GULF COAST REGIONAL AQUIFER-SYSTEM ANALYSIS--A MISSISSIPPI PERSPECTIVE

By Hayes F. Grubb

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CONVERSION FACTORS

Multiply	By	To obtain
foot	0.3048	meter
mile	1.609	kilometer
square mile	2.509	square kilometer
million gallons per day	0.04381	cubic meter per second

National Geodetic Vertical Datum of 1929 (NGVD of 1929).- A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level. NGVD of 1929 is referred to as sea level in this report.

GULF COAST REGIONAL AQUIFER-SYSTEM ANALYSIS--

A MISSISSIPPI PERSPECTIVE

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ABSTRACT

The Gulf Coast Regional Aquifer-System Analysis is a study of regional aquifers in sediments of mostly Cenozoic age in an area of about 230,000 square miles in the Coastal Plain of Alabama, Arkansas, Florida, Illinois, Kentucky, Louisiana, Mississippi, Missouri, Tennessee, and Texas, and an additional 60,000 square miles offshore. Three aquifer systems have been identified: two in sediments of mostly Eocene age, the Mississippi embayment aquifer system and the Texas coastal uplands aquifer system, and one in sediments of Miocene and younger age, the coastal lowlands aquifer system. These aquifer systems thicken from less than 100 feet near their updip limit to thousands of feet gulfward toward their downdip limits. Two of these aquifer systems occur in Mississippi. The Mississippi embayment aquifer system is present in about 90 percent of the State and the coastal lowlands aquifer system is present in the southern one-third of the State.

The Mississippi embayment aquifer system exceeds 5,000 feet in thickness in central Louisiana and in southwestern Mississippi. The thickest area in southwestern Mississippi underlies most of six Mississippi counties, centered around Jefferson County. The coastal lowlands aquifer system is more than 10,000 feet thick in southern Texas and southern Louisiana. The greatest thickness of the coastal lowlands aquifer system in Mississippi occurs in southern Hancock County where the system is slightly more than 5,000 feet thick. Each of the three aquifer systems is composed of several individual aquifers and confining units. There are seven aquifers and three confining units in the Mississippi embayment aquifer system, five aquifers and two confining units in the Texas coastal uplands aquifer system, and five aquifers and two confining units in the coastal lowlands aquifer system. Most of the thicker parts of each aquifer system contain moderately saline to very saline water. Water in the Mississippi embayment aquifer system is moderately saline to very saline in most of a seven county area in southwestern Mississippi. Water in the coastal lowlands aquifer system is moderately saline to very saline in parts of three counties in south western Mississippi and in parts of the three counties along the Gulf Coast.

About 9,600 million gallons per day of ground water was pumped from the aquifers in the study area during 1980. About 15 percent of that pumpage (or about 1,400 million gallons per day) was in Mississippi, mostly from the Mississippi River Valley alluvial aquifer of the Mississippi embayment aquifer system. About 10 percent of the Mississippi pumpage, or 140 million gallons per day, was from the coastal lowlands aquifer system. Preliminary results from simulation of ground-water flow indicates that parts of Mississippi are major regional recharge areas for both the Mississippi embayment aquifer system and the coastal lowlands aquifer system. The Mississippi River alluvial plain or 'Delta' area of Mississippi is part of a much larger regional discharge area that extends westward into parts of eastern Arkansas and northeastern Louisiana.

INTRODUCTION

The Gulf Coast Regional Aquifer-System Analysis (RASA) is a study of regional aquifers in sediments of mostly Cenozoic age in an area of about 230,000 square miles in the Coastal Plain of Alabama, Arkansas, Florida, Illinois, Kentucky, Louisiana, Mississippi, Missouri, Tennessee, and Texas, and about 60,000 square miles of the Gulf of Mexico, between the coast and the edge of the Continental Shelf (fig. 1). The study is part of the U.S. Geological Survey's Regional Aquifer-System Analysis program. This program began in 1978 and is designed to provide a regional understanding and assessment of the Nation's ground-water resources (Bennett, 1979). Four other RASA studies have been delineated in areas adjacent to the Gulf Coast RASA study area (fig. 1).

The objectives of the Gulf Coast Regional Aquifer-System Analysis are to define the geohydrologic framework, describe the ground-water chemistry, and analyze the regional ground-water flow. These objectives and the study approach have been discussed in detail by Grubb (1984: 1985). This report will present a general discussion on the regional aquifer systems and will focus on how aquifers in Mississippi relate to the regional geohydrology of the Gulf Coast RASA study area.

The maps presented as part of the following discussion were all prepared using the computer-contouring package, Surface II [1/] (Sampson, 1978). The data used for maps related to the geohydrologic framework are from an analysis of geophysical well logs described by Grubb (1985); the water-chemistry data are median values per 100 square miles as described by R. A. Pettijohn (U.S. Geological Survey, written commun., 1985); and preliminary results from the simulation of ground-water flow are based on contour maps of potentiometric surfaces and other model output.

[1/] The use of trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

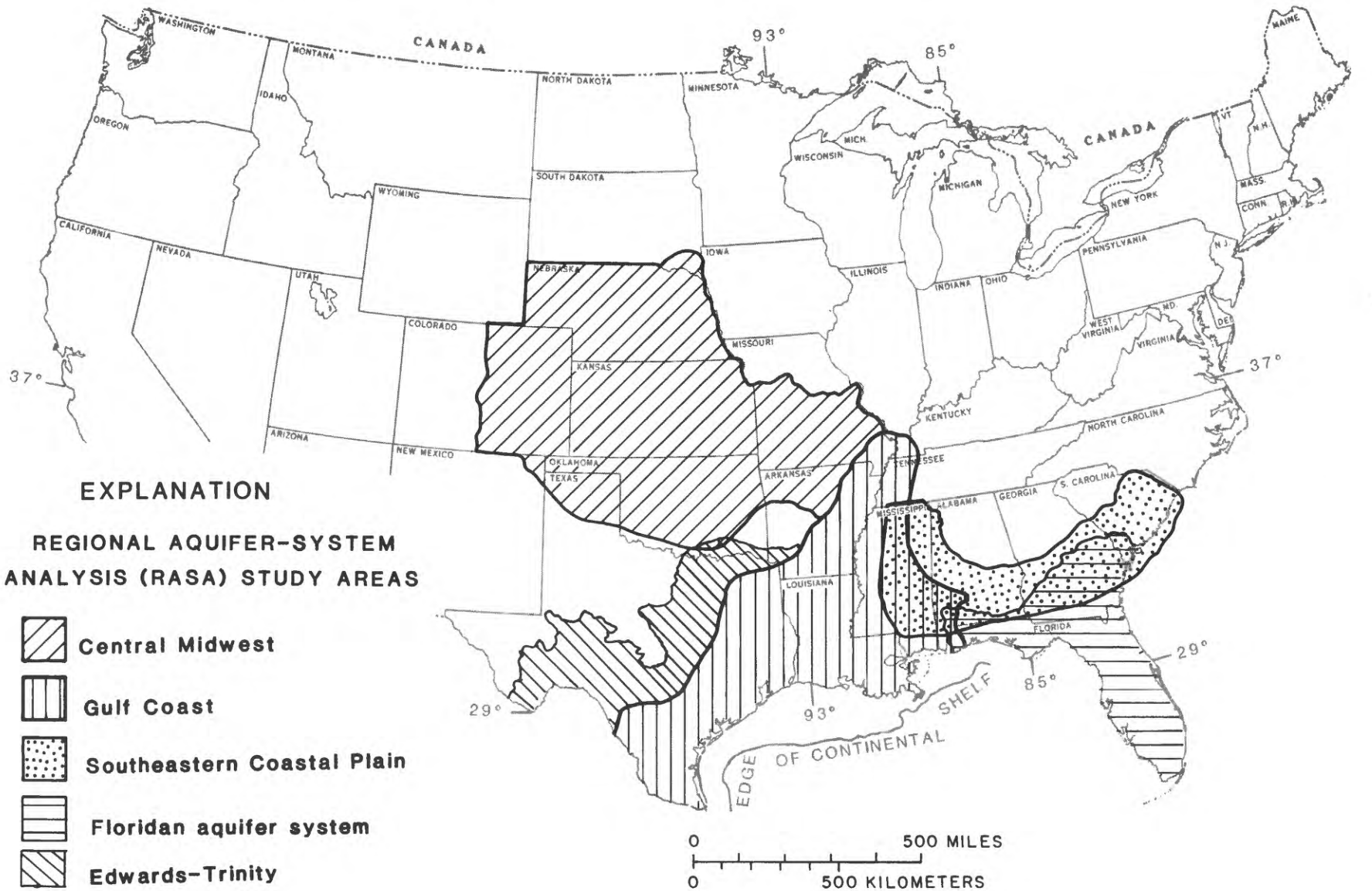


Figure 1.--Gulf Coast Regional Aquifer-System Analysis study area and adjacent Regional Aquifer-System Analysis study areas.

AQUIFER SYSTEMS

Three aquifer systems have been identified within the Gulf Coast RASA study area (Grubb, 1984): the Mississippi embayment aquifer system and the Texas coastal uplands aquifer system, which consist principally of Eocene age sediments, and the coastal lowlands aquifer system which consists of Miocene and younger age sediments. These aquifer systems thicken from less than 100 feet thick near their updip limit to thousands of feet gulfward toward their downdip limits.

The downdip limit of both the Mississippi embayment and the Texas coastal uplands aquifer systems is a zone of abnormally high fluid pressure (commonly called geopressure) that occurs at depths above the top of the sediments comprising these aquifer systems in coastal Texas and Louisiana and offshore Texas, Louisiana, Mississippi, and Alabama (Wallace and others, 1981, and fig. 2). The movement of fluids between the geopressured zone and the overlying normally pressured sediments is believed to be very small relative to the movement of fluids within the normally pressured sediments. Therefore, the top of the geopressured zone is treated as the base of the regional flow system where it occurs above the top of the sediments comprising the Midway confining unit.

The geopressured zone is the base of the coastal lowlands aquifer system onshore, in a narrow band that ranges from about 10 to 50 miles wide along the Texas and Louisiana coast (fig. 2). The area where the geopressured zone is above the base of the sediments comprising the coastal lowlands aquifer system extends offshore, at least as far as theedge of the continental shelf (Wallace and others, 1981).

As noted by Grubb (1985), both the Mississippi embayment aquifer system and the Texas coastal uplands aquifer system thin and eventually pinch out downdip. This pinchout is due to the loss of permeability where the sediments become geopressured or where they undergo facies changes. The occurrence of geopressure in successively younger sediments gulfward from the landward boundary of the study area results in the aquifer systems attaining maximum thickness several 10's of miles updip of their downdip limit. Effects of facies changes on permeability are pronounced in the Mississippi embayment aquifer system, especially in the southeastern part of the study area where the Claiborne Group grades laterally into either clay or carbonate rocks that are part of the contiguous Floridan aquifer system. The sand percentage tends to be greater in the updip parts of the system and to decrease toward the Gulf of Mexico in the Mississippi embayment aquifer system. In the coastal lowlands aquifer system, sand percentages tend to increase downdip (Grubb, 1985).

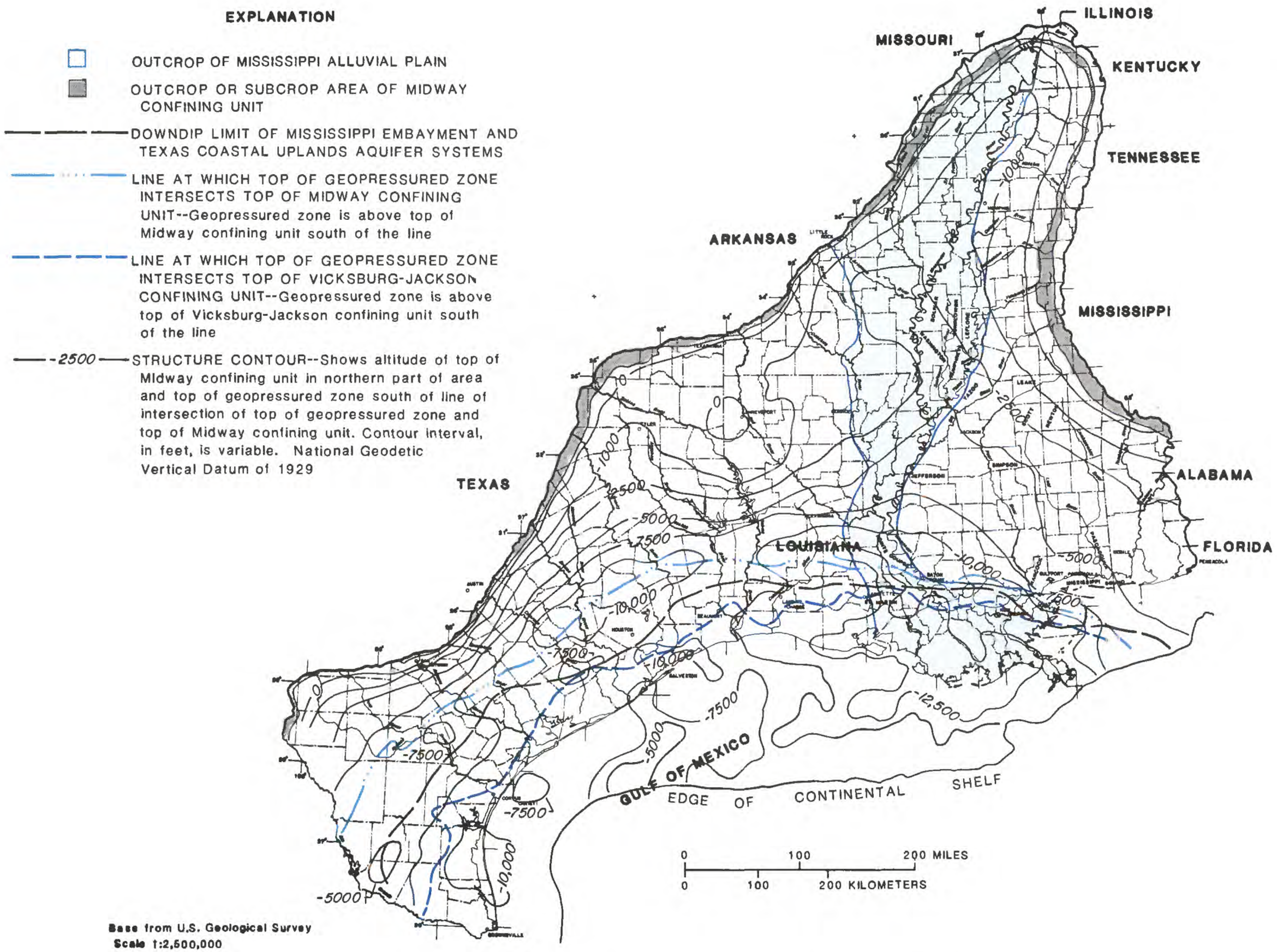


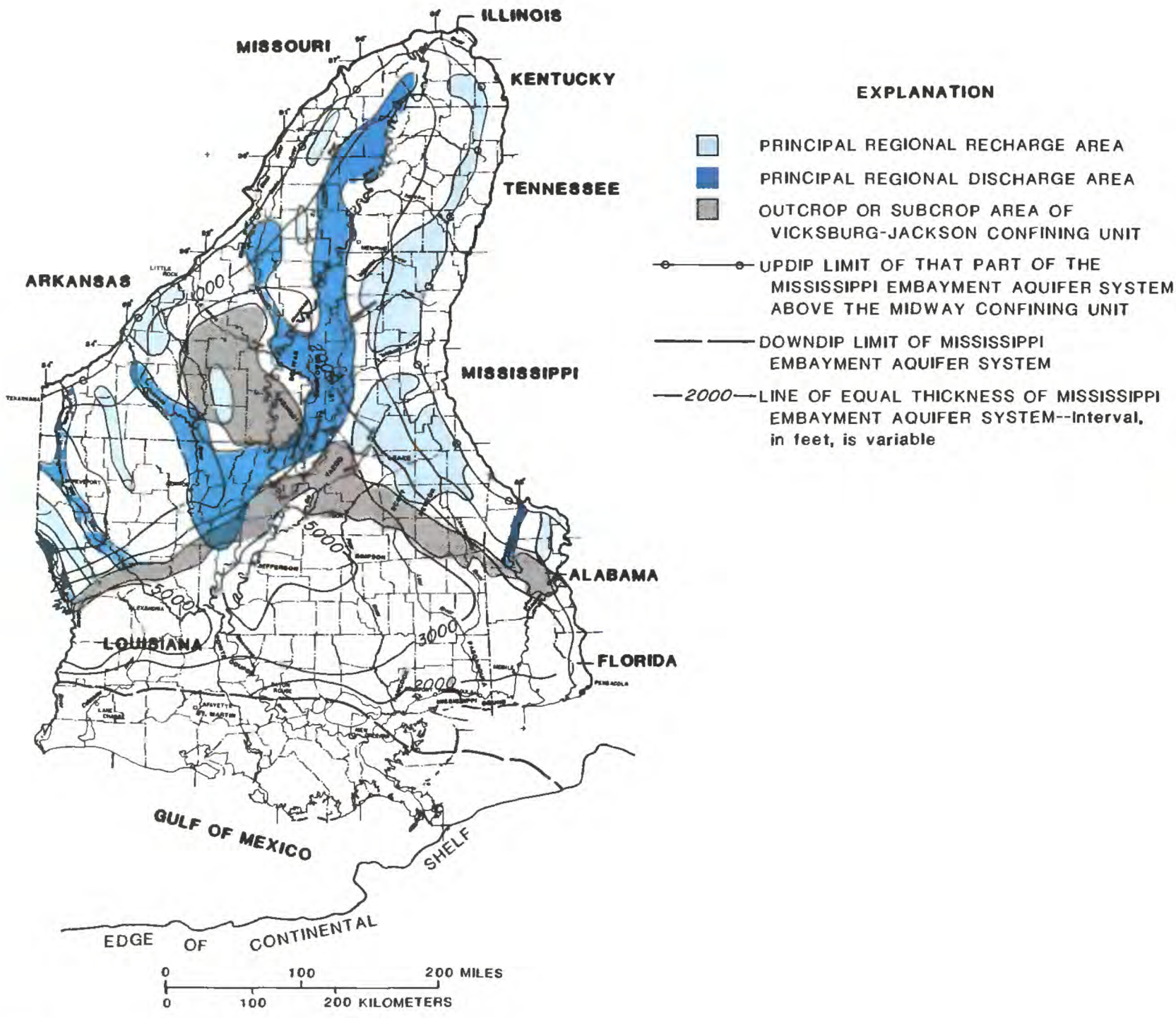
Figure 2.--Generalized base of the ground-water-flow system, Gulf Coast Regional Aquifer-System study area.

Only the Mississippi embayment and coastal lowlands aquifer systems occur in Mississippi. The Mississippi embayment aquifer system is present in about 90 percent of the State and the coastal lowlands aquifer system is present in the southern one-third of the State. In central Louisiana and in southwestern Mississippi (fig. 3), the Mississippi embayment aquifer system slightly exceeds 5,000 feet in thickness. The base of the Mississippi embayment aquifer system, updip of the geopressured zone, is the Midway confining unit which averages about 750 to 850 feet in thickness. The unit reaches a maximum thickness of more than 3,500 feet in Louisiana and is more than 1,500 feet thick throughout an elongate area about 130 miles long and 20 miles wide in Louisiana, just beyond the southwest tip of Mississippi (R. L. Hosman and J. S. Weiss, U.S. Geological Survey, written commun., 1985).

The coastal lowlands aquifer system is more than 10,000 feet thick in parts of southern Texas and southern Louisiana (fig. 4). In southern Hancock County, Mississippi, the coastal lowlands aquifer system is more than 5,000 feet thick (fig. 4).

The base of the coastal lowlands aquifer system, updip of the geopressured zone, is the thick sequence of marine clays of the Jackson and Vicksburg Groups. The unit (designated Vicksburg-Jackson confining unit, table 1) averages about 500 to 750 feet thick, and has a maximum thickness of about 6,600 feet. It is more than 1,500 feet thick in an elongate area about 220 miles long and 20 miles wide across south-central Louisiana. (R. L. Hosman and J. S. Weiss, U.S. Geological Survey, written commun., 1985.)

Each aquifer system is composed of several individual aquifers and confining units. For purposes of this study, seven regional aquifers have been recognized in the Mississippi embayment aquifer system, and five regional aquifers have been recognized in the coastal lowlands aquifer system. A comparison of geologic units in Mississippi to aquifers defined by other workers and the regional aquifers delineated for the purposes of this study is shown in table 1. In some cases, two or more locally defined aquifers have been included in one regional aquifer if the vertical hydraulic-head differences were not large or if the confining beds separating them were not regionally extensive. The division of the sediments of Miocene and younger age in the coastal lowlands aquifer system was based on an analysis of vertical hydraulic-head gradients in pumped areas. The resulting regional geohydrologic units tend to have minimal variations in vertical hydraulic-head within units and greater variations between units (Weiss and Williamson, 1985). The units were extended beyond and between pumping centers by keeping the units a constant proportion of the total system thickness, thereby avoiding abrupt discontinuities in unit thicknesses.



Base from U.S. Geological Survey Scale 1:2,500,000

Figure 3.--Thickness, recharge, and discharge areas, Mississippi embayment aquifer system.

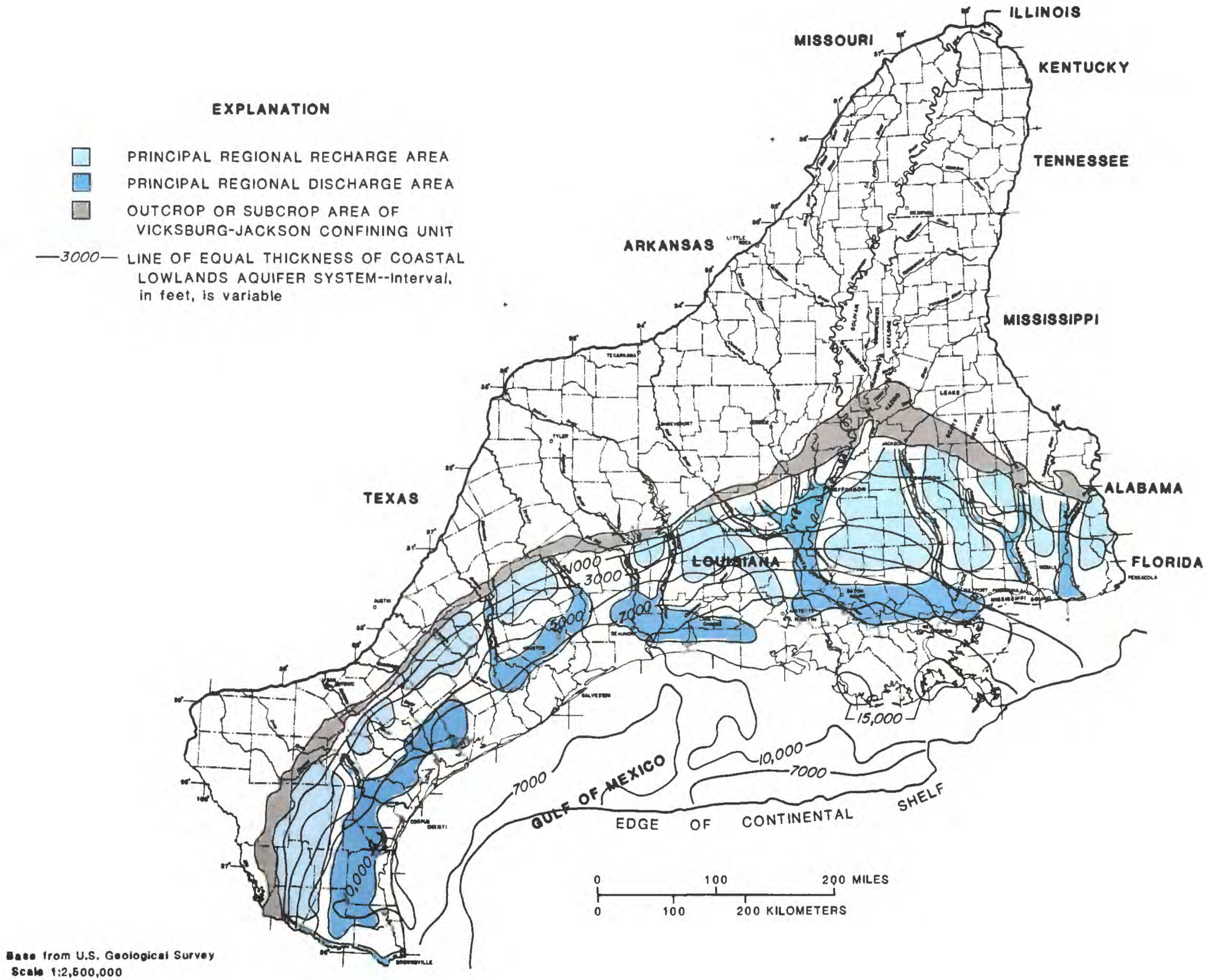


Figure 4.--Thickness, recharge, and discharge areas, coastal lowlands aquifer system.

Table 1.--Geologic units and comparison of aquifer terminology for the Mississippi embayment and coastal lowlands aquifer systems.

Mississippi embayment aquifer system

Geologic unit			Aquifers and references from regional studies	Geohydrologic units for the Gulf Coast Regional Aquifer-System Analysis	Aquifers and references from Mississippi reports
System	Series	Group			
Quaternary	Pleistocene and Holocene		Mississippi River Valley alluvial aquifer (Boswell and others, 1968)	Mississippi River Valley alluvial aquifer	Mississippi River Valley alluvial aquifer (Dalsin, 1978)
Tertiary	Eocene and Oligocene	Jackson and Vicksburg		Vicksburg-Jackson confining unit [1]	
	Eocene	Claiborne	Cockfield aquifer system (Payne, 1970) Cockfield Formation (Hosman and others, 1968)	upper Claiborne aquifer	Cockfield aquifer (Spiers, 1977a)
			Sparta hydraulic system (Payne, 1968) Sparta Sand (Hosman and others, 1968) Memphis aquifer (Hosman and others, 1968)	middle Claiborne aquifer	Sparta aquifer system (Newcome, 1976)
			Carrizo and Meridian Sand aquifer (Payne, 1975) Carrizo Sand and Meridian-Upper Wilcox aquifer (Hosman and others, 1968)	lower Claiborne-upper Wilcox aquifer	Winona-Tallahatta aquifer (Spiers, 1977b) Meridian-upper Wilcox aquifer (Boswell, 1976b)
		Wilcox	Wilcox Group (Hosman and others, 1968)	middle Wilcox aquifer	(not considered a major aquifer in Mississippi)
	Paleocene		Lower Wilcox aquifer (Hosman and others, 1968)	lower Wilcox aquifer	lower Wilcox aquifer (Boswell, 1976a)
		Midway		Midway confining unit [1]	
Cretaceous	Upper Cretaceous		Ripley Formation (Boswell and others, 1965)	Upper Cretaceous aquifer	Ripley aquifer (Boswell, 1978b)

Table 1.--Geologic units and comparison of aquifer terminology for the Mississippi embayment and coastal lowlands aquifer systems--Continued.

Coastal lowlands aquifer system

Geologic unit			Aquifers and references from regional studies	Geohydrologic units for the Gulf Coast Regional Aquifer-System Analysis	Aquifers and references from Mississippi reports
System	Series	Group			
Quaternary	Pleistocene and Holocene		Chicot reservoir (Jones and others, 1956) Chicot aquifer (Meyer and Carr, 1979)	upper Pleistocene aquifers	
Tertiary	Pliocene		Evangeline aquifer (Whitfield, 1975) Evangeline aquifer (Meyer Carr, 1979)	lower Pleistocene-upper Pliocene aquifers	Citronelle aquifers
	Miocene		Jasper aquifer (Whitfield, 1975) '2,000-foot' sand of the Baton Rouge area (Torak and Whiteman, 1982)	lower Pliocene-upper Miocene aquifers middle Miocene aquifers lower Miocene-upper Oligocene aquifers	Miocene aquifer system (Newcome, 1975)
	Eocene and Oligocene	Jackson and Vicksburg		Vicksburg-Jackson confining unit [1]	Oligocene aquifer system (Gandl, 1979)

[1] The confining units are defined as the massive clay section (with interbedded sands) of the Midway Group and the undifferentiated Jackson and Vicksburg Groups that are recognizable on geophysical logs. The recognizable lithologic unit may not be equivalent to the geologic unit as determined by fossils or other means of correlation and dating, because the upper or lower part of either the Midway Group or the undifferentiated Jackson and Vicksburg Groups may be sandy and therefore included in the adjacent aquifer. The Midway confining unit was referred to as the Coastal Uplands confining unit and the Vicksburg-Jackson confining unit was referred to as the Coastal Lowlands confining unit by Grubb, (1984, p. 11).

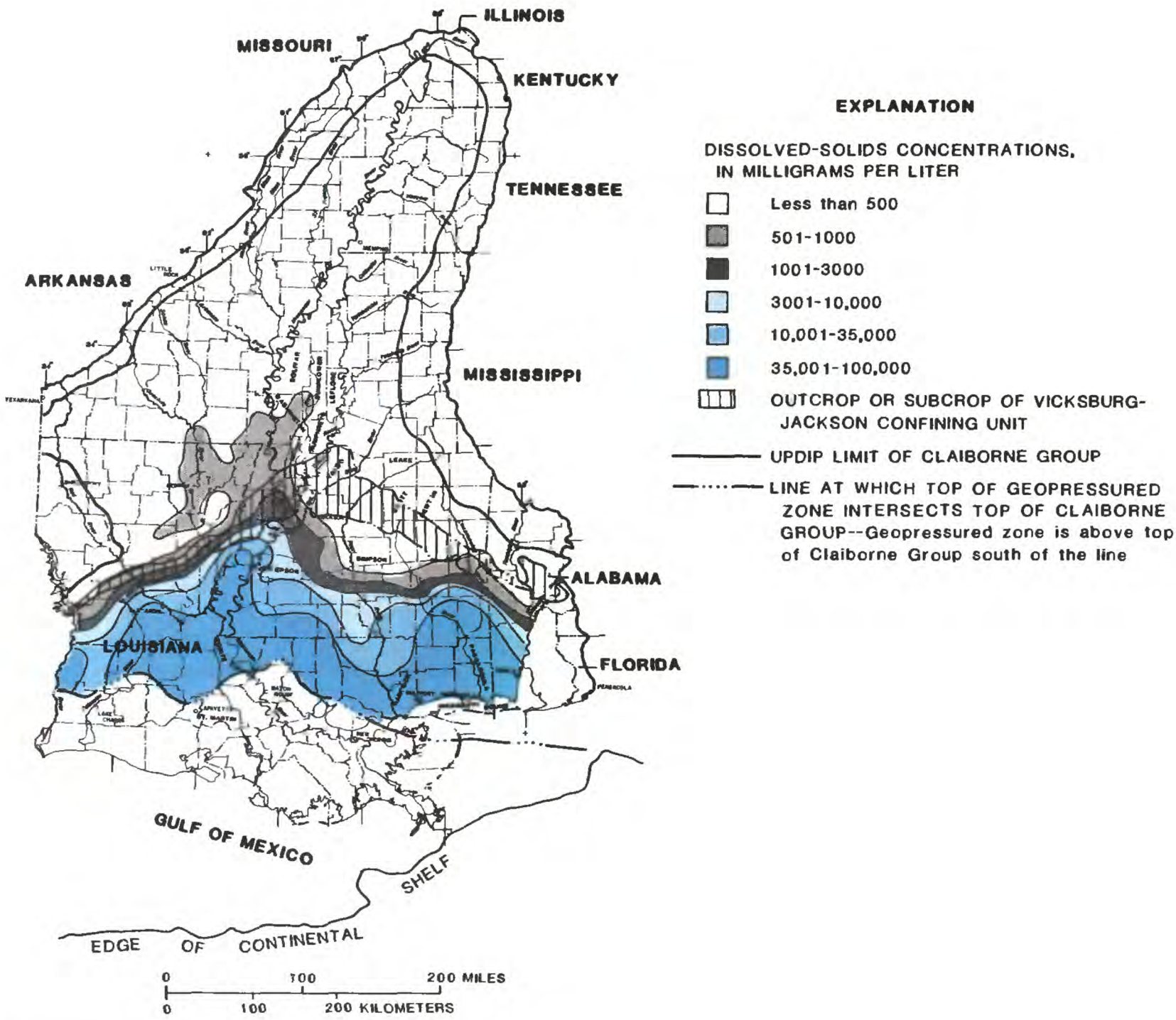
GROUND-WATER CHEMISTRY

The regional trend of dissolved solids is illustrated by the distribution of dissolved solids for water from the Claiborne Group (fig. 5, and R. A. Pettijohn, U.S. Geological Survey, written commun., 1985). Water with dissolved-solids concentration less than 1,000 milligrams per liter is available from an extensive area where aquifers of the Claiborne Group are present in the Mississippi embayment aquifer system. Salinity of the water increases to more than 10,000 milligrams per liter in a relatively short distance. The median value of dissolved solids for each 100-square-mile block generally increases from 1,000 milligrams per liter to more than 10,000 milligrams per liter in less than 20 miles (fig. 5).

A rectangular grid used for simulating ground-water flow was selected as a convenient and consistent way to summarize the water chemical data in the study area (R. A. Pettijohn, U.S. Geological Survey, written commun., 1985). The grid which was described by Grubb (1985) consists of blocks that are 10 miles on each side with the principal axis oriented at an angle of about 45° north. Median values for large thicknesses of sediments gives a regional perspective on the distribution of chemical properties in ground water and aids in the interpretation of water chemistry in the individual regional aquifers where the data coverage is less extensive.

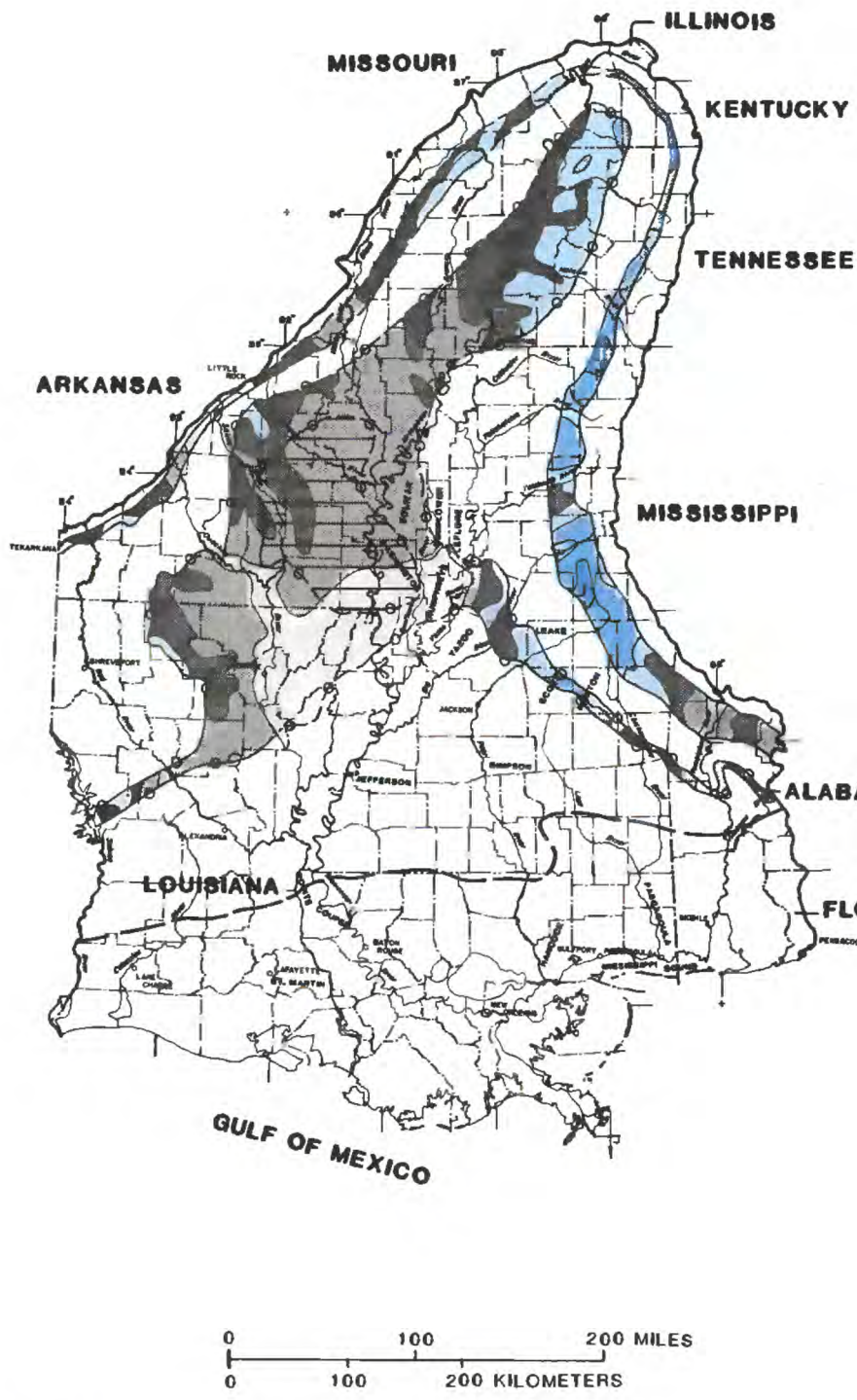
Dissolved-solids concentrations are small in water from the Claiborne Group in an area from Yazoo County, Mississippi, southeastward to Simpson County, Mississippi, downdip of the Vicksburg-Jackson confining unit outcrop area. On the west side of the Mississippi River, the area shown in figure 5 with 1,000 to 3,000 milligrams per liter dissolved solids closely parallels and is within a few miles of the updip limit of the Vicksburg-Jackson confining unit. On the east side of the Mississippi River, an area with a median dissolved solids of 1,000 to 3,000 milligrams per liter is as much as 30 miles south of the Vicksburg-Jackson confining unit outcrop area (fig. 5). This large area where relatively fresh water circulates south of the Vicksburg-Jackson confining unit outcrop area in south-central Mississippi is attributed to the location of the regional recharge area between the Big Black and the Tombigbee Rivers (figs. 3 and 6), the minimal permeability of the Vicksburg-Jackson confining unit, and the location of the regional discharge area associated with a topographic low in northeastern Louisiana.

Most of the thicker parts of each aquifer system contain moderately saline to very saline water. In the Mississippi embayment aquifer-system, water is moderately saline to very saline in most of a seven-county area in southwestern Mississippi. In the coastal lowlands aquifer system, water is moderately saline to very saline in parts of three counties in southwestern Mississippi and in parts of the three counties along the Mississippi Gulf Coast (fig. 5, and R. A. Pettijohn, U.S. Geological Survey, written commun., 1985).



Base from U.S. Geological Survey Scale 1:2,500,000

Figure 5.--Areal distribution of dissolved solids in water from rocks of the Claiborne Group, Mississippi embayment aquifer system.



Base from U.S. Geological Survey Scale 1:2,500,000

EXPLANATION

LAND-SURFACE ALTITUDE, IN FEET, ESTIMATED FROM U.S. GEOLOGICAL SURVEY DATA BASE DESCRIBED BY GODSON, 1981. NATIONAL GEODETIC VERTICAL DATUM OF 1929

- 51-100
- 101-200
- 201-300
- 301-400
- 401-500
- 501-600

ISOLATED AREA OF OCCURRENCE OF VICKSBURG-JACKSON CONFINING UNIT NORTH OF UNIT'S PRINCIPAL AREA OF OCCURRENCE

OUTCROP OR SUBCROP AREA OF MIDDLE AND LOWER WILCOX AQUIFERS--Dashed where covered by Mississippi River Valley alluvial aquifer

OUTCROP OR SUBCROP AREA OF UPPER CLAIBORNE AQUIFER--Dashed where covered by Mississippi River Valley alluvial aquifer

DOWNDIP LIMIT OF UPPER CLAIBORNE AQUIFER

Figure 6.--Land-surface altitude in the outcrop and subcrop areas of the lower and middle Wilcox aquifers, and the upper Claiborne aquifers, Mississippi embayment aquifer system.

GROUND-WATER PUMPAGE

About 9,600 million gallons per day of ground water was pumped from the aquifers in the study area during 1980 (table 2). About 15 percent of that pumpage (or about 1,400 million gallons per day) was in Mississippi, mostly from the Mississippi River Valley alluvial aquifer of the Mississippi embayment aquifer system. About 10 percent of the Mississippi pumpage, or 140 million gallons per day, was from the coastal lowlands aquifer system. Among the States in the study area, the largest volume of ground-water pumpage for 1980 was from Arkansas which accounted for about 41 percent of the total. Among the aquifer systems, the largest quantity of pumpage, about 63 percent (or about 6,000 million gallons per day), was from the Mississippi embayment aquifer system, about 32 percent of the total was from the coastal lowlands aquifer system, and about 5 percent was from the Texas coastal uplands aquifer system.

Bolivar County, Mississippi, is 1 of 4 counties in the study area where ground-water pumpage was estimated at more than 250 million gallons per day during 1980 (Grubb, 1985). Ground-water pumpage was more than 100 million gallons per day from 33 counties in the study area including 5 counties in Mississippi: Bolivar, Humphreys, Leflore, Sunflower, and Washington (Callahan, 1983, and Grubb, 1985).

GROUND-WATER FLOW

Parts of Mississippi are major regional recharge areas for both the Mississippi embayment aquifer system and the coastal lowlands aquifer system (fig. 3 and 4). Simulation of flow conditions prior to pumping ground water (referred to as predevelopment) also indicates that the Mississippi Alluvial Plain or 'Delta' area of Mississippi is part of a much larger regional discharge area that extends northward and westward into parts of eastern Arkansas and northeastern Louisiana and southeastern Missouri (fig. 3). However, the primary predevelopment discharge area for much of the recharge to the coastal lowlands aquifer system in Mississippi is mostly in Louisiana south of the outcrop area of the Vicksburg-Jackson confining unit (fig. 4).

Table 2. -- Ground-water pumpage in million gallons per day, for 1980, by State and aquifer or aquifer system.

State	Mississippi embayment aquifer system			Coastal lowlands aquifer system	Texas coastal uplands aquifer system	Total
	Mississippi River Valley alluvial aquifer	Aquifers in sediments of Tertiary age	Upper Cretaceous aquifer			
Alabama	--	10	--	50	--	60
Arkansas	3,700	250	10	--	--	3,960
Florida	--	--	--	80	--	80
Kentucky	--	10	<10	--	--	>10
Louisiana	160	90	--	1,500	--	1,750
Mississippi	1,140	150	--	140	--	1,430
Missouri	220	<10	<10	--	--	>220
Tennessee	<1	250	10	--	--	260
Texas	--	--	--	1,360	460	1,820
Total	5,220	760	>20	3,130	460	9,590

The following discussion of recharge and discharge areas is based on preliminary results of ground-water-flow simulation using a variable-density flow model developed by Kuiper (1983, and 1985) and a regional-scale model grid described by Grubb (1985). A constant-head layer was used to represent the regional predevelopment water table in the outcrop area of each aquifer. A uniform value of hydraulic conductivity was used for each individual regional aquifer. Therefore, the transmissivity varied areally as a function of thickness and sand percent (A. K. Williamson and J. S. Weiss, U.S. Geological Survey, written commun., 1985). The boundaries of each regional aquifer extend downdip from the outcrop area to the point where permeability becomes negligible due to facies changes or to the presence of geopressure. Details of the preliminary analysis will be refined with further work. However, insights into the nature of the regional flow have been gained by examining the preliminary results of ground-water-flow simulation in view of aquifer-system geometry and theoretical considerations.

Principal predevelopment regional recharge areas for the Mississippi embayment aquifer system are in and near the outcrop areas along the eastern side of the Mississippi embayment (fig. 3). Water that enters the lowermost aquifers in sediments of Eocene age, and that is not part of the local or intermediate flow system, is discharged to the Mississippi Alluvial Plain of Mississippi, Arkansas, Louisiana, and Missouri.

Predevelopment flow in the lower and middle Wilcox aquifers was from the high land surface outcrop areas in Mississippi, Tennessee, and Kentucky, and to a smaller extent from the outcrop areas along the western side of the Mississippi embayment toward the center of the Mississippi River Alluvial Plain. These sediments occur at the land surface along a band about 140 miles long and from 15 to 20 miles wide between the valleys of the Tombigbee and Yalobusha Rivers in east-central Mississippi (fig. 6). In this area, the land surface typically is between 400 and 500 feet above sea level. On the west side of the Mississippi embayment in Arkansas, there are only three small areas where the land-surface altitude is above 300 feet in the outcrop area of these sediments. The location of major regional recharge and discharge areas is determined by the greater energy level of the flow system on the east side of the Mississippi embayment, the less permeable rocks that comprise the Vicksburg-Jackson confining unit to the south, and the low land-surface altitude in northern Louisiana, southeastern Arkansas, and west-central Mississippi.

Regional predevelopment ground-water flow in the upper Claiborne aquifer primarily was from the areas of relatively high land surface altitude in western Kentucky, western Tennessee, central Mississippi, and from vertical leakage from four underlying aquifers to the regional discharge areas shown in figure 3.

Flow from the recharge areas in western Kentucky and Tennessee to the Mississippi River Valley alluvial aquifer in the regional discharge area occurs within a relatively short distance (figs. 3 and 6) because the upper Claiborne aquifer occurs only in a band about 50 miles wide and 200 miles long from east-central Arkansas to western Kentucky and because of the contrast in land surface altitude from east to west in this area (fig. 6).

It appears that a large area of the upper Claiborne aquifer receives significant quantities of leakage from the four underlying aquifers, especially in areas where the regional discharge areas and the upper Claiborne aquifer is coincident.

The shape of the regional discharge area in northeastern Louisiana, central Mississippi, and southeastern Arkansas, largely north of the major occurrence of the Vicksburg-Jackson confining unit and around the isolated area of the same unit in southeastern Arkansas and central Mississippi indicates that the Vicksburg-Jackson confining unit is a major restriction to vertical flow. Relatively high land-surface altitudes and the resulting configuration of the water table in the coastal lowlands aquifer system through southern Mississippi also may be affecting vertical flow through the Vicksburg-Jackson confining unit. Regional flow from the recharge area of Leake, Scott, and Newton Counties, Mississippi (fig. 3) to the discharge area of northeastern Louisiana occurs throughout a large area in south-central Mississippi. In this area, the dissolved-solids concentration of water from the Claiborne Group is much less than commonly is observed downdip of the Vicksburg-Jackson confining unit.

Two of several large areas of regional ground-water recharge to the coastal lowlands aquifer system are in the southern part of Mississippi (fig. 4). A large area of relatively high land between the valleys of the Mississippi and Pearl Rivers is one of the largest predevelopment regional recharge areas in the study area. Another narrow elongate area to the east between the Pearl and the Pascagoula Rivers also is an important predevelopment regional recharge area. The regional discharge area for these two recharge areas is to the three rivers mentioned above and to an area of relatively low land along the Mississippi River which is continuous with the large discharge area across southeastern Louisiana from Pointe Coupee and St. Martin Parishes, Louisiana, to the Mississippi Sound.

Major variations in subsurface permeability in the aquifer systems of the study area have been accounted for in the delineation of regional aquifers and confining units. The configuration of the water table is known from maps prepared as part of this study (Hosman, 1985). The above discussion of flow patterns, discharge, and recharge areas indicate that the principal features of regional, predevelopment ground-water flow can be explained in terms of the water-table configuration and the delineation of regional subsurface permeability. Although there are many large structural features like the Jackson dome, the Mississippi salt basin, and numerous faults, which effect the regional geology the effects on regional predevelopment ground-water flow are small compared to the effects of the water-table configuration and the subsurface permeability. These results are consistent with the work of Freeze and Witherspoon (1967). They demonstrated that two of the most important factors affecting steady-state regional ground-water flow are the water-table configuration and the stratigraphy and resulting subsurface variations in permeability.

SUMMARY

The Gulf Coast RASA is one of several regional studies being conducted as part of the U.S. Geological Survey's Regional Aquifer-System Analysis program which is designed to provide a regional understanding and assessment of the Nation's ground-water resources. Only two of three regional aquifer systems identified in the study area occur in Mississippi; the Mississippi embayment and the coastal lowlands aquifer systems. Each of these systems is more than 5,000 feet thick in parts of Mississippi. Regional trends of dissolved-solids concentrations indicate that the salinity of water commonly increases from 1,000 milligrams per liter to more than 10,000 milligrams per liter in relatively short distances. The compilation of 1980 ground-water-pumpage data indicates that about 9,600 million gallons per day were withdrawn from aquifers in the study area and about 15 percent of the total was from aquifers in Mississippi. Results of the preliminary simulation of ground-water flow indicates that predevelopment regional recharge areas for both the Mississippi embayment aquifer system and the coastal lowlands aquifer system were located in Mississippi. The 'Delta' area of Mississippi is part of a much larger regional discharge area located in parts of northeastern Louisiana, eastern Arkansas, and southeastern Missouri.

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