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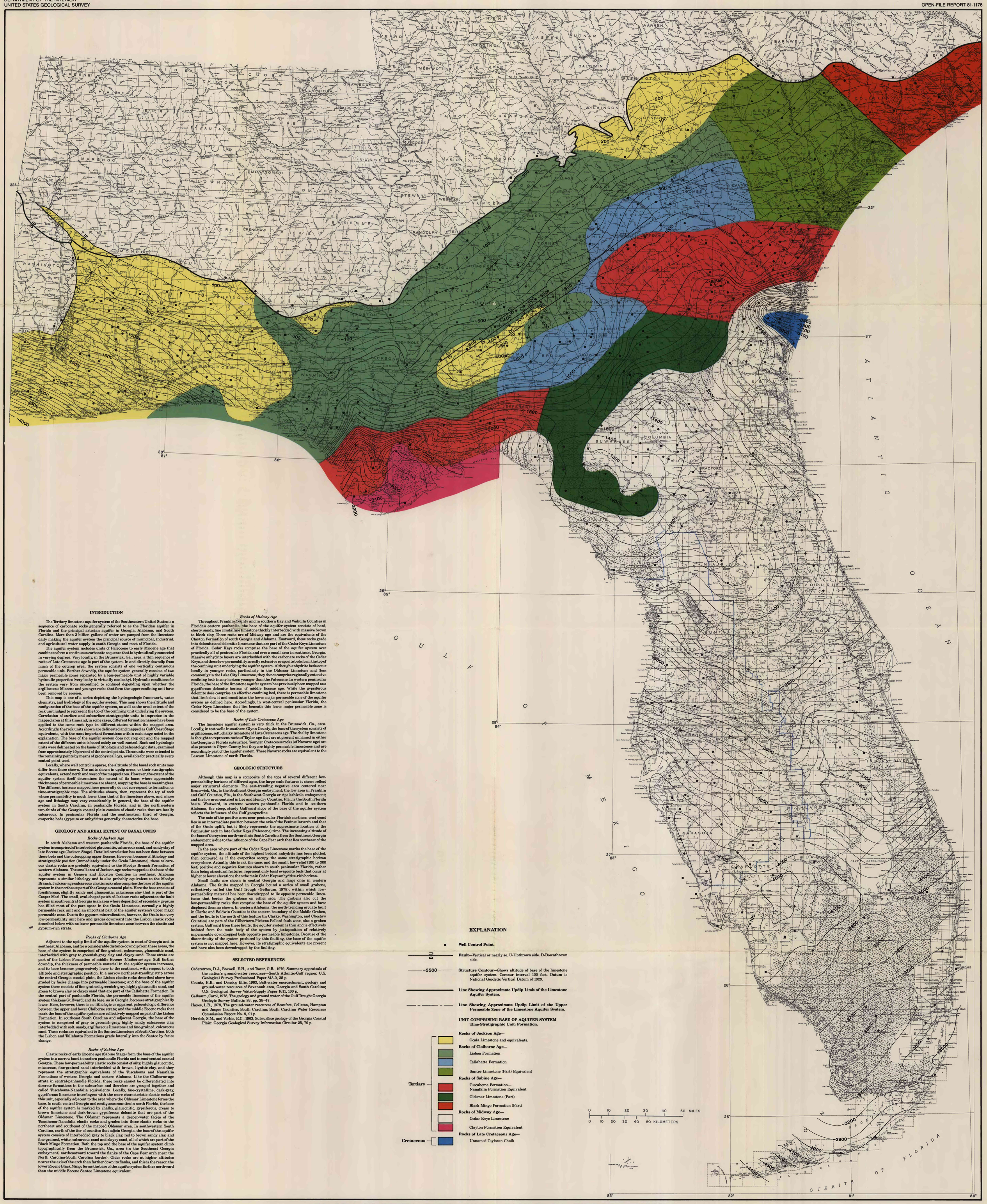

INTRODUCTION

The Tertiary limestone aquifer system of the Southeastern United States is a sequence of carbonate rocks generally referred to as the Floridan aquifer in Florida and the principal artesian aquifer in Georgia, Alabama, and South Carolina. More than 3 billion gallons of water are pumped from the limestone daily making the aquifer system the principal source of municipal, industrial, and agricultural water supply in south Georgia and most of Florida.

The aquifer system includes units of Paleocene to early Miocene age that combine to form a continuous carbonate sequence that is hydraulically connected in varying degrees. Very locally, in the Brunswick, Ga., area, a thin sequence of rocks of Late Cretaceous age is part of the system. In and directly downdip from much of the outcrop area, the system consists of one vertically continuous permeable unit. Farther downdip, the aquifer system generally consists of two major permeable zones separated by a less-permeable unit of highly variable hydraulic properties (very leaky to virtually nonleaky). Hydraulic conditions for the system vary from unconfined to confined depending upon whether the argillaceous Miocene and younger rocks that form the upper confining unit have been removed by erosion.

This map is one of a series depicting the hydrogeologic framework, water chemistry, and hydrology of the aquifer system. This map shows the altitude and configuration of the base of the aquifer system, as well as the areal extent of the rock unit judged to represent the top of the confining unit underlying the system. Correlation of surface and subsurface stratigraphic units is imprecise in the mapped area at this time and, in some cases, different formation names have been applied to the same rock type in different states within the mapped area. Accordingly, the rock units shown are delineated and mapped as Gulf Coast Stage equivalents, with the most important formations within each stage noted in the explanation. The base of the aquifer system does not crop out and the mapped extent of the different units is based solely on well control. Rock and hydrologic units were delineated on the basis of lithologic and paleontologic data, examined from approximately 40 percent of the control points. These units were extended to the remaining points by means of geophysical logs, available for practically every control point used.

Locally, where well control is sparse, the altitude of the basal rock units may differ from those shown. The units shown in updip areas, or their stratigraphic equivalents, extend north and west of the mapped area. However, the extent of the aquifer system itself determines the extent of its base; where appreciable thicknesses of permeable limestone are absent, mapping the base is meaningless. The different horizons mapped here generally do not correspond to formation or time-stratigraphic tops. The altitudes shown, then, represent the top of rock whose permeability is much lower than that of the limestone above, and whose age and lithology may vary considerably. In general, the base of the aquifer system in South Carolina, in panhandle Florida, and in the northwestern two-thirds of the Georgia coastal plain consists of clastic rocks that are locally calcareous. In peninsular Florida and the southeastern third of Georgia, evaporite beds (gypsum or anhydrite) generally characterize the base.

GEOLOGY AND AREAL EXTENT OF BASAL UNITS

Rocks of Jackson Age

In south Alabama and western panhandle Florida, the base of the aquifer system is comprised of interbedded glauconitic, calcareous sand, and sandy clay of late Eocene age (Jackson Stage). Detailed correlation has not been done between these beds and the outcropping upper Eocene. However, because of lithology and stratigraphic position (immediately under the Ocala Limestone), these calcareous clastic rocks are probably equivalent to the Moodys Branch Formation of western Alabama. The small area of Jackson-age rocks mapped as the base of the aquifer system in Geneva and Houston Counties in southeast Alabama represents a similar lithology and is also probably equivalent to the Moodys Branch. Jackson-age calcareous clastic rocks also comprise the base of the aquifer system in the northeast part of the Georgia coastal plain. Here the base consists of fossiliferous, slightly sandy and glauconitic, calcareous clay that is part of the Cooper Marl. The small, oval-shaped patch of Jackson rocks adjacent to the fault system in south-central Georgia is an area where deposition of secondary gypsum has filled most of the pore space in the Ocala Limestone, normally a highly permeable rock unit and an important part of the aquifer system's upper major permeable zone. Due to the gypsum mineralization, however, the Ocala is a very low-permeability unit here and grades downward into the Lisbon clastic rocks described below with no lower permeable limestone zone between the clastic and gypsum-rich strata.

Rocks of Claiborne Age

Adjacent to the updip limit of the aquifer system in most of Georgia and in southeast Alabama, and for a considerable distance downdip from these areas, the base of the system is comprised of fine-grained, calcareous, glauconitic sand, interbedded with gray to greenish-gray clay and clayey sand. These strata are part of the Lisbon Formation of middle Eocene (Claiborne) age. Still farther downdip, the thickness of permeable material in the aquifer system increases, and its base becomes progressively lower to the southeast, with respect to both altitude and stratigraphic position. In a narrow northeast-trending strip across the central Georgia coastal plain, the Lisbon clastic rocks described above have graded by facies change into permeable limestone; and the base of the aquifer system there consists of fine-grained, greenish-gray, highly glauconitic sand, and green to brown clay or clayey sand that are part of the Tallahatta Formation. In the central part of panhandle Florida, the permeable limestone of the aquifer system thickens Gulfward; and its base, as in Georgia, becomes stratigraphically lower. Here, however, there is no lithologic or apparent paleontologic difference between the upper and lower Claiborne strata; and the middle Eocene rocks that mark the base of the aquifer system are collectively mapped as part of the Lisbon Formation. In southeast South Carolina and adjacent Georgia, the base of the system is comprised of gray to greenish-gray, highly sandy, calcareous clay, interbedded with soft, sandy, argillaceous limestone and fine-grained, calcareous sand. These rocks are equivalent to the Santee Limestone of South Carolina. Both the Lisbon and Tallahatta Formations grade laterally into the Santee by facies change.

Rocks of Sabine Age

Clastic rocks of early Eocene age (Sabine Stage) form the base of the aquifer system in a narrow band in eastern panhandle Florida and in east-central coastal Georgia. These low-permeability clastic rocks consist of silty, highly glauconitic, micaceous, fine-grained sand interbedded with brown, lignitic clay, and they represent the stratigraphic equivalents of the Tuscahoma and Nanafalia Formations of western Georgia and eastern Alabama. Like the Claiborne-age strata in central-panhandle Florida, these rocks cannot be differentiated into discrete formations in the subsurface and therefore are grouped together and called Tuscahoma-Nanafalia equivalents. Locally, fine-crystalline, dark-gray, gypsiferous limestone interfingers with the more characteristic clastic rocks of this unit, especially adjacent to the area where the Oldsmar Limestone forms the base. In south-central Georgia and contiguous counties in north Florida, the base of the aquifer system is marked by chalky, glauconitic, gypsiferous, cream to brown limestone and dark-brown gypsiferous dolomite that are part of the Oldsmar Limestone. The Oldsmar represents a deeper-water facies of the Tuscahoma-Nanafalia clastic rocks and grades into these clastic rocks to the northeast and southeast of the mapped Oldsmar area. In southwestern South Carolina, north of the tier of counties that adjoin Georgia, the base of the aquifer system consists of interbedded gray to black clay, red to brown sandy clay, and fine-grained, white, calcareous sand and clayey sand, all of which are part of the Black Mingo Formation. Both the top and the base of the aquifer system climb topographically from the Brunswick, Ga., area (in the Southeast Georgia embayment) northeastward toward the flanks of the Cape Fear arch (near the North Carolina-South Carolina border). Older rocks are at higher altitudes nearer the axis of the arch than farther down its flanks, and this is the reason the lower Eocene Black Mingo forms the base of the aquifer system farther northward than the middle Eocene Santee Limestone equivalent.

Rocks of Midway Age

Throughout Franklin County and in southern Bay and Wakulla Counties in Florida's eastern panhandle, the base of the aquifer system consists of hard, cherty, sandy, fine crystalline limestone thickly interbedded with massive brown to black clay. These rocks are of Midway age and are the equivalents of the Clayton Formation of south Georgia and Alabama. Eastward, these rocks grade into dolomite and dolomitic limestone that are part of the Cedar Keys Limestone of Florida. Cedar Keys rocks comprise the base of the aquifer system over practically all of peninsular Florida and over a small area in southeast Georgia. Massive anhydrite layers are interbedded with the carbonate rocks of the Cedar Keys, and these low-permeability, areally extensive evaporite beds form the top of the confining unit underlying the aquifer system. Although anhydrite beds occur locally in younger rocks, particularly in the Oldsmar Limestone and (less commonly) in the Lake City Limestone, they do not comprise regionally extensive confining beds in any horizon younger than the Paleocene. In western peninsular Florida, the base of the limestone aquifer system has previously been mapped as a gypsiferous dolomite horizon of middle Eocene age. While the gypsiferous dolomite does comprise an effective confining bed, there is permeable limestone that lies below it and constitutes the lower major permeable zone of the aquifer system as defined here. Accordingly, in west-central peninsular Florida, the Cedar Keys Limestone that lies beneath this lower major permeable zone is considered to be the base of the system.

Rocks of Late Cretaceous Age

The limestone aquifer system is very thick in the Brunswick, Ga., area. Locally, in test wells in southern Glynn County, the base of the system consists of argillaceous, soft, chalky limestone of Late Cretaceous age. The chalky limestone is thought to represent rocks of Taylor age that are at present unnamed in either the Georgia or Florida subsurface. Younger Cretaceous rocks (of Navarro age) are also present in Glynn County, but they are highly permeable limestones and are accordingly part of the aquifer system. These Navarro rocks are equivalent to the Lawson Limestone of north Florida.

GEOLOGIC STRUCTURE

Although this map is a composite of the tops of several different low-permeability horizons of different ages, the large-scale features it shows reflect major structural elements. The east-trending negative area centered near Brunswick, Ga., is the Southeast Georgia embayment; the low area in Franklin and Gulf Counties, Fla., is the Southwest Georgia or Apalachicola embayment; and the low area centered in Lee and Hendry Counties, Fla., is the South Florida basin. Westward, in extreme western panhandle Florida and in southern Alabama, the steep, steady Gulfward slope of the base of the aquifer system reflects the influence of the Gulf geosyncline.

The axis of the positive area near peninsular Florida's northern west coast lies in an intermediate position between the axis of the Peninsular arch and that of the Ocala uplift, but it likely represents the approximate location of the Peninsular arch in late Cedar Keys (Paleocene) time. The increasing altitude of the base of the system northward into South Carolina from the Southeast Georgia embayment is due to the influence of the Cape Fear arch that lies northeast of the mapped area.

In the area where part of the Cedar Keys Limestone marks the base of the aquifer system, the altitude of the highest bedded anhydrite has been plotted, then contoured as if the evaporites occupy the same stratigraphic horizon everywhere. Actually, this is not the case; and the small, low-relief (100 to 300 feet) positive and negative features shown in south peninsular Florida, rather than being structural features, represent only local evaporite beds that occur at higher or lower elevations than the main Cedar Keys anhydrite-rich horizon.

Small faults are shown in central Georgia and large ones in western Alabama. The faults mapped in Georgia bound a series of small grabens, collectively called the Gulf Trough (Gelbaum, 1978), within which low-permeability material has been downdropped to lie opposite permeable limestones that border the grabens on either side. The grabens also cut the low-permeability rocks that comprise the base of the aquifer system and have displaced them as shown. In western Alabama, the north-trending arcuate fault in Clarke and Baldwin Counties is the eastern boundary of the Mobile Graben, and the faults to the north of this feature (in Clarke, Washington, and Choctaw Counties) are part of the Gilbertown-Pickens-Pollard fault zone, also a graben system. Gulfward from these faults, the aquifer system is thin and is effectively isolated from the main body of the system by juxtaposition of relatively impermeable downdropped beds opposite permeable limestones. Because of the discontinuity of the system produced by this faulting, the base of the aquifer system is not mapped here. However, its stratigraphic equivalents are present and have also been downdropped by the faulting.

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EXPLANATION

Well Control Point.

Fault—Vertical or nearly so. U-Upthrown side. D-Downthrown side.

Structure Contour—Shows altitude of base of the limestone aquifer system. Contour interval 100 feet. Datum is National Geodetic Vertical Datum of 1929.

Line Showing Approximate Updip Limit of the Limestone Aquifer System.

Line Showing Approximate Updip Limit of the Upper Permeable Zone of the Limestone Aquifer System.

UNIT COMPRISING BASE OF AQUIFER SYSTEM
Time-Stratigraphic Unit: Formation.

Tertiary
- **Rocks of Jackson Age—** Ocala Limestone and equivalents.
- **Rocks of Claiborne Age—** Lisbon Formation; Tallahatta Formation; Santee Limestone (Part) Equivalent
- **Rocks of Sabine Age—** Tuscahoma Formation—Nanafalia Formation Equivalent; Oldsmar Limestone (Part); Black Mingo Formation (Part)
- **Rocks of Midway Age—** Cedar Keys Limestone; Clayton Formation Equivalent

Cretaceous
- **Rocks of Late Cretaceous Age—** Unnamed Taylorian Chalk

0 10 20 30 40 50 MILES
0 10 20 30 40 50 KILOMETERS

GEOLOGY AND CONFIGURATION OF THE BASE OF THE TERTIARY LIMESTONE AQUIFER SYSTEM, SOUTHEASTERN UNITED STATES

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