineral resources occurring in Escambia County are quartz sand, gravel and clay. These commodities are mined from open pits in the shallow undifferentiated sediments and Citronelle Formation. The following discussion summarizes the current mining status and potential for each commodity in Escambia County.

Sand and Gravel

Quartz sand and gravel are mined by three companies in Escambia County. Information on each operation is from Spencer (1993). Campbell Sand & Gravel Company operates the Century Mine, situated in section 4 of Township 5N, Range 30W, near Century. Sand and a range of gravel sizes for masonry and concrete mixes are the primary products from this operation. Clark Sand Company produces masonry sand from the Pensacola Mine, located in multiple sections of Township 2S, Range 30W. American Clay and Shell Company operates the Belview Pit in Township 1S, Range 39W, section 39, which provides local fill material.

Several other small commercial operations and numerous private pits are worked for various mixtures of sand and clay. This material is used locally for fill. Sand is an abundant resource throughout Escambia County, and future exploitation will be largely dependent upon local market demand.

Clay

Refractory clay, used in making brick products, has been mined in the county for many years. The Taylor Brick Company, followed later by Bickerstaff, operated a large pit located near the town of Molino. Although currently inactive, these companies mined brick clay from a 50 feet thick bed in the Citronelle Formation.

In the central and northern parts of the county, the Citronelle Formation contains clay beds ranging from a few inches up to tens of feet in thickness. These beds extend from a few feet to several miles in length (Musgrove et al., 1961). The presence of these deposits suggests that economic quantities of clay are readily available in Escambia County. However, resumption of the mining at Molino, or development of other clay mines within the county will depend largely on the local demand for clay products.

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