

C. 1

REFERENCE

State of Florida
Department of Natural Resources
Tom Gardner, Executive Director

Division of Resource Management
Jeremy Craft, Director

Florida Geological Survey
Walt Schmidt, State Geologist and Chief

Open File Report 24

The Geology of Flagler County, Florida

by

Jonathan D. Arthur

Florida Geological Survey
Tallahassee, Florida
1988

FLAGLER COUNTY

GEOMORPHOLOGY

Flagler County is located within the Atlantic Coastal Lowlands physiographic zone. White (1970) has delineated six geomorphic features within Flagler County (Figure 1). The following discussion is primarily a summary of his observations.

The largest geomorphic feature in Flagler County is the Eastern Valley, which covers the western two-thirds of the county. This valley is approximately 20 miles wide and contains most of the low lying wetlands of Flagler County. Elevations in this region range from 5 to 28 feet above mean sea-level (MSL). Crescent Lake is the major drainage basin in the western half of the county. Tributaries flowing into the lake include Salt Creek, Haw Creek, Black Branch and Hunter Branch. Lake Diston, located in the southwest corner of the county, receives drainage from surrounding wetlands and Little Haw Creek.

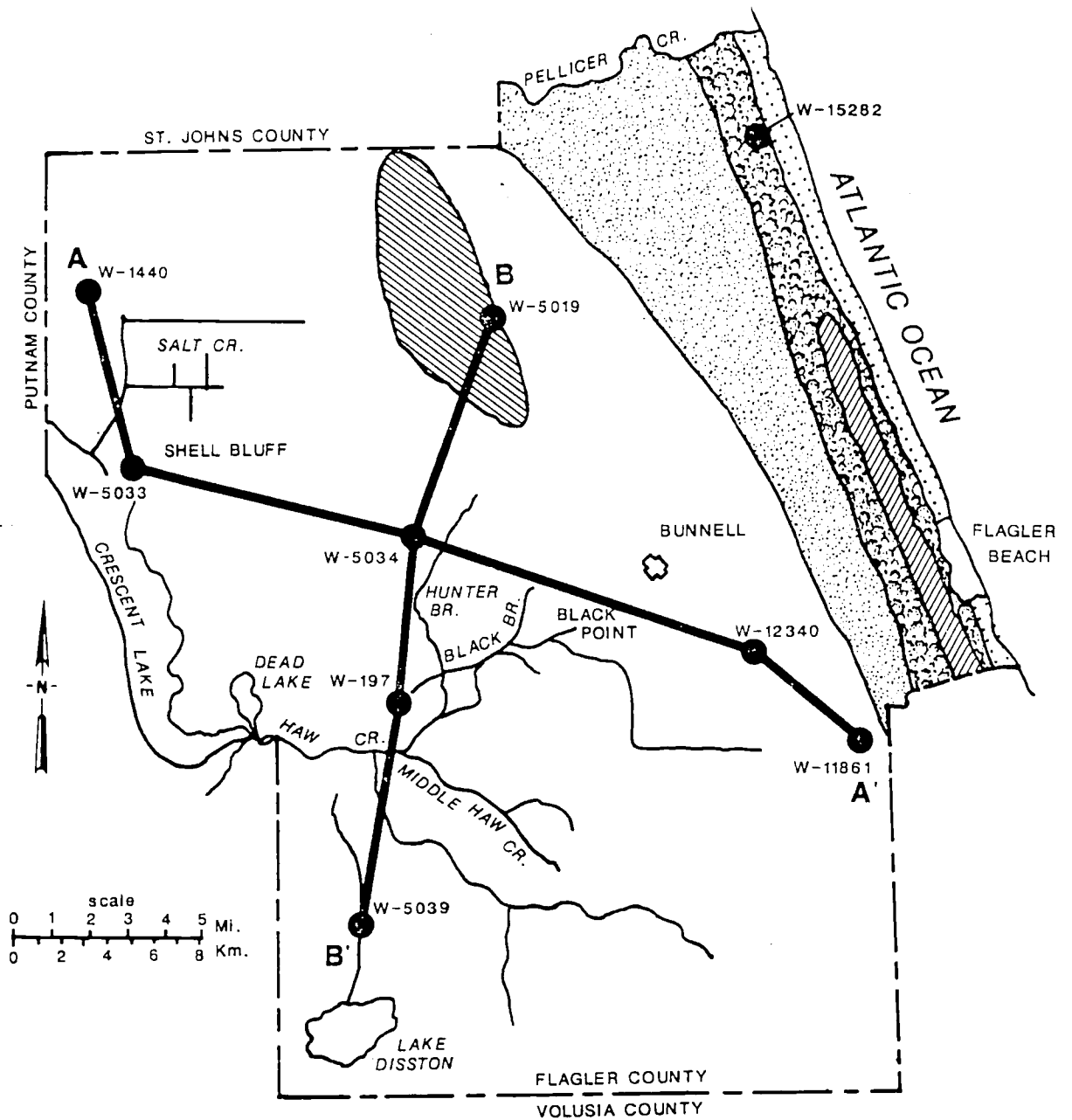
Espanola Hill, a topographic high within the Eastern Valley, is an elongate feature that parallels the Atlantic coastline and has a maximum elevation of 59 feet above MSL. The orientation of Espanola Hill and its location proximal to the Atlantic Coastal Ridge suggests that the feature may be a relict beach ridge (White, 1970).

Four narrow, linear geomorphic provinces are located within the eastern third of Flagler County, all of which parallel the

Atlantic coastline. These features include the Atlantic Coastal Ridge, the Atlantic Coastal Lagoons, the Atlantic Barrier Chain and the Atlantic Beach Ridges. During Pamlico sea-level stands, about 340,000 years ago (Stringfield, 1966), the shoreline known as the Atlantic Coastal Ridge was developed. Oscillating regression of the Pamlico seas produced linear coastal deposits which are components of the Atlantic Barrier Chain. The Atlantic Beach Ridges and Coastal Lagoons are products of Holocene shoreline sedimentation.

STRATIGRAPHY

Flagler County is underlain by several thousand feet of sedimentary rocks which overlies upper Pre-Cambrian - Lower Cambrian crystalline basement, beginning at approximately 5000 feet in depth (Barnett, 1975). The oldest geologic formation penetrated by water wells in the county is the Avon Park Formation of Middle Eocene age. Overlying this formation are the limestones of the Ocala Group and the phosphatic clays, sands and limestones of the Hawthorn Group. These units underlie Pleistocene and Recent undifferentiated sand, shell and clay deposits, which are exposed at the surface. Figure 1 shows geologic cross-section locations and Figures 2 and 3 show the geologic formations that are penetrated by wells in Flagler County.



EXPLANATION

-  Atlantic Beach Ridges
-  Atlantic Coastal Lagoons
-  Atlantic Barrier Chain
-  Atlantic Coastal Ridge
-  Eastern Valley
-  Espanola Hill

Figure 1. Geomorphology of Flagler County and Cross-section location map.

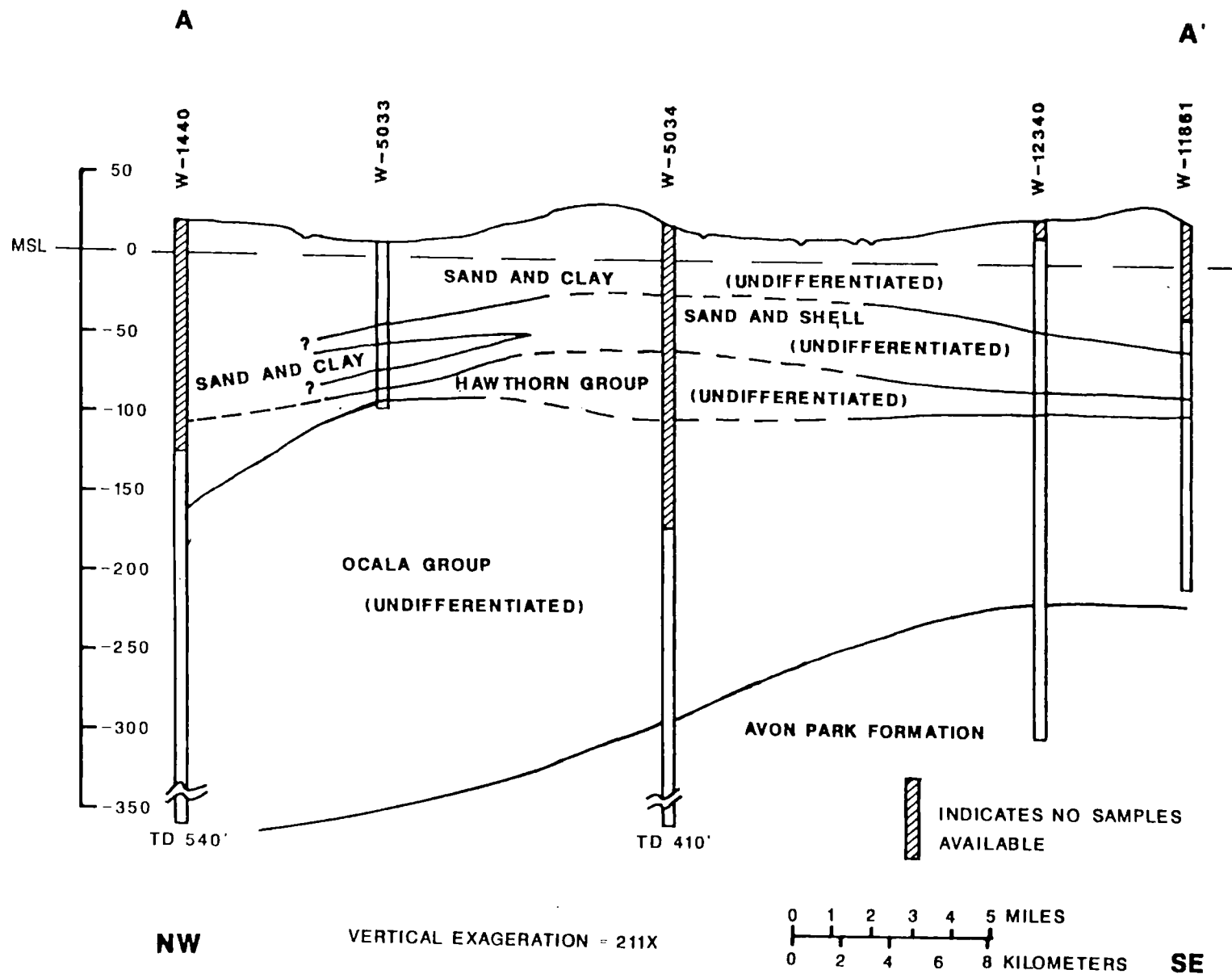


FIGURE 2. GEOLOGIC CROSS-SECTION A - A'

FGS 010988

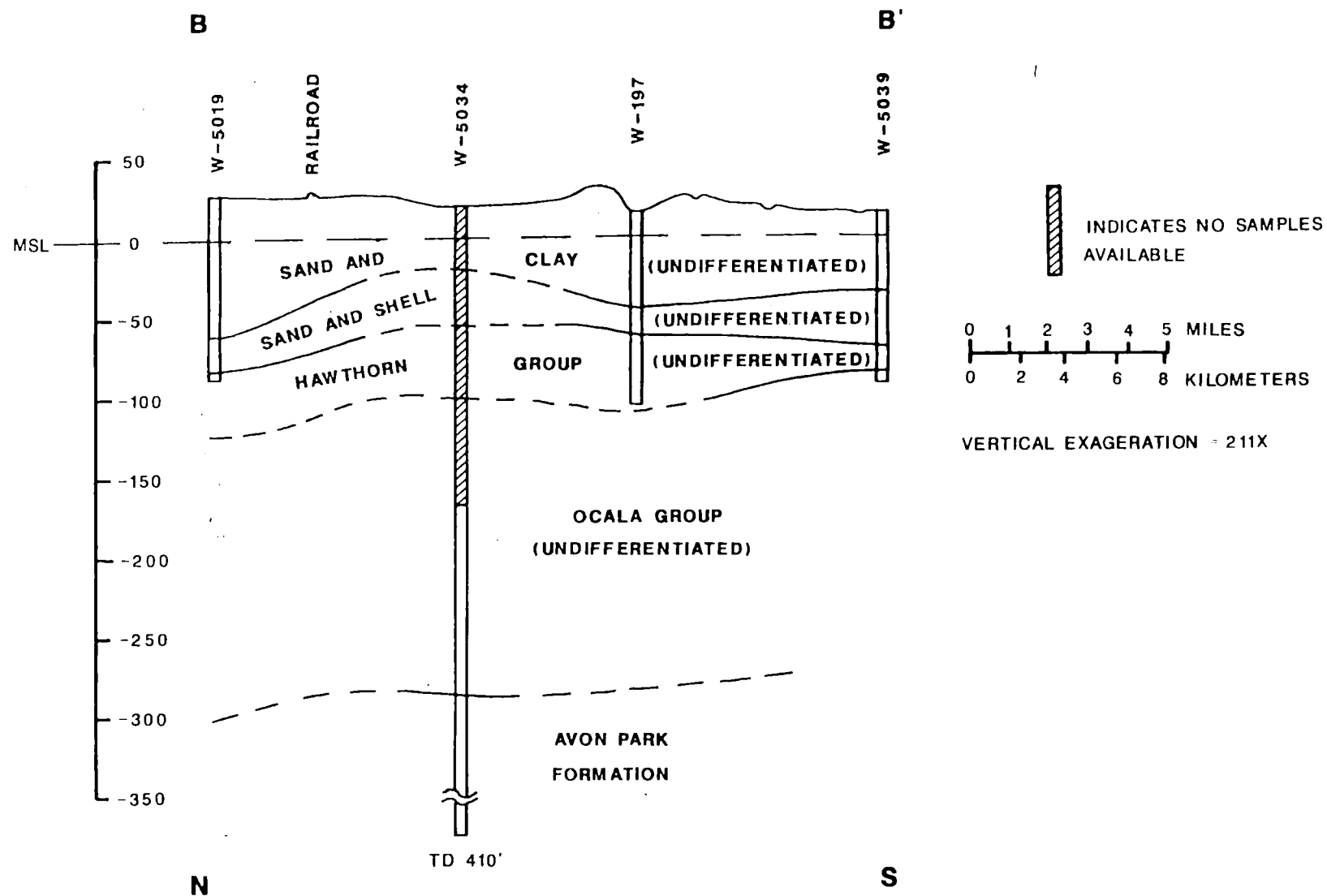


FIGURE 3. GEOLOGIC CROSS-SECTION B - B'

FGS 020988

EOCENE SERIES

Avon Park Formation

The Avon Park Formation (Miller, 1986) in this region contains a variable lithology, both vertically and laterally. In general, it consists of a dense, reddish brown to buff, organic-rich, seamed limestone and brown to gray, crystalline dolomitic limestone near the base, grading upward to an interbedded gray to white chalky limestone and hard, crystalline dolomite near the top (Bermes et al., 1963). Some of these limestone beds contain abundant foraminifera and echinoids. The top of the Avon Park Formation is found at depths ranging from 205 feet to 370 feet below MSL. This formation is a component of the Floridan aquifer system.

Ocala Group

The Ocala Group (Puri, 1957) consists of three formations. In ascending order, these are the Inglis Formation, the Williston Formation and the Crystal River Formation. Lithology of the Ocala Group generally consists of tan to buff, coarsely granular limestone of the Inglis Formation at the base, becoming more indurated within the Williston Formation and white to cream, chalky massive marine limestone in the Crystal River Formation. The fossil content of these formations includes a variety of foraminifera, bryozoans, mollusks and echinoids. Delineation of the Ocala Group into formations was based upon these fossils, as

well as lithology. Ocala Group sediments range from 50 feet thick in southern Flagler County (Bermes et al., 1963) to approximately 200 feet thick in northwest Flagler County. Depth to the top of the Ocala Group averages 100 feet below MSL. Also a component of the Floridan aquifer system, the Ocala Group is the principle source of water in the area (Bermes et al., 1963).

MIOCENE SERIES

Hawthorn Group

The Hawthorn Group (Scott, 1988) unconformably overlies the Ocala Group beneath Flagler County. Three formations are recognized within the Hawthorn Group in northern Florida. In ascending order, these are the Penney Farms Formation, an interbedded phosphatic sand, clay and carbonate; the Marks Head Formation, a complexly interbedded phosphatic clay, sand and carbonate; and the Coosawatchee Formation, which consists of green to tan phosphatic quartz sand with variable amounts of clay and dolomite. These formations have been described separately in one core (W-15282) located in northeastern Flagler County. Lithologic descriptions of this well show 9 feet of the Penney Farms Formation overlain by 33 feet of the Coosawatchee Formation with an absence of the Marks Head Formation (T. Scott in Johnson, 1986). The Hawthorn Group averages approximately 35 feet in thickness and thins toward the south and east portions of Flagler County. Depth to the top of the Hawthorn Group sediments ranges from 60 to 80 feet below MSL. The clayey Hawthorn Group

sediments serve as confining beds for the Floridan aquifer system. Small sand bodies within the Hawthorn are a component of a near surface aquifer in the area (Bermes et al., 1963).

PLIOCENE TO HOLOCENE SERIES (UNDIFFERENTIATED)

In the subsurface of coastal northeast Florida, Pliocene and Pleistocene formations have been delineated on a regional basis, however, within Flagler County, these sands, shells and clays at or near the surface have not been assigned to specific formations. Therefore, these surficial and coastal lithologies are termed Pliocene to Holocene (undifferentiated) sediments.

The Pliocene component of this undifferentiated package is the Nashua Formation. This formation represents a near shore marine depositional environment and was named by Matson and Clapp (1909). The Nashua Formation consists of a quartz sand with variable amounts of clay and carbonate matrix and common mollusk shells.

The remaining overlying sands, shells and clays are either part of the Pleistocene Anastasia Formation or are categorized as Pleistocene to Holocene undifferentiated deposits. Variably cemented shell beds (coquina) as well as unconsolidated sands and shells comprise the Anastasia Formation (Sellards, 1912), which is found only near the coast in Flagler County. Shell-bearing lithologies vary from over 100 feet thick near the coast, thinning to zero thickness towards western Flagler County

(Florida Geological Survey well file data). The total Pliocene to Holocene deposits range from 50 to 140 feet thick in the area.

MINERAL RESOURCES

The mineral resources of Flagler County include sand, clay and coquina. The following discussion provides an overview of the occurrence and commercial use of these resources.

Sand

Sand accumulations cover approximately three quarters of Flagler County. Maximum sand thickness occurs in the northwest part of the county, reaching depths of 140 feet. The sand ranges in grain size from medium sand to silt and commonly contains small shell fragments and localized clay lenses. Recent tests by the Florida Geological Survey (Hoenstine et al., 1988) indicate that the sands are suitable for brick masonry, sand-cement riprap, sand-asphalt hot mix and sand seal coat. Due to a large percentage of impurities, the sands are probably not suitable for manufacturing glass. Although economic heavy mineral deposits occur in north-central and northeast Florida, no public information exists regarding the abundance or distribution of heavy minerals in Flagler County sand bodies.

Clay

Few relatively pure clay deposits occur near the surface in Flagler County. Most of the clay is found as a clayey-sand lithology. Calver (1949) reports pure clay deposits are located near Black Point and Haw Creek. He states that the clays are suitable for manufacturing common brick, hollow block and drain tile. Bell (1924) reports an eight foot thick unit of clay, at a depth of three feet in the vicinity of Shell Bluff which borders Crescent Lake. This clay is thought to underlie an extensive portion of western Flagler County. Physical properties suggest that the Shell Bluff clay may also be used for brick, tile and hollow block ware (Bell, 1924). Bell (1924) also reports clay beds exposed near St. Johns Park, located on the north shore of Dead Lake.

Coquina

Coquina is a clastic sedimentary rock composed of shells and shell fragments cemented by calcium carbonate. The source of coquina in Flagler County is the Anastasia Formation. Cooke (1945) reports two coquina pits exposed on either side of the brick road to Bunnell, 2.6 miles west of Flagler Beach. The brick road is now known as Highway 100 and the pits are currently in operation. Well cemented coquina is suitable for building material. Less consolidated varieties are useful as concrete mix and road surfacing material.

HYDROGEOLOGY

Groundwater is defined as the water in the saturated zone within the subsurface where water is free to move within the interstices of the rocks and sediment under the influence of gravity or pressure. A physical characteristic of rocks and sediment which defines their ability to transmit water (or other fluids) is known as permeability. The degree of permeability generally depends on the size, shape and extent of pore spaces and their interconnections. For example, clay has low permeability whereas sand has high permeability.

Regional hydrogeologic units in Florida have been established on the basis of varying permeabilities within stratigraphic units (Southeastern Geological Society, 1986). Pertinent to Flagler County, the hydrogeologic units include the surficial aquifer system, the intermediate aquifer system and the Floridan aquifer system.

The surficial aquifer system in Flagler County contains permeable sands and shells ranging from Pliocene to Holocene in age. This aquifer system is non-artesian (non-flowing) and is primarily replenished by local rainfall. The extensive wetlands in northern Flagler County are probably not the result of impermeable beds impeding the infiltration of rain but rather a result of the surficial aquifer system being filled to capacity (Bermes et al., 1963). The surficial aquifer system reaches depths of 100 feet below MSL.

The intermediate aquifer system occurs primarily within the

Hawthorn Group sediments. Impermeable clay-rich lithologies of the Hawthorn Group serve as confining layers within this system. However, localized permeable sand and limestone lenses within the Hawthorn yield moderate amounts of artesian (flowing) water to some domestic wells in the county (Bermes et al., 1963). In Flagler County, thickness of the intermediate aquifer system, which in some cases may be more appropriately termed the intermediate confining unit, ranges from approximately five to 80 feet. Upper impermeable portions of the intermediate system serve as the base of the surficial aquifer system. The Floridan aquifer system is capped by the impermeable sediments of the lower Hawthorn. Permeable portions of the Hawthorn Group, such as basal carbonates, may be an upper component of the Floridan.

The Floridan aquifer system in Flagler County is the major source of water for irrigation, public supply and industry. In general, Eocene limestones and dolomites of the Avon Park Formation and the Ocala Group comprise a majority of this aquifer. Depth to the Floridan aquifer system in the area ranges from 75 to 190 feet below MSL. Recharge to the system occurs where the Hawthorn Group is thin enough (or absent) to allow downward leakage from the intermediate and primarily the surficial aquifer system as pressure conditions allow.

REFERENCES

- Bell, O. G., 1924, A preliminary report on clays of Florida: Florida Geological Survey Fifteenth Annual Report, 266 p.
- Barnett, R. S., 1975, Basement structure of Florida and its tectonic implications: Gulf Coast Association of Geological Societies Transactions, v.25, p. 122-142.
- Bermes, B. J., 1963, Geology and ground-water resources of Flagler, Putnam, and St. Johns Counties, Florida: Florida Geological Survey Report of Investigation 32, 97 p.
- Calver, J. L., 1949, Florida kaolins and clays: Florida Geological Survey Information Circular 2, 59 p.
- Cooke, C. W., 1945, Geology of Florida: Florida Geological Survey Bulletin 29, 339 p.
- Hoenstine, R., Yon, B., Lane, E., Spencer, S. and Bond, P., 1988, Mineral Resources of Flagler County: Florida Geological Survey (in preparation).
- Johnson, R., 1986, Shallow stratigraphic core tests on file at the Florida Geological Survey: Florida Geological Survey Information Circular 103, 431 p.
- Matson, G. C. and Clapp, F. G., 1909, Florida Geological Survey Second Annual Report, 299 p.
- Miller, J. A., 1986, Hydrogeologic framework of the Floridan aquifer system in Florida and parts of Georgia, Alabama and South Carolina: U.S. Geological Survey Professional Paper 1403-B, p. 25-27.
- Puri, H. S., 1957, Stratigraphy and zonation of the Ocala Group: Florida Geological Survey Bulletin 38, 248 p.

- Scott, T. M., 1988, The lithostratigraphy of the Hawthorn Group (Miocene) of Florida: Florida Geological Survey Bulletin 59, 148 p.
- Sellards, E. H., 1912, Florida Geological Survey Fourth Annual Report, 175 p.
- Southeastern Geological Society Ad Hoc Committee on Florida hydrostratigraphic unit definition, 1986, Hydrogeologic units of Florida, Florida Geological Survey Special Publication 28, 9 p.
- Stringfield, V. T., 1966, Artesian water in Tertiary limestone in the southeastern United States: U. S. Geological Survey Professional Paper 517, 226 p.
- White, W. A., 1970, Geomorphology of the Florida Peninsula: Florida Geological Survey Bulletin 51, 164 p.

3938000014805+



FLORIDA GEOLOGICAL SURVEY