

GEOLOGY AND WASTE DISPOSAL IN FLORIDA

BY PAULETTE BOND

PRINCIPAL AQUIFERS

Introduction

A large part of Florida's potable water comes from subsurface rock units called aquifers. Aquifers are rock layers which are both porous (that is they contain void spaces) and permeable (the void spaces are interconnected so that water can actually move through the rock). In most parts of Florida, there are several aquifers, usually stacked at different depths or adjacent to each other. The aquifer which serves as the major source of water in an area is its principal aquifer.

Florida Aquifer System

The Florida aquifer system (Southeastern Geological Society, 1986) is a thick sequence of limestone. It includes the Lake City Limestone, Ocala Group, and Suwannee Limestone. The Ocala Group, the Ocala aquifer, and Suwannee Limestone, the Tampa Formation and gemstone layers within the Hawthorn Formation (Vernon and Puri, 1964). The Suwannee Limestone, Scott, in prep.) of Miocene age. This aquifer underlies all of Florida although it is highly irregularly (especially brackish to saline water) along Gulf and Atlantic coastal areas (Hyde, 1976).

In some areas the Florida aquifer system lies at or near the surface of the ground. In other regions it may occur as much as 1000 feet below the ground surface (Stewart, 1980). When the rocks of the Florida aquifer system are buried, they are covered by a variable sequence of sediments and sedimentary rocks including sand, clay, marl, and limestone. The thickness, lithology and permeability of these covering materials affect both the quality and quantity of the water that reaches the Florida aquifer system to recharge it. The relatively impermeable materials that often lie above the Florida aquifer system generally result in its being an artesian aquifer.

Biscayne Aquifer

The Biscayne aquifer underlies parts of Dade, Broward, and southern Palm Beach counties. Unlike the Florida, the Biscayne is not covered by a confining layer of shale and within it is not under artesian pressure. The aquifer is wedge-shaped, in that it is thickest (100-400 feet) near the coast and thins to several feet near the western boundaries of Dade and Broward counties (Hyde, 1976).

The rocks which make up the Biscayne aquifer include the Tamihi Limestone of Pliocene age, the Caloosahatchee Marl of Pliocene age and the Fort Thomas Sand of Pleistocene age (Hyde, 1976).

The Sand and Gravel Aquifer

The sand and gravel aquifer is the main source of groundwater for the entire western panhandle of Florida. It is not an artesian aquifer (although artesian conditions may exist locally) and is recharged mainly by local rainfall. The sand and gravel aquifer is located to the west and southwest and its sediments range in age from Late Miocene through Pleistocene. The sediments range from fine to very coarse quartz sand which is sometimes mixed with gravels and small pebbles of quartz and chert. The aquifer is characterized by lenses and stringers of clay and gravel (Hyde, 1976).

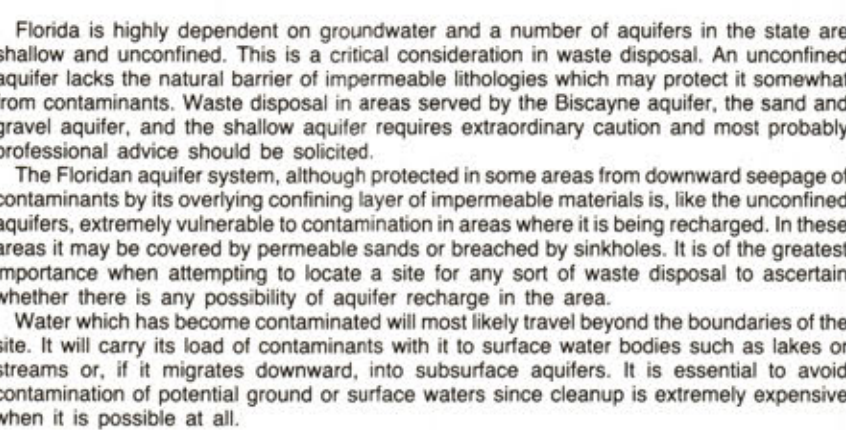
Shallow Aquifer

The shallow aquifer is characterized by the presence of a shallow non-artesian aquifer. It is most only in areas where it is an important source of water supply. Counties which may heavily on the shallow aquifer include Marion, Palm Beach, Hendry, Lee, Collier, Indian River, St. Lucie, Glades and Charlotte (Hyde, 1976).

The shallow aquifer is recharged by rainfall. Hyde (1976) reports that in southern Florida the aquifer ranges in age from Miocene to Recent and is characterized by lenses of quartz sand, the shelly sand beds of the Anadara Formation, the shelly limestone of the Tamihi Formation and the limestones of the Fort Hawthorn Formation.

AQUIFERS AND WASTE DISPOSAL

The distribution of aquifers, both laterally and vertically, is perhaps the foremost consideration in waste disposal. Waste must be isolated from water which may reach contaminants from waste and transport them to unsuitable locations such as laterally adjacent aquifers. In general, it is advantageous to protect water from contamination since its final destination and use may not be immediately obvious.



Florida is highly dependent on groundwater and a number of aquifers in the state are shallow and unconfined. This is a critical consideration in waste disposal. An unconfined aquifer lacks the natural barrier of impermeable lithologies which may protect it somewhat from contamination. Waste disposal in areas served by the Biscayne aquifer, the sand and gravel aquifer, and the shallow aquifer requires extraordinary caution and most probably professional advice should be sought.

The Florida aquifer system, although protected in some areas from downward seepage of contaminants by its overlying confining layer of impermeable materials, is, like the unconfined aquifer, extremely vulnerable to contamination in areas where it is being recharged. In these areas it may be covered by permeable sands or brackish by artesian. It is of the greatest importance when attempting to locate a site for any sort of waste disposal to ascertain whether there is any possibility of aquifer recharge in the area.

Water which has become contaminated will most likely travel beyond the boundaries of the area. It will carry to itself contaminants which it is surface water bodies such as lakes or streams or, if it migrates downward, into subsurface aquifers. It is essential to avoid contamination of potential ground or surface waters since cleanup is extremely expensive when it is possible at all.

References

Hyde, L.W., 1965, Revised 1976, Principal aquifers in Florida, Florida Department of Natural Resources, Bureau of Geology, Map Series No. 16.

Scott, T.M., 1976, The lithostratigraphy of the Hawthorn Group (Miocene) of Florida, in preparation, Southeastern Geological Society, Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986, Hydrogeological units of Florida, Florida Department of Natural Resources, Bureau of Geology, Special Publication No. 35.

Stewart, J.W., 1980, Areas of natural recharge to the Florida aquifer in Florida, Florida Department of Natural Resources, Bureau of Geology, Map Series No. 98.

Vernon, R.O. and Puri, H.S., 1964, Geologic map of Florida, Florida Board of Conservation, Division of Geology, Map Series No. 18.

RECHARGE TO THE FLORIDIAN AQUIFER

Areas of Generally No Recharge

These areas are designated based on areas in which artesian flow occurs and were originally mapped by Healy (1975). In areas of artesian flow, the water in the aquifer will flow up and out naturally if a well is drilled. Under these conditions (natural discharge) significant recharge is not occurring. Concentrated pumping may locally depress the potentiometric surface of the Florida aquifer system allowing limited recharge in the area (Stewart, 1980).

Areas of Known Very Low Recharge

These areas were mapped based on the characteristics of confining beds covering the Florida aquifer system. Areas of known very low recharge are areas where relatively impermeable confining beds are usually more than 25 feet thick and continuous. This is connected across the confining beds between shallow rocks and the Florida aquifer system and not known to exist (Stewart, 1980).

Areas of Very Low to Moderate Recharge

The mapping of these areas is based on a variety of conditions which relate to the degree of recharge to the Florida aquifer system. The thickness and extent of the confining layer are primary factors. Areas where the confining layer is sufficiently thick and extensive to significantly restrict movement of water into the Florida aquifer are included in this category. Areas which lack the confining layer, but are characterized by the water table and the potentiometric surface of the Florida aquifer occurring near the surface are mapped in this category. Moderate recharge occurs where confining beds are locally thin or breached and where the water table occurs significantly higher than the potentiometric surface of the Florida aquifer system (Stewart, 1980).

Areas of High Recharge

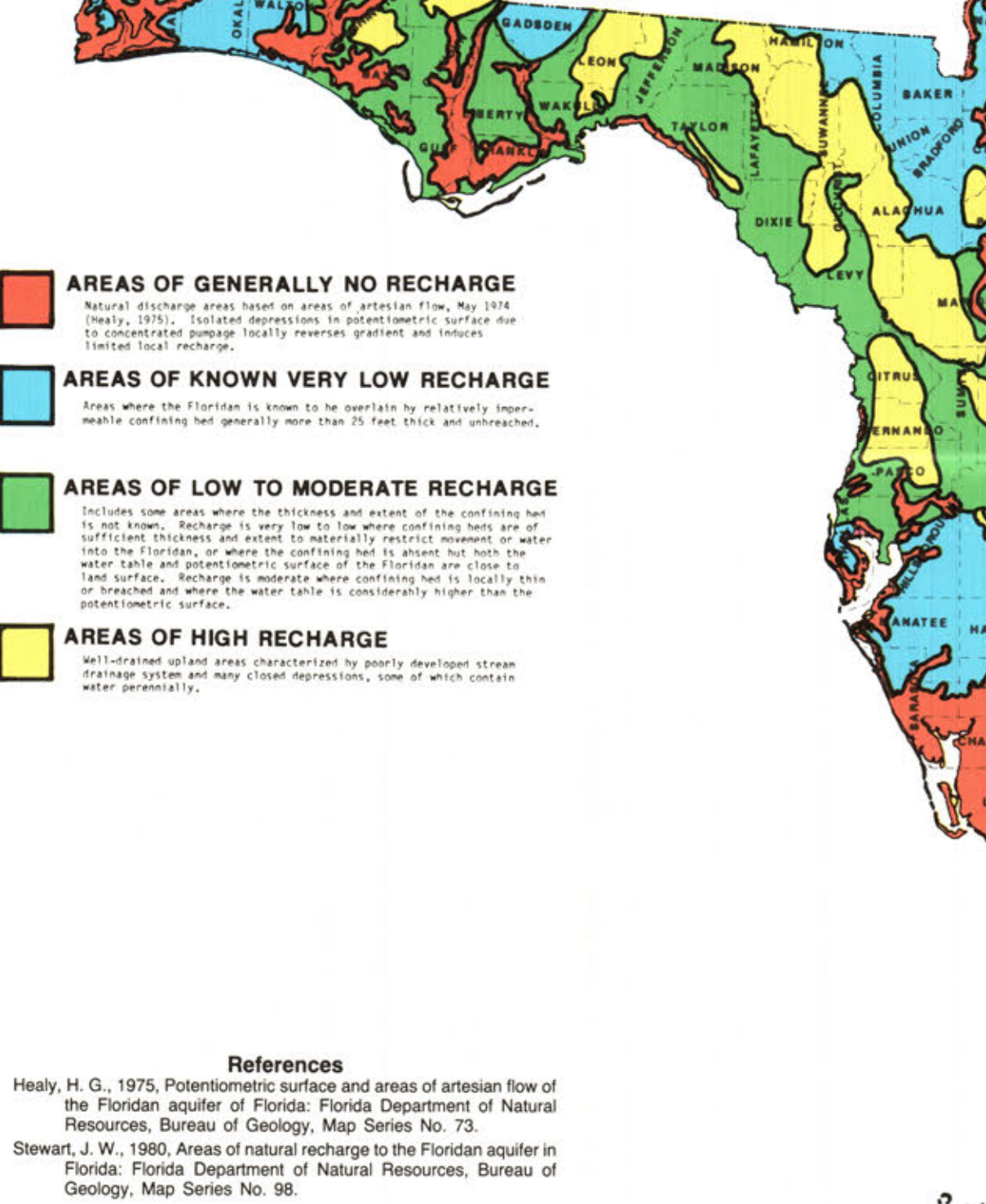
These areas are generally well-drained uplands, with poorly developed stream drainage systems and many closed depressions (i.e., sinkholes) some of which may contain water perennially (Stewart, 1980).

The Significance of Natural Recharge Areas in the Location of Waste Disposal Sites

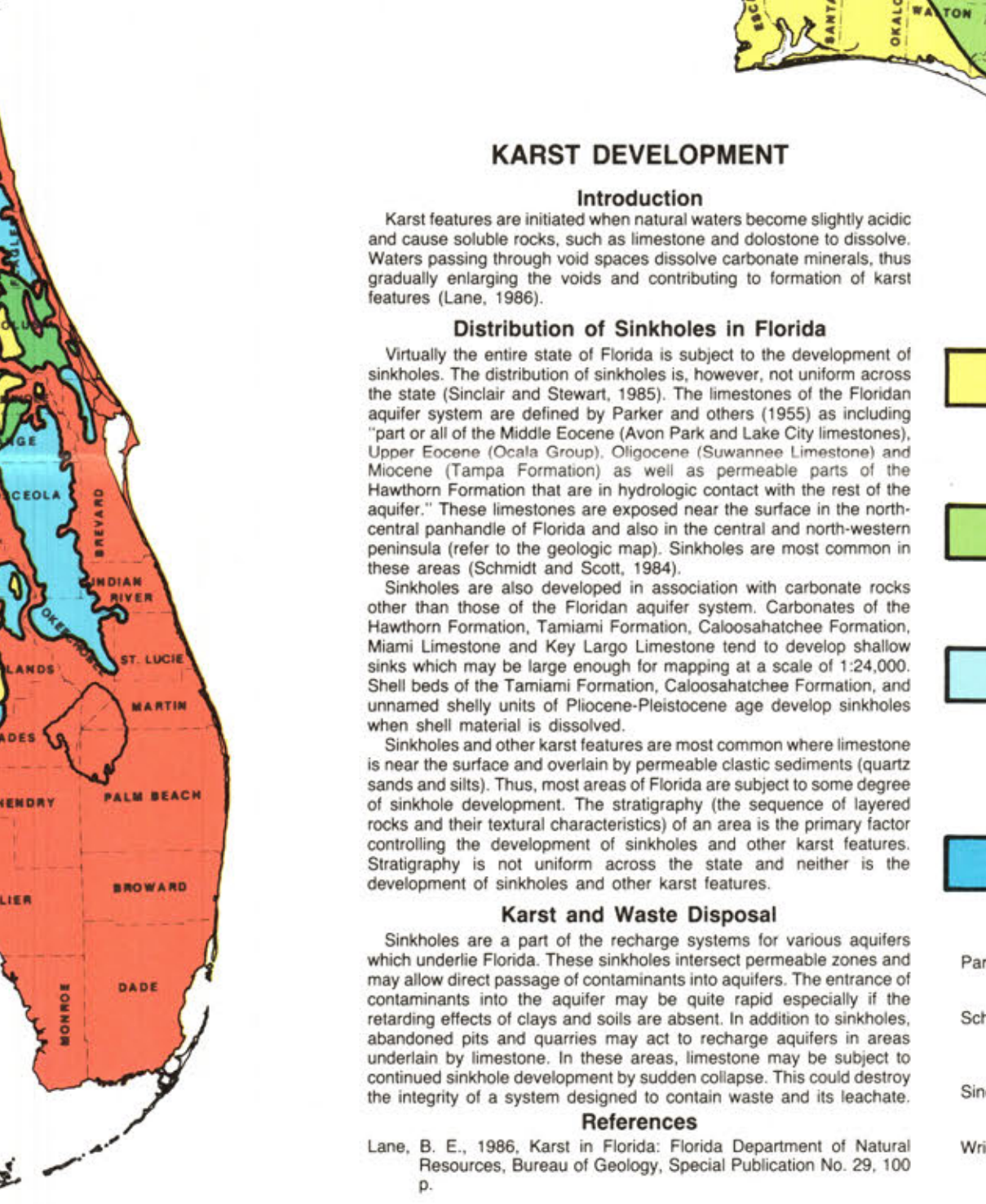
If a map of principal aquifers is compared with the map showing principal recharge areas it can be noted that the Florida aquifer system is being actively recharged in many areas where it is the principal source of potable water. Since "recharge" indicates that water from the surface is entering the aquifer it is obvious that the replenishing water should be protected from contamination in so far as is possible. Thus, placement of waste with respect to recharge areas is critical if water quality is to be preserved.

Additionally, it should be noted that recharge to the Florida aquifer system is only one of several interrelated parameters which must be considered in locating waste disposal sites. Many of the areas characterized by minimal recharge to the Florida aquifer system are grossly unsuitable for waste disposal based on other proximity to the Florida aquifer system. The Florida aquifer system is included in these areas are defined also results in major wetlands (e.g., the Everglades National Park, 1961). Lesser amounts of shelly sand and clay occur to the west of Lake Okechobee and in some coastal areas.

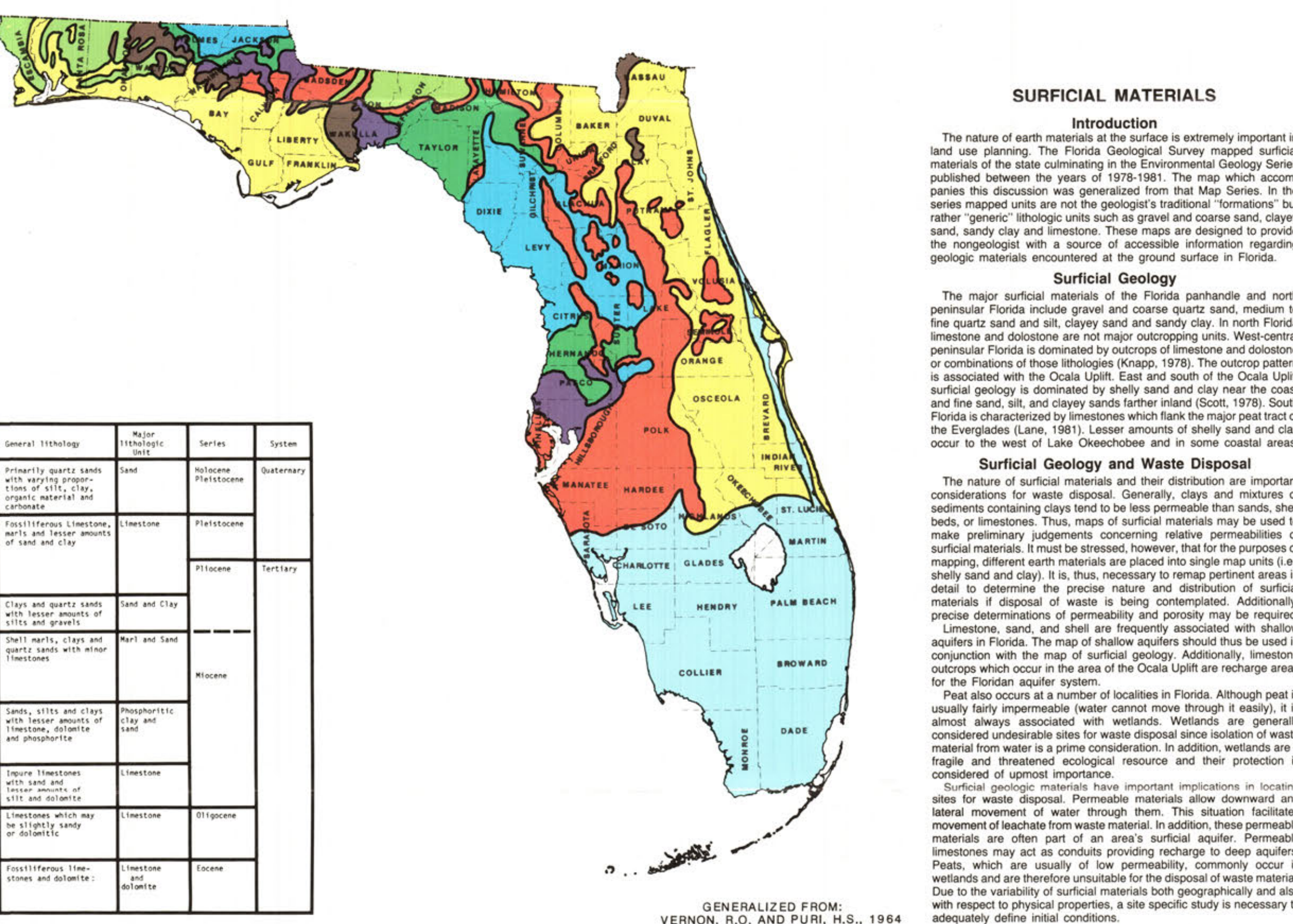
This map shows the state of Florida divided into areas based on the degree of natural recharge to the Florida aquifer system. This map has been generated. This map is intended to replace a site specific assessment.



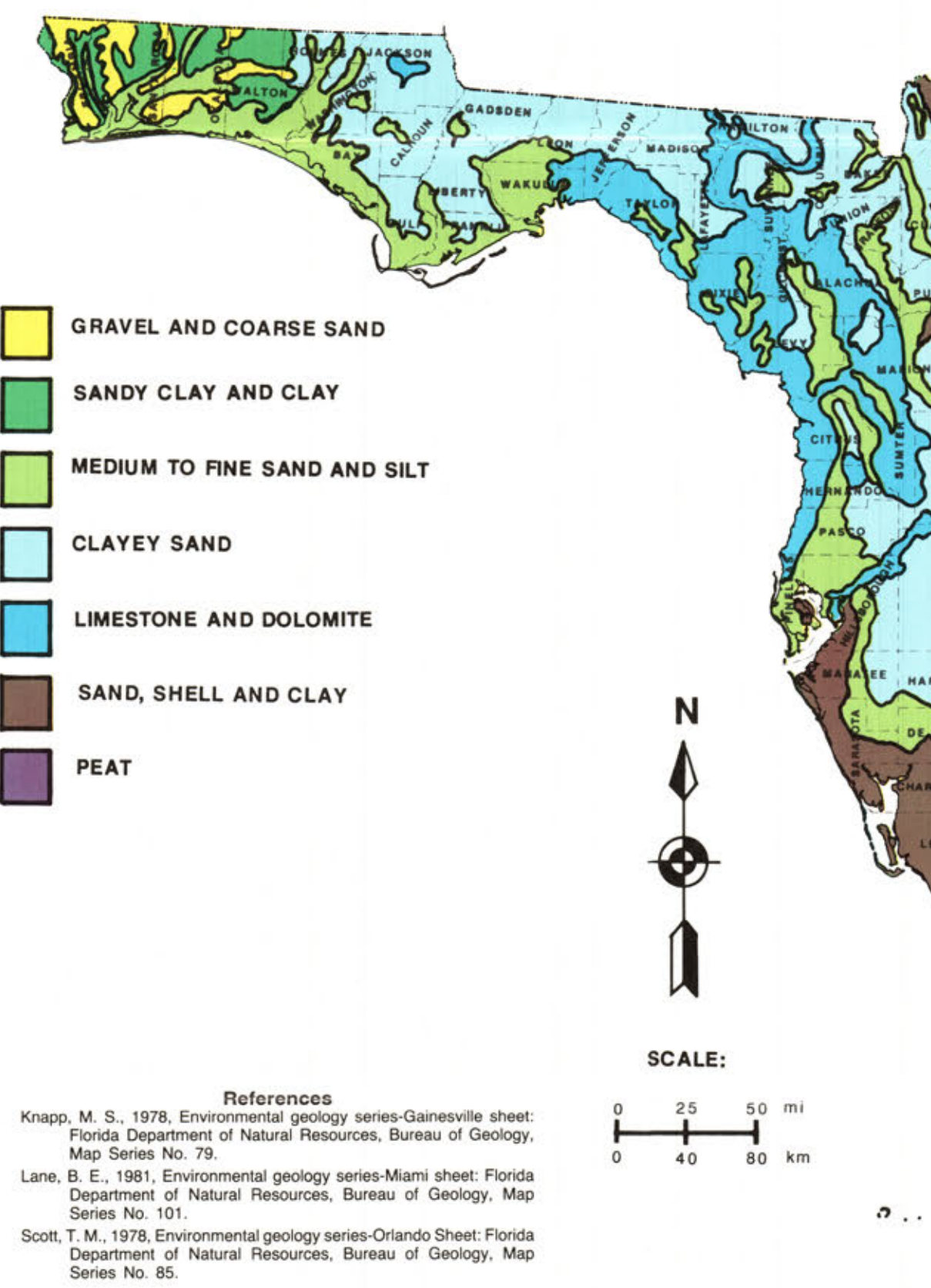
GENERALIZED FROM: HEALY, H.G., 1975, RECHARGE TO THE FLORIDIAN AQUIFER, Florida Department of Natural Resources, Bureau of Geology, Map Series No. 98.



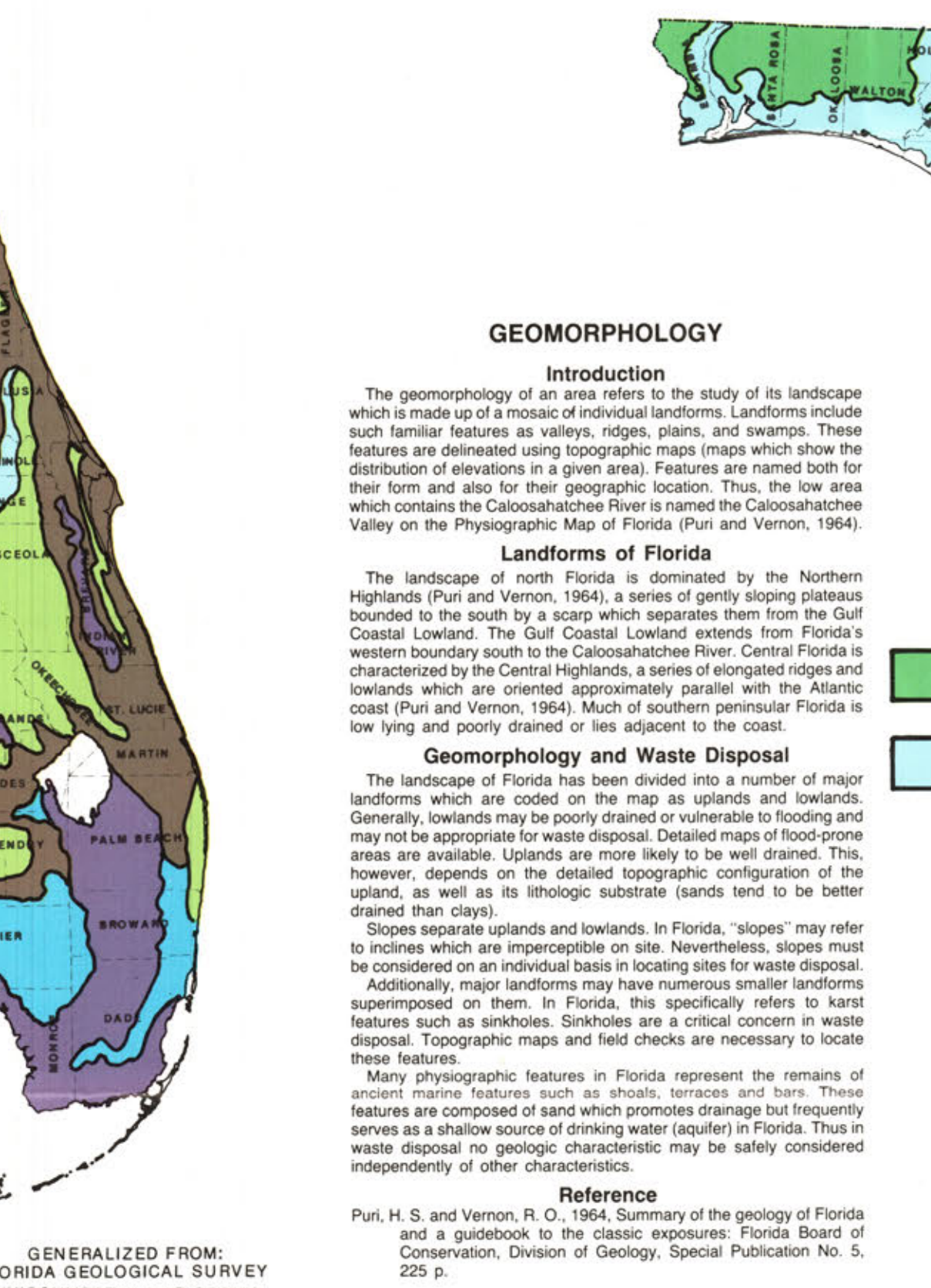
GENERALIZED FROM: STEWART, J., 1980



GENERALIZED FROM: VERNON, R.O. and PURI, H.S., 1964



GENERALIZED FROM: PURI, H.S. and VERNON, R., 1964



GENERALIZED FROM: PATRICK, P. and SETHEN, D., 1976 and RADBRUNN-HALL, D., ET AL., 1976

BEDROCK GEOLOGY OF FLORIDA

Introduction

The geologic map of Florida shows the distribution of rocks at ground surface. Rocks are divided into formations, based on their lithologic properties, and the spatial extent of these formations can be mapped. The legend of the map shows formations arranged in order of their age with older rocks at the bottom. Age relations of the formations are indicated by the distribution of a very powerful aid in understanding the geology of an area. Due to the scale of the map used here, some individual geologic formations are combined based on age relations and lithology. These combinations are shown in the table which accompanies this map.

Geologic Trends

The Florida panhandle is dominated by outcrops of rock which reflect the influence of the Chattahoochee Anticline. Rocks of Eocene and Oligocene age are fairly distinct. The limestone are flanked by formations which consist mainly of clastic sediments including quartz sand, clay, silt and various combinations of these lithologic materials. The clastic sediments range in age from Miocene through Pliocene-Pleistocene (Clark and Schmidt, 1983). Rocks of the panhandle are locally blanketed by fluvial and marine terrace sands of Pleistocene age (Vernon and Puri, 1964).

The outcrop pattern of northern and central peninsular Florida is characterized by the structural influence of the Ocala Uplift (Puri and Vernon, 1964). Eocene limestones are the oldest rocks exposed in this area of Florida and they are flanked to the north and south by outcrops of Oligocene limestones. These older limestones are highly eroded and contain clastic sediments and sedimentary rocks of Miocene age. Miocene age sediments include sand, silt and clay with lesser amounts of limestone and dolomite. Locally, they contain continental phosphate deposits. To the east, marine quartz sands of Pleistocene age overlie the rocks of the northern and central peninsular Florida (Vernon and Puri, 1964).

The near-surface geology of south Florida is dominated by various types of limestone with varying degrees of metamorphism. The limestone is generally composed of limestone and dolomite. The Miami Limestone (consisting of an oolitic facies and a brecciated facies) and the Key Largo Limestone (a reefal limestone) are prominent. The Fort Thomas Sand (consisting of a shelly limestone and a calcareous sandstone) is also prominent. The Tamihi Formation (consisting of a shelly limestone and a calcareous sandstone) is also prominent. The Tamihi Formation (consisting of a shelly limestone and a calcareous sandstone) is also prominent.

Bedrock Geology and Waste Disposal

The main consideration in the disposal of waste materials is that the waste be isolated from ground and surface waters. The lithologic properties of permeability and porosity directly affect the movement of water through rocks. Porosity refers to the amount of void space in a rock and permeability to the extent to which the voids are interconnected. Sands, limestones and dolomites are frequently porous and permeable. Clays are generally considered to be of low permeability and tend to retard the movement of water while more permeable sand, limestone and dolomite tend to facilitate water movement. The map of bedrock geology provides a "first approximation" of lithologic properties pertinent to waste disposal in the ground.

References

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Puri, H. S. and Vernon, R. O., 1964, Summary of the geology of Florida and a guidebook to the classic exposures, Florida Board of Conservation, Division of Geology, Special Publication No. 5, 225 p.

Vernon, R. O. and Puri, H. S., 1964, Geologic map of Florida, Florida Board of Conservation, Division of Geology, Map Series No. 18.

Stratigraphic Unit	General Lithology	Major Lithologic Unit	Series	System
Surficial sands and silts, locally underlain by sandstone and calcarenite	Primarily quartz sands with minor amounts of calcarenite, organic material and calcarenite	Sands and silts	Micocene	Quaternary
Lower Pleistocene	Fluviatile sandstone, silty sandstone, silty clay and clay	Fluviatile sandstone	Fluviatile	Tertiary
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