TABLE. 1—*Generalized correlation chart showing time-stratigraphic, rock-stratigraphic and regional hydrogeologic units in the southeastern United States Coastal Plain*

ERATHEM	SYSTEM	Series	Gulf Coast Stage	Mississippi (N–SE)	Alabama (W–E)	Georgia (W–E)	South Carolina (W–NE)	North Carolina (SE–Mid-central)	Northern Florida (Panhandle–Northern peninsula)
CENOZOIC	QUATERNARY	Holocene and Pleistocene		Alluvium and terrace deposits	Alluvium and terrace deposits	Alluvium and terrace deposits	Alluvium and terrace deposits; Canepatch Formation; Waccamaw Formation	Alluvium and terrace deposits; Canepatch Formation; Waccamaw Formation	Terrace deposits
		Pliocene		Citronelle Formation; Graham Ferry Formation	Citronelle Formation	Charlton Formation; Raysor Formation	Raysor Formation; Bear Bluff Formation; Yorktown Formation	Bear Bluff Formation; Yorktown Formation	Citronelle Formation
	TERTIARY	Miocene		Pascagoula Formation; Hattiesburg Formation; Catahoula Sandstone; ? ? ?	Undifferentiated; Catahoula Sandstone; ? ? ?	Hawthorn Formation	Hawthorn Formation; Edisto Formation	Pungo River Formation; Belgrade Formation	Alum Bluff Group; Undifferentiated Miocene deposits; Hawthorn Formation; Tampa Limestone and equivalents
		Oligocene	Chickasawhayan	Paynes Hammock Formation; Chickasawhay Limestone	Paynes Hammock Formation; Chickasawhay Limestone	Cooper Formation (upper part)	Chandler Bridge Formation; Cooper Formation Ashley Member	River Bend Formation	Chickasawhay Limestone; Suwannee Limestone
			Vicksburgian	Bucatunna Formation; Byram Formation; Glendon Formation; Marianna Formation; Mint Spring Formation; Forest Hill Formation; Red Bluff Formation	Bucatunna Formation; Byram Formation; Glendon Formation; Marianna Formation; Mint Spring Formation; Red Bluff Formation; Bumpnose Formation	Suwannee Limestone			Bucatunna Fm.; Byram Formation; Marianna Formation; Bumpnose Formation
		Eocene	Jacksonian	Yazoo Formation; Moodys Branch Formation	Yazoo Formation; Ocala Limestone; Moodys Branch Formation	Ocala Limestone; Tobacco Road Sand; Irwinton Sand Member; Twiggs Clay Member; Clinchfield Sand; Cooper Formation (lower part); Barnwell Formation (updip)	Cooper Fm.; Parkers Ferry Mbr; Harleyville Mbr; Barnwell Formation (updip)		Ocala Limestone; Moodys Branch Formation
			Claibornian	Cockfield Formation; Cook Mountain Formation; Sparta Sand; Zilpha Clay; Winona Sand; Tallahatta Formation: Neshoba Sand Member, Basic City Shale Member, Meridian Sand Member	Gosport Sand; Lisbon Formation; Tallahatta Formation	Avon Park Formation (subsurface); McBean Formation (updip); Lisbon Formation; Tallahatta Formation; Huber Formation	McBean Formation (updip); Warley Hill Marl (updip); Congaree Formation (updip); Santee Limestone (downdip); Cross Member; Moultrie Member; Huber Formation	Castle Hayne Formation	Lisbon Formation; Tallahatta Formation; Avon Park Formation
			Sabinian	Wilcox Grp: Bashi Formation; Hatchetigbee Formation; Tuscahoma Formation; Nanafalia Formation	Bashi Formation; Hatchetigbee Formation; Tuscahoma Formation; Nanafalia Formation; Baker Hill Formation	Bashi Formation; Hatchetigbee Formation; Tuscahoma Formation; Nanafalia Formation; Oldsmar Formation (subsurface)	Fishburne Formation (subsurface); Black Mingo Formation		Undifferentiated lower Eocene rocks; Oldsmar Formation
		Paleocene	Midwayan	Naheola Formation; Porters Creek Clay; Tippah Sand Lentil; Clayton Formation	Naheola Formation; Porters Creek Formation; Clayton Formation	Porters Creek Fm.; Clayton Formation; Cedar Keys Formation (subsurface)	Black Mingo Formation; Ellenton Formation (subsurface); Beaufort (?) Formation	Beaufort Formation	Undifferentiated Paleocene rocks; Cedar Keys Formation
MESOZOIC	CRETACEOUS	Upper Cretaceous (Gulfian)	Navarroan	Owl Creek Formation; Prairie Bluff Chalk; Ripley Formation; Chiwapa Limestone Member; McNairy Sand Member; Coon Creek Tongue; Bluffport Member; Selma Group	Prairie Bluff Chalk; Providence Sand; Ripley Formation; Selma Group	Providence Sand; Ripley Formation; Lawson Limestone (subsurface)	Peedee Formation	Peedee Formation	Rocks of Navarroan age; Lawson Limestone
			Tayloran	Demopolis Chalk; Coffee Sand; Arcola Limestone Member; Mooreville Chalk	Demopolis Chalk; Cusseta Sand Member; Arcola Limestone Member; Mooreville Chalk; Blufftown Formation	Cusseta Sand; Blufftown Formation; Undifferentiated	Black Creek Formation; Unnamed sediments in coastal areas	Black Creek Formation; Unnamed sediments in coastal areas	Rocks of Tayloran age
			Austinian	Tombigbee Sand Member; Eutaw Formation; McShan Formation	Tombigbee Sand Member; Eutaw Formation; McShan Formation	Eutaw Formation; Atkinson Formation (upper part-subsurface)	Middendorf Formation; Cape Fear Formation	Middendorf Formation; Cape Fear Formation	Rocks of Austinian age
			Eaglefordian	Tuscaloosa Group undifferentiated; Gordo Formation; Coker Formation; Unnamed upper member; Marine eoline member; Massive sand; ?—?—?	Gordo Formation; Coker Formation; Tuscaloosa Group undifferentiated; Atkinson Formation (upper and lower parts)	Tuscaloosa Formation; Atkinson Formation (lower part-subsurface)	Unnamed rocks	Unnamed rocks	Unnamed rocks; Atkinson Formation
			Woodbinian	Marine shale[1]	Marine shale[1]	Marine shale[1]			Marine shale; Unnamed rocks
		Lower Cretaceous (Comanchean)	Washitan and Fredericksburgian	Undifferentiated	Undifferentiated	Undifferentiated[3]	Undifferentiated[3]	Undifferentiated[3]	Undifferentiated; ?
	JURASSIC			Undifferentiated	Undifferentiated	Undifferentiated[3]			Undifferentiated
	TRIASSIC				Undifferentiated	Undifferentiated	Undifferentiated	Undifferentiated	Undifferentiated
PALEOZOIC				Undifferentiated	Undifferentiated	Undifferentiated	Undifferentiated	Undifferentiated	Undifferentiated

EXPLANATION
- SURFICIAL AQUIFER
- UPPER CONFINING UNIT
- FLORIDAN AQUIFER SYSTEM
- SOUTHEASTERN COASTAL PLAIN AQUIFER SYSTEM
- A1, aquifer unit
- C1, confining unit
- A2, aquifer unit
- C2, confining unit
- A3, aquifer unit
- C3, confining unit
- A4, aquifer unit
- BASE OF SYSTEM
- ABSENT
- LOCAL UNIT NOT CONSIDERED PART OF SYSTEM

[1] Mancini and others (1980) considered the Marine Shale of Southern Alabama to be part age equivalent to a portion of the Woodbine Formation and/or Eagle Ford Group of Texas.

[2] Since the report was prepared the Cooper Formation in South Carolina has been raised to group and its members to formation rank. (Weems and Lemon, 1984).

[3] Brown and others, 1972, Brown and others, 1979.

A4 REGIONAL AQUIFER

The A4 aquifer is the most regionally extensive clastic aquifer of the Southeastern United States Coastal Plain (plate 3). Correlative sand beds that are part of this aquifer extend in the subsurface or outcrop from Tennessee into central North Carolina. The upper surface of the A4 aquifer slopes gently seaward at a gradient of 15 to 30 feet per mile in Georgia, northern Florida, South Carolina, and adjacent counties of North Carolina but slopes more steeply in Alabama and Mississippi (30 to 50 feet per mile or greater). Where this aquifer unit crops out in western Georgia, Alabama, and Mississippi, its landward limit marks the inner margin of Coastal Plain sediments. Cropping out as a 40- to 50-mile wide band in eastern Mississippi-western Alabama, its width of outcrop decreases gradually in eastern Alabama and western Georgia; the A4 unit is completely covered in eastern and central Georgia by onlapping rocks of Late Cretaceous and Tertiary age. Where the updip limit of this aquifer is shown to occur well south of the Fall Line such as in eastern Georgia and South Carolina, its location is due to erosion or nondeposition of equivalent strata. Although the A4 aquifer does not crop out in South Carolina, equivalent strata are exposed locally along the Cape Fear River in North Carolina. The A4 aquifer is absent along the axis of the Peninsular arch in northeastern Florida and southeastern Georgia.

Poorly sorted, nonmarine, mottled red to reddish-brown, fine to coarse grained, feldspathic quartz sand considered, in part, equivalent to the outcropping Cape Fear Formation and in part, equivalent to Unit F (Brown and others, 1972) forms the top of the A4 aquifer in South Carolina and adjacent counties of North Carolina. Interbedded noncalcareous clay, siderite, hematite, pyrite, shell fragments and a few microfossils are common minor constituents associated with these water-bearing rocks.

Subsurface strata previously described as the upper part of the Atkinson Formation (Applin and Applin, 1967) outline the upper surface of the A4 aquifer in Georgia, in northern Florida, and in southeastern Alabama. In these areas, rock that comprises the upper surface of the aquifer consist largely of marine deposits but includes some nonmarine beds. The aquifer typically consists in these localities of glauconitic quartz sand and sandstone that are interbedded with silt, shale and minor limestone; the sands are feldspathic in shallow updip regions.

In most of Mississippi and Alabama, and in the northwestern Georgia Coastal Plain, strata that are equivalent to the Eutaw or Eutaw and McShan Formation(s) make up the top of the A4 aquifer. In those localities, the aquifer is comprised of sparsely fossiliferous, greenish gray to yellowish brown, fine to coarse grained, glauconitic, calcareous sand that is interbedded with gray micaceous shale. Minor constituents include volcanic ash (bentonite), siderite, pyrite and lignite.

In downdip areas of southwestern Mississippi, the permeability of the Eutaw and McShan sand decreases as these rocks grade into dense marine chalk and argillaceous shale that are part of the C3 confining unit (fig. 5). As a result, the top of the A4 aquifer here consists of underlying sand, sandstone, and gravel that are considered equivalent to the upper part of the Tuscaloosa Group. Important water-bearing units within the A4 aquifer that are part of the Tuscaloosa Group or Formation include: (1) deltaic, highly cross-bedded, fine to coarse grained, ferruginous quartz sand and cherty gravel deposits ascribed to the Gordo Formation; (2) fluvial and nearshore marine, glauconitic quartz sand deposits of the Coker Formation; and (3) nonmarine, massively bedded, medium to coarse grained quartz sand of the so-called "massive sand" section. Taken as a whole, strata of the Tuscaloosa Group or Formation tend to be interbedded with dark, micaceous marine shale as they grade coastward.

Outcropping and subsurface strata that are part of the Coffee Sand form the top of the A4 aquifer in some of the northeastern counties of Mississippi. These strata consist of massively bedded, marine, fine to medium grained, loosely consolidated, glauconitic quartz sand that is often laminated with silt and clay; minor constituents include mica, siderite, and lignite.

Permeable clastic rocks of Early Cretaceous age (Washitan and Fredericksburgian Stages) form the base of the A4 aquifer in downdip areas of Georgia, Alabama, Mississippi, and northern Florida but are not known to crop out in the Southeastern Coastal Plain. These rocks consist of red to reddish brown sand, sandstone, and gravel that were deposited under nonmarine conditions; interlaminated marine and nonmarine shale, siltstone and minor limestone beds are also present.

Deeply buried sedimentary rocks of Jurassic age that are found in parts of Georgia, Alabama, Mississippi, and Florida underlie the basal Cretaceous sedimentary rocks. However, they are not considered to be part of the Southeastern Coastal Plain regional aquifer system. Jurassic rocks were excluded from the system because they are not known to contain ground water with a dissolved-solids content of less than 10,000 mg/L (milligrams per liter). It is assumed that little or no movement of ground water occurs in these deeply buried saline aquifers.

RELATION OF STRATIGRAPHY AND PERMEABILITY

The extent and thickness of the major aquifer and confining units that comprise the Southeastern Coastal Plain aquifer system are primarily a function of gradational changes in permeability, and secondarily, a result of differential movement within the rocks that comprise the Coastal Plain and its floor. The following discussion demonstrates the control of these factors on the distribution, geometry, and character of the major aquifers and confining units of the Southeastern Coastal Plain aquifer system.

The relation between an aquifer's permeability and lithology is an important criterion in delineating the boundaries of water-bearing units. For example, the highly permeable Floridan aquifer system overlies and is hydraulically interconnected with the less-permeable A2 aquifer in Georgia, southwestern South Carolina, and southern Alabama. The boundary between the two aquifers represents a transitional, or facies, boundary separating carbonate rocks of the Floridan from the underlying clastic rocks. This boundary generally represents a contrast in permeability. From a regional perspective, the permeability of the Floridan is one or more orders of magnitude higher than that of the underlying A2 aquifer. Consequently, the configuration of the top of the A2 aquifer is largely coincident with the base of the Floridan aquifer system (Miller, 1982a) where the two systems are juxtaposed. The "transgression" of this boundary across time-stratigraphic lines, shown on several of the hydrogeologic sections presented in this report (figs. 4, 6, 8, 9, and 10), explains the diversity of rock units that comprise the top of the A2 aquifer.

The wavy, undulating contour pattern that typifies the surface of the A2, C2, A3, and C3 regional units generally reflects local changes in permeability. This relationship is shown by the configuration of the basal surface of the A3 aquifer (plate 2B). Hydrogeologic sections F-F' and G-G' (figs. 10 and 11) show the A3 aquifer grading coastward from porous sand, sandstone, and minor limestone beds found in updip localities into low-permeability chalk and calcareous shale that lie in the deep subsurface of southwestern Georgia and southeastern Alabama. Consequently, the permeable parts of the A3 aquifer thin seaward greatly. These sections also show that permeable rocks of Tertiary age extend further downdip than the underlying permeable Cretaceous rocks that comprise the A3 aquifer. This is in contrast to southeastern Georgia where clastic Cretaceous strata of the A3 aquifer grade seaward to permeable limestone (Lawson Limestone) that is part of the Floridan aquifer system (fig. 9). Such major permeability variations overshadow the influence of minor structural features and account for many of the local highs and lows drawn on the maps showing the top or base of the different regional aquifer units. For example, the apparent structural low that is mapped on the base of the A3 aquifer in Colquitt and Grady Counties in southwest Georgia and its alignment with the position of the postulated Gulf Trough (compare plates 1A, 2B, and fig. 13) is considered to be coincidental.

In spite of the generally poor correspondence between hydrogeologic an stratigraphic units of the Southeastern United States Coastal Plain, several large and small-scale structural features are subtly reflected on the top of the major hydrogeologic units. Major embayments that appear on maps of some of these units include the Southeast Georgia, Southwest Georgia, and Mississippi embayments. The Southeast Georgia embayment (Maher, 1971) is centered and most prominent in coastal counties of southeastern Georgia and is evident on the map showing the surface of the A4 aquifer (plate 3). The Southwest Georgia embayment forms the dominant structural element in the southern tier counties of Georgia and the central Florida panhandle; it is strongly reflected by the contour pattern shown on the A4 aquifer map. The Mississippi embayment, with its north-south trending axis nearly coincident with the Mississippi River (fig. 13), strongly controls the western and southwestern dip of beds in western Mississippi.

The Cape Fear and the Peninsular arches form two major salients of the Southeastern United States Coastal Plain (fig. 13). They have resulted in the nondeposition or erosion of Tertiary clastic rocks in eastern South Carolina as well as the absence of the basal Cretaceous sands in the southeast Georgia-northeast Florida region (see plates 1A, 1B, and 3). The effect of the Wiggins anticline in Southeastern Mississippi is limited to the deep subsurface strata that comprise the saline part of the A4 aquifer (plate 3). Shallower overlying clastic aquifers (A2, A3) do not extend as far south and were not influenced by this structural feature. The Jackson dome, near Jackson, MS, forms a positive feature and strongly controls the configuration of the A2 and A4 aquifers (plates 1A, and 3).

Small- and large-scale faults associated with Pickens-Gilbertown fault system (fig. 13) bound graben-type structures that displace sediments downward in varying degrees across southwestern Alabama and south-central Mississippi. Detailed mapping of these complex features is beyond the scope of this report but the position of the system as previously mapped (Gulf Coastal Association of Geological Societies, 1972) is shown. Downwarping or faulting associated with the postulated Gulf trough (Herrick and Vorhis, 1963, and Gelbaum, 1978) in south Georgia has been inferred on the basis of limited well control and is mapped on the upper surface of the A2 aquifer. However, this feature is not discernable at the base of the A2 aquifer and its depositional and structural influence may have been limited to post-Sabine time. Likewise, the postulated Millet fault of Faye and Prowell (1982) is not recognizable at the top of any of the aquifers or confining units mapped herein. The Millet fault, which supposedly displaced upper Cretaceous rocks several hundred feet and affected the potentiometric surface of two aquifers in Burke County, GA and Allendale and Barnwell Counties, S.C., has been shown by subsequent drilling (Bechtel Corporation, 1982) not to exist.

An unnamed northwest-trending structural lineament or possible fault centered in Marion and Dillon Counties, S.C., and Robeson County, N.C., is inferred on the basis of an anomalous change in dip on the upper surface of the A4 aquifer (plate 3). There is subparallel alignment of this postulated structural component with the so-called "Florence basin" of Triassic age (Popenoe and Zietz, 1977; Daniels and others, 1983), possibly indicating that border faulting associated with the Florence basin continued from Triassic into Late Cretaceous time. However, information is not available to confirm or deny this feature or ascertain its affect on the regional ground-water flow system.

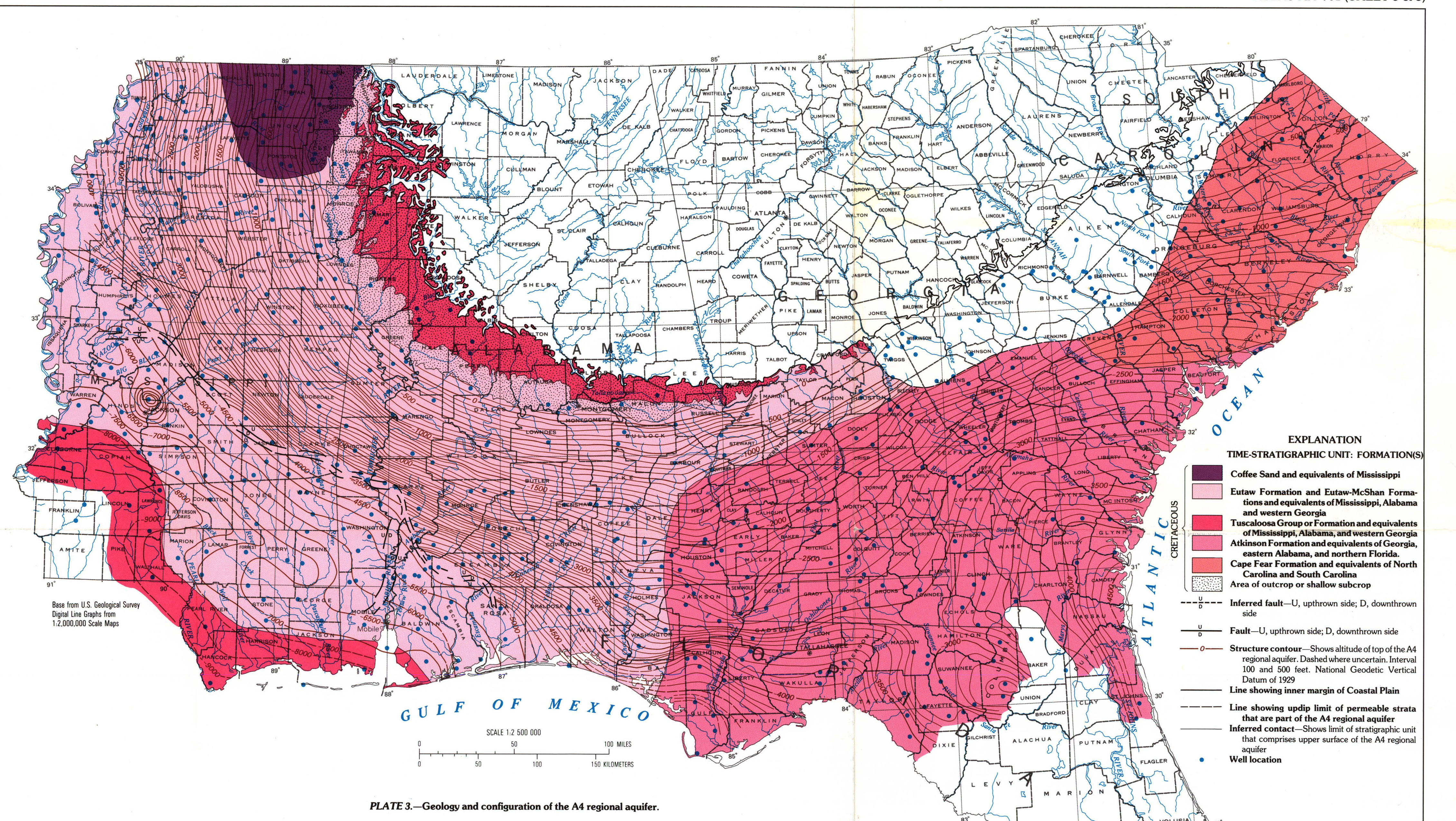

PLATE 3.—**Geology and configuration of the A4 regional aquifer.**

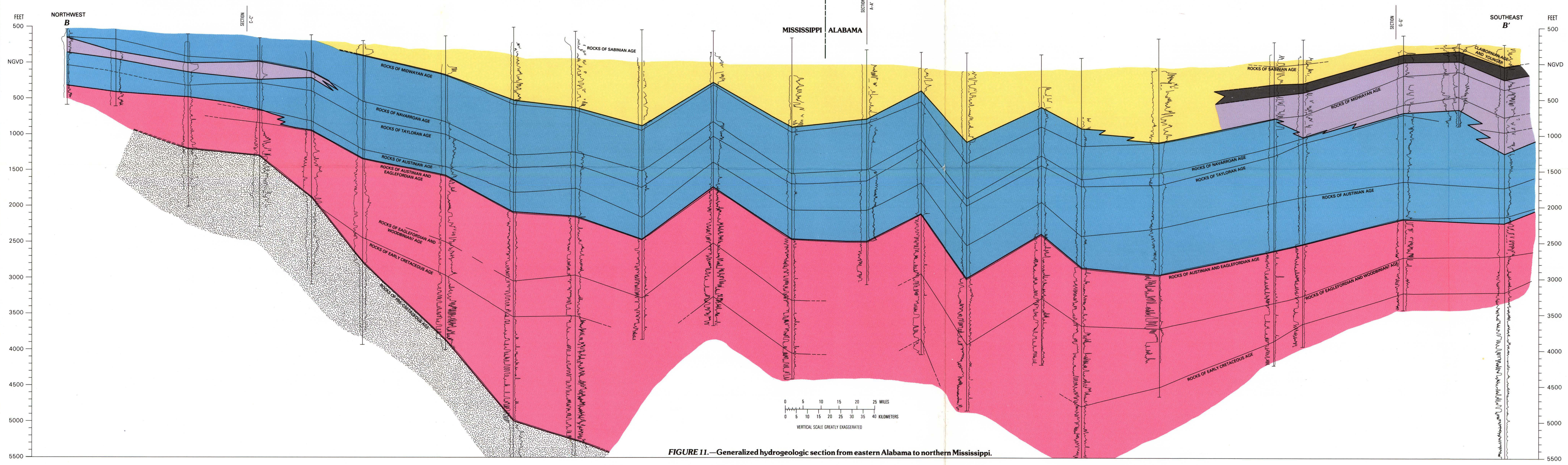

FIGURE 11.—**Generalized hydrogeologic section from eastern Alabama to northern Mississippi.**

EXPLANATION
- FLORIDAN AQUIFER SYSTEM
- SOUTHEASTERN COASTAL PLAIN AQUIFER SYSTEM
- A2, aquifer unit
- C2, confining unit
- A3, aquifer unit
- C3, confining unit
- A4, aquifer unit
- BASE OF SYSTEM
- AQUIFER-CONFINED BED BOUNDARY—Dashed where uncertain
- TIME-STRATIGRAPHIC BOUNDARY—Dashed where uncertain

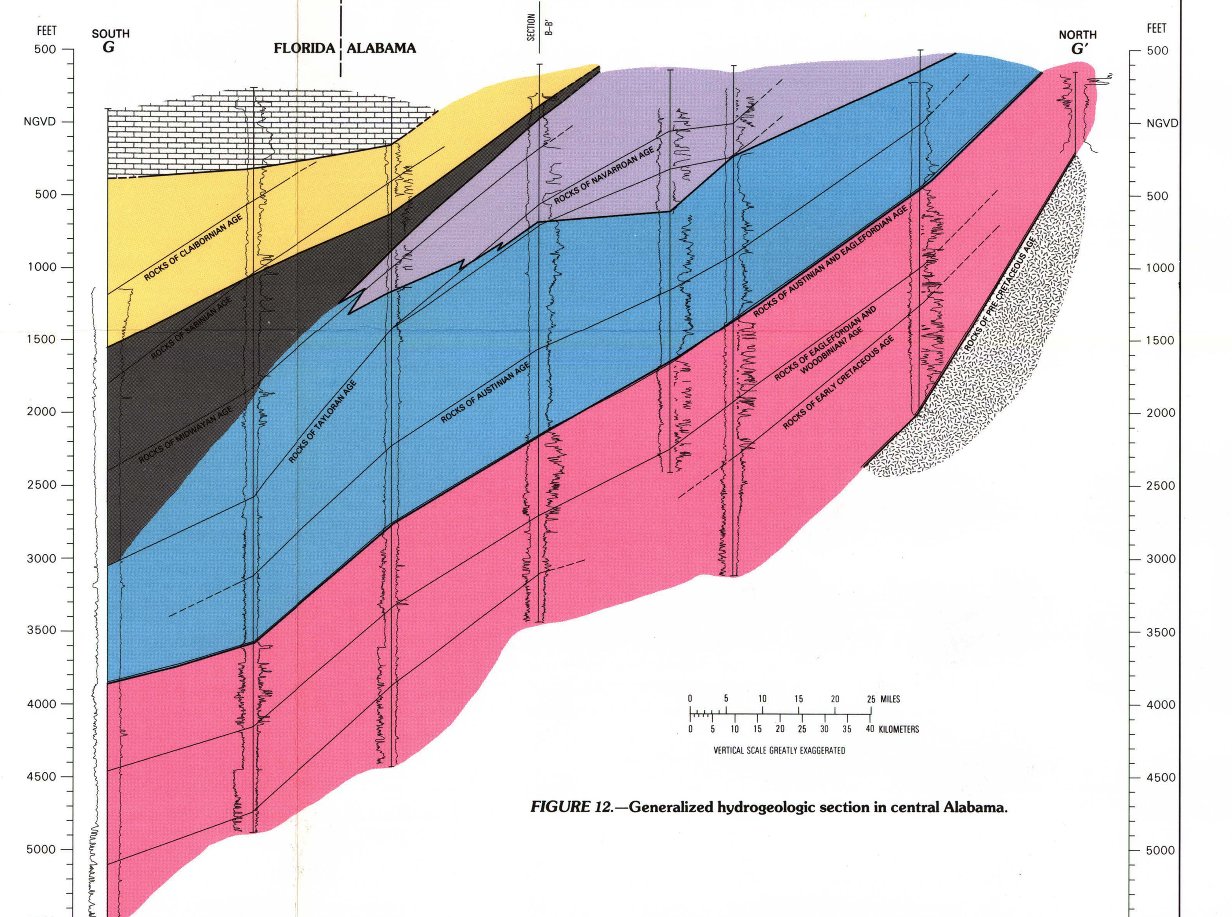

FIGURE 12.—**Generalized hydrogeologic section in central Alabama.**

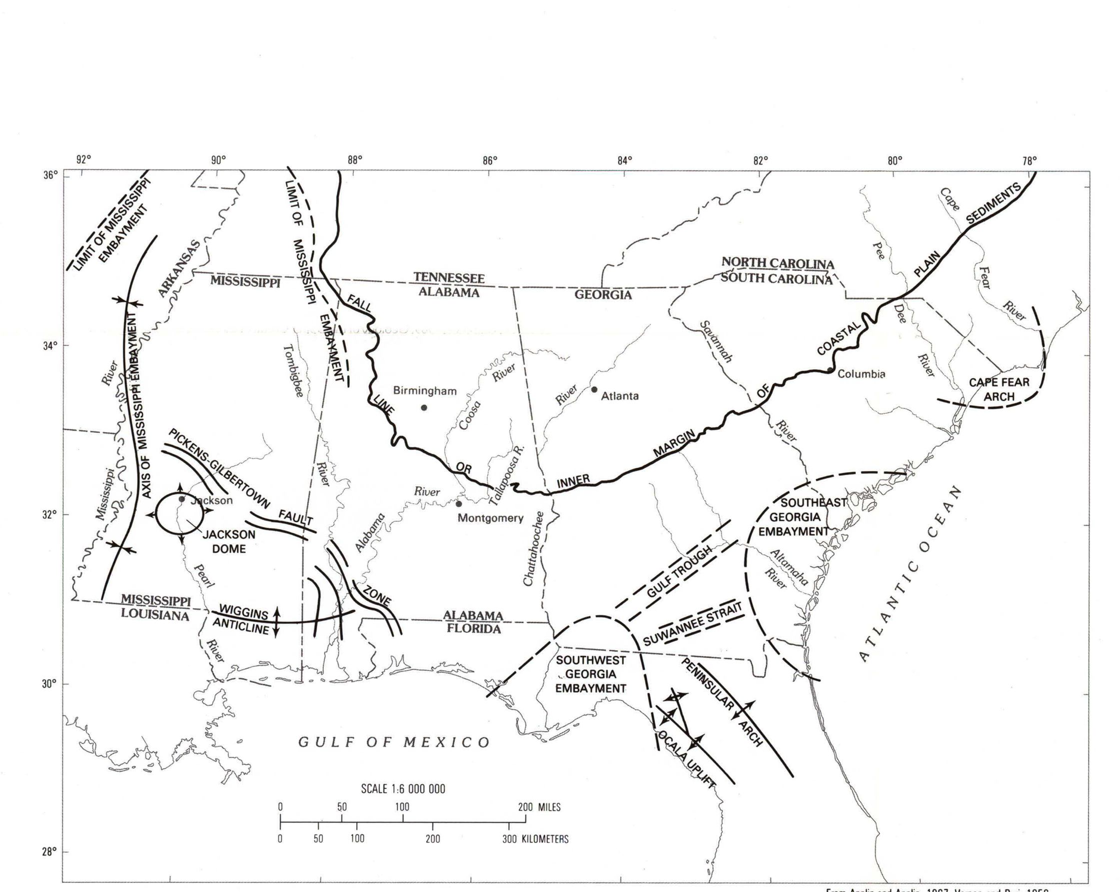

FIGURE 13.—**Principal structural features of the Southeastern Coastal Plain of the United States.**

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HYDROGEOLOGY OF CLASTIC TERTIARY AND CRETACEOUS REGIONAL AQUIFERS AND CONFINING UNITS IN THE SOUTHEASTERN COASTAL PLAIN AQUIFER SYSTEM OF THE UNITED STATES

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