PLANNING REPORT FOR THE GULF COAST REGIONAL AQUIFER-SYSTEM ANALYSIS IN THE GULF OF MEXICO COASTAL PLAIN, UNITED STATES

By Hayes F. Grubb

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 84-4219

Austin, Texas
1984

UNITED STATES DEPARTMENT OF THE INTERIOR

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For those readers interested in metric units, the factors for converting inch-pound units to the International System (SI) of Units are given below:

Multiply inch-pound units	By	To obtain SI units
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
million gallons per day (Mgal/d)	0.0438	cubic meter per second (m^3/s)

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ABSTRACT

Large quantities of water for municipal, industrial and agriculture use are supplied from the aquifers in Tertiary and younger sediments over an area of about 225,000 square miles in the Coastal Plain of Alabama, Arkansas, Florida, Illinois, Kentucky, Louisiana, Mississippi, Missouri, Tennessee, and Texas. Three regional aquifer systems, the Mississippi Embayment aquifer system, the Coastal Lowlands aquifer system, and the Texas Coastal Uplands aquifer system have been developed to varying degrees throughout the area. A variety of problems has resulted from development such as movement of the saline-freshwater interface into parts of aquifers that were previously fresh, lowering of the potentiometric surface with resulting increases in pumping lift, and land-surface subsidence due to the compaction of clays within the aquifer. Increased demand for ground water is anticipated to meet the needs of urban growth, expanded energy development, and growth of irrigated agriculture. The U. S. Geological Survey initiated an eight-year study in 1981 to define the geohydrologic framework, describe the chemistry of the ground water, and to analyze the regional ground-water flow patterns. The objectives, plan, and organization of the study are described in this report and the major tasks to be undertaken are outlined.

INTRODUCTION

The Gulf Coast Regional Aquifer-System Analysis (RASA) study area covers an area of about 225,000 square miles onshore in parts of Alabama, Arkansas, Florida, Illinois, Kentucky, Mississippi, Missouri, Tennessee, Texas, and all of Louisiana (fig. 1). The study area also includes several thousand square miles offshore because the aquifers extend beyond the coast line beneath the Gulf of Mexico. The study is limited to the Coastal Plain sediments of Tertiary and younger age except for an area in the Mississippi embayment where Upper Cretaceous sediments supply ground water in parts of several states. The sediments are thin in and near the outcrop areas but attain thicknesses of several thousand feet downdip. None of the individual aquifers is continuous throughout the study area and some cover only a few hundred square miles and are therefore primarily of local significance. Some of the aquifers in sediments of Eocene age are present in as many as eight of the ten states and supply large quantities of fresh ground water for municipal, industrial, and agricultural use.

Increased demand for ground water is anticipated in the Gulf Coast study area in the 1980's and beyond to meet the needs of urban growth, expanded energy development in the petroleum industry and in the lignite and uranium mining industries, and the spread of irrigated agriculture.

The impact of ground-water withdrawals to date has already become regional in nature. Water-level declines have migrated across local and state political boundaries beyond the immediate vicinity of cities, industries, and irrigated lands where the water is pumped.

This study is one of several studies being conducted of the most important regional aquifers by the U.S. Geological Survey to provide a regional understanding and assessment of the Nation's ground-water resources (Bennett, 1979).

Relation To Other Studies

Three other regional aquifer studies are under way or have been completed in areas adjacent to the Gulf Coast study area (fig. 1). A potential exists for water to flow between the aquifers in these study areas and the aquifers of the Gulf Coast study area. However, either the size of the areas of coincidence is small or the vertical permeabilities are believed to be small; thus the quantities of flow are expected to be relatively small and will be included as a known flux in each of the studies of regional flow.

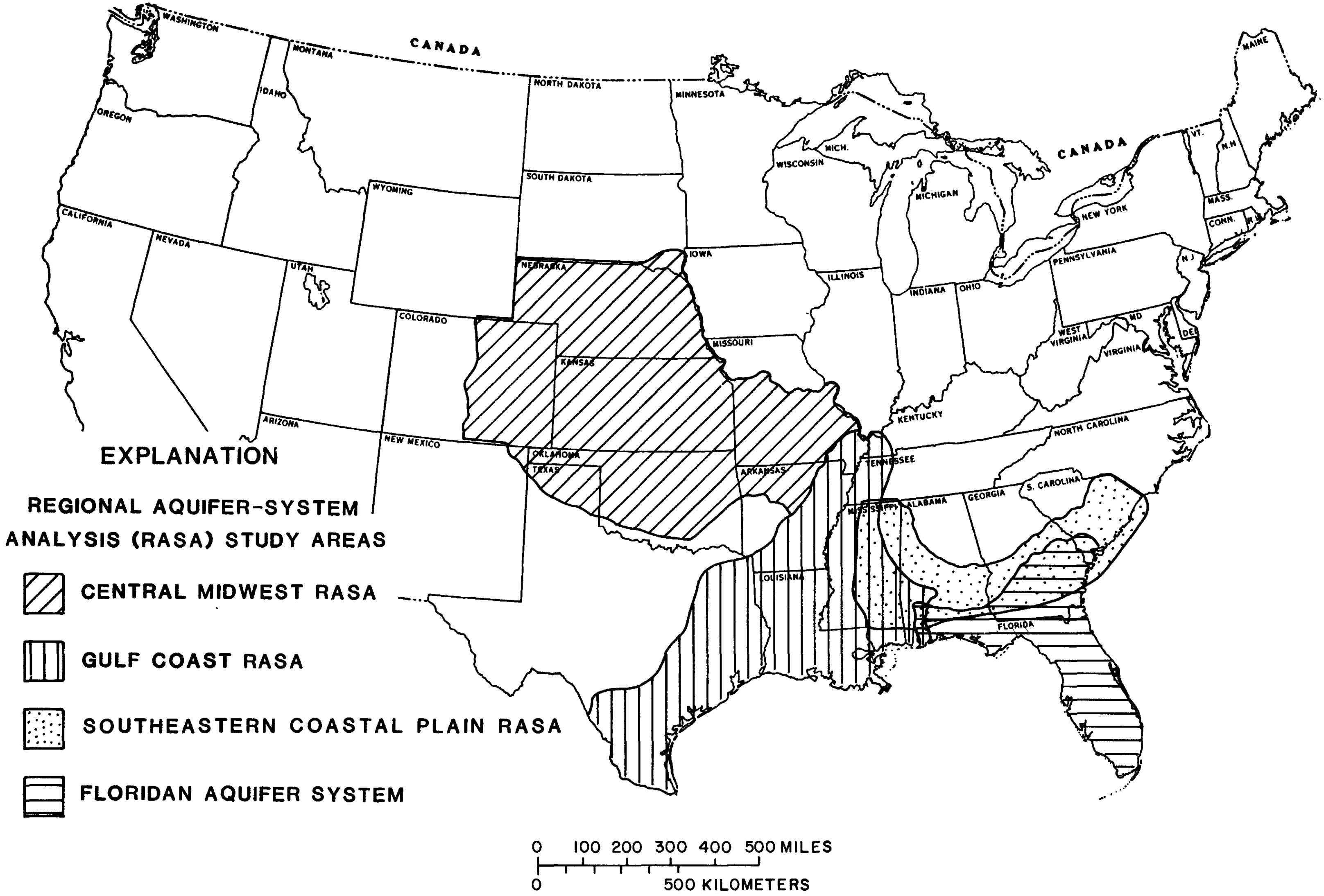

Figure I.--Gulf Coast Regional Aquifer-System Analysis study area and adjacent Regional Aquifer-System Analysis study areas.

The Floridan Aquifer System is restricted to the Tertiary carbonate aquifer of the southeastern United States (Johnston, 1978). The study's western boundary is in south-central Alabama (fig. 1) where the carbonate facies changes to the marine clays of the Jackson and Vicksburg Groups which is a regional confining bed in the Gulf Coast study area.

The Southeastern Coastal Plain Regional Aquifer-System Analysis is restricted to the Cretaceous and Tertiary aquifers of South Carolina, Georgia, and eastern Alabama. In western Alabama and eastern Mississippi (fig. 1) the Southeastern Coastal Plain Aquifer study is restricted to the Cretaceous aquifers which are separated from the Gulf Coast aquifers in sediments of Tertiary age by the Midway Group. The Midway Group contains an aquifer in Georgia and east central Alabama but is a confining system composed of thick marine clays in west central Alabama and throughout Mississippi.

The Central Midwest Regional Aquifer-System Analysis (fig. 1) is restricted to the Paleozoic rocks in areas adjacent to the Gulf Coast study area in northeastern Arkansas and southeastern Missouri (Jorgensen, 1981). The Paleozoic rocks extend beneath the Upper Cretaceous sediments in the Mississippi embayment but are not used as a source of water supply in the Gulf Coast study area because there is plenty of water available above the Paleozoic rock units. The Paleozoic rocks are generally less permeable than the Upper Cretaceous sediments but some water may move vertically from the Paleozoic rocks to the Upper Cretaceous sediments.

Problems

Among the problems facing users of ground water in the Gulf Coast study area are: (1) increasing competition between users as overall water demand increases, (2) movement of the saline-freshwater interface into parts of aquifers that were previously fresh, (3) lowering of the potentiometric surface with the resulting increase in pumping lift, (4) land-surface subsidence due to the withdrawal of ground water which causes the compaction of interbedded clays within the aquifer, and (5) a lack of understanding of the interaction of the fresh and saline part of the flow system especially as it relates to man-induced stresses such as large scale pumping of freshwater or injection of fluids into permeable zones containing saline water. Extensive areas where the potentiometric surface has been lowered by pumping and areas of land surface subsidence are shown on figure 2.

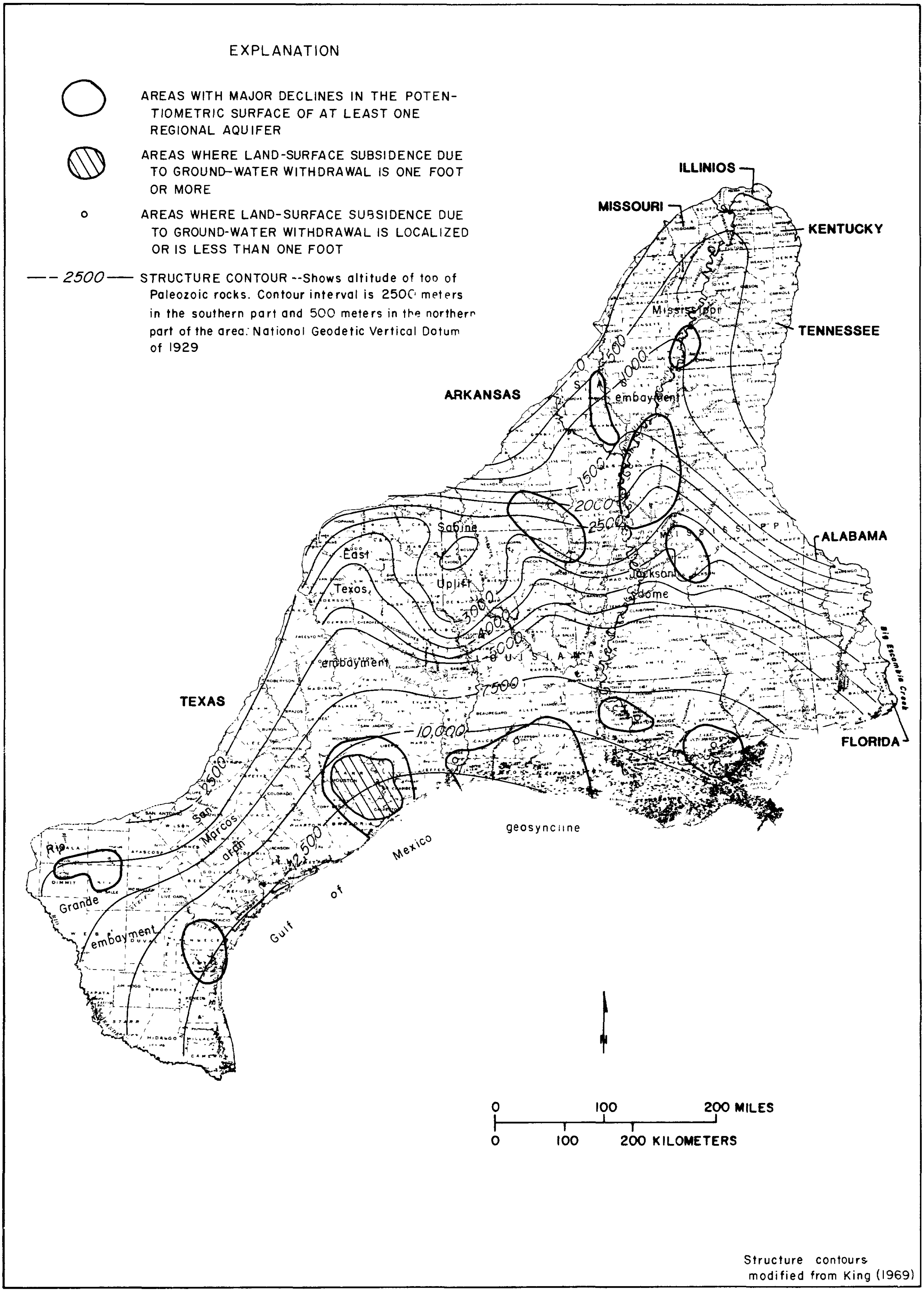

Figure 2.--Altitude of the top of Paleozoic rocks and problems related to ground water pumpage in the Gulf Coast Regional Aquifer-System Analysis study area.

OBJECTIVES

The objectives of the study are to define the geohydrologic framework in which the aquifers exist, describe the chemistry of the ground water, and analyze the regional ground-water flow patterns within the flow system. Each of these objectives is discussed in detail in the Plan of Study section of this report.

APPROACH

A regionally consistent geohydrologic framework will be delineated from previously collected data. The data will include geophysical well logs, interpretative reports, data from the U. S. Geological Survey's WATSTORE files, files of other Federal and State agencies, and data collected by the petroleum industry that is available from commercial sources.

Regional scale ground-water flow models will be constructed using the geohydrologic framework. Aquifer and confining bed characteristics, pumpage and aquifer responses will be assembled from data in the WATSTORE files, interpretative reports, and data from the files of other Federal and State agencies. Several subregional-scale ground-water flow models will be constructed for parts of the study area where it is determined that a more detailed analysis is needed in either the horizontal or vertical dimension.

The ground-water chemistry will be described from previously collected data. The data will include chemical analysis of ground water from the WATSTORE file, interpretative reports, files of other Federal and State agencies, and data collected by the petroleum industry that is available from commercial sources. Very little of the chemical analysis of ground water is expected to be suitable for chemical equilibrium modeling. Therefore collection of ground-water samples is planned specifically for the purpose of the chemical equilibrium modeling.

HYDROLOGIC SETTING

The Gulf Coast study area is in the Gulf Coastal Plain physiographic province of the United States. Among the major structural features are the Mississippi embayment, the Gulf of Mexico geosyncline, the Sabine uplift, the San Marcos arch, the Jackson dome, the East Texas embayment, and the Rio Grande embayment (fig. 2).

The sediments within the study area are composed predominately of alternating beds of sand and clay with some interbedded gravel, silt, lignite, and limestone. The thick sequence of marine clays that make up the Midway Group restricts the flow of water between the sediments of Cretaceous age and the sediments of Eocene age and acts as a regional confining bed.

The sediments that comprise the individual aquifers and associated confining beds are exposed at land surface in narrow bands several miles wide that roughly parallel the present Gulf of Mexico coastline. Significant interruptions of this general outcrop pattern occur around the Sabine uplift and around the head of the Mississippi embayment (fig. 3). The Miocene and the Pliocene and Pleistocene sediments with the exception of the alluvium of the Mississippi River, crop out in a similar pattern that parallels the present Gulf shoreline. However, these outcrop patterns show little influence from the Sabine uplift or the Mississippi embayment.

The sediments in the study area generally dip toward the Gulf of Mexico geosyncline and tend to become thicker and less permeable gulfward of the outcrop area. The regional ground-water flow pattern in these sediments is interrupted downdip by growth faulting or by a zone of abnormally high fluid pressure called the geopressure zone. An extensive area of geopressure exists onshore in a band about 80 miles wide and approximately parallel to the coast line from the Rio Grande River to the southern tip of Mississippi (Wallace and others, 1979). The depth to the top of the geopressure zone in Texas is typically less than 10,000 feet, and in a few areas it is no more than 3,000 to 4,000 feet deep. In southern Louisiana the top of the geopressure is generally greater than 10,000 feet, and in a few areas it is as deep as 18,000 to 20,000 feet.

The dissolved solids content of water in the aquifers of the Gulf Coast study area varies among individual aquifers and with distance from the aquifer outcrop area. Typically the salinity of the water increases downdip from the outcrop area.

Regional Aquifer Systems

Three regional aquifer systems are delineated in the Gulf Coast study area; the Mississippi Embayment aquifer system, the Texas Coastal Uplands aquifer system, and the Coastal Lowlands aquifer system (fig. 4). The designation of these aquifer systems is based upon differences in the geologic frame-work, regional ground-water flow patterns, and the presence of two or more significant regional aquifers.

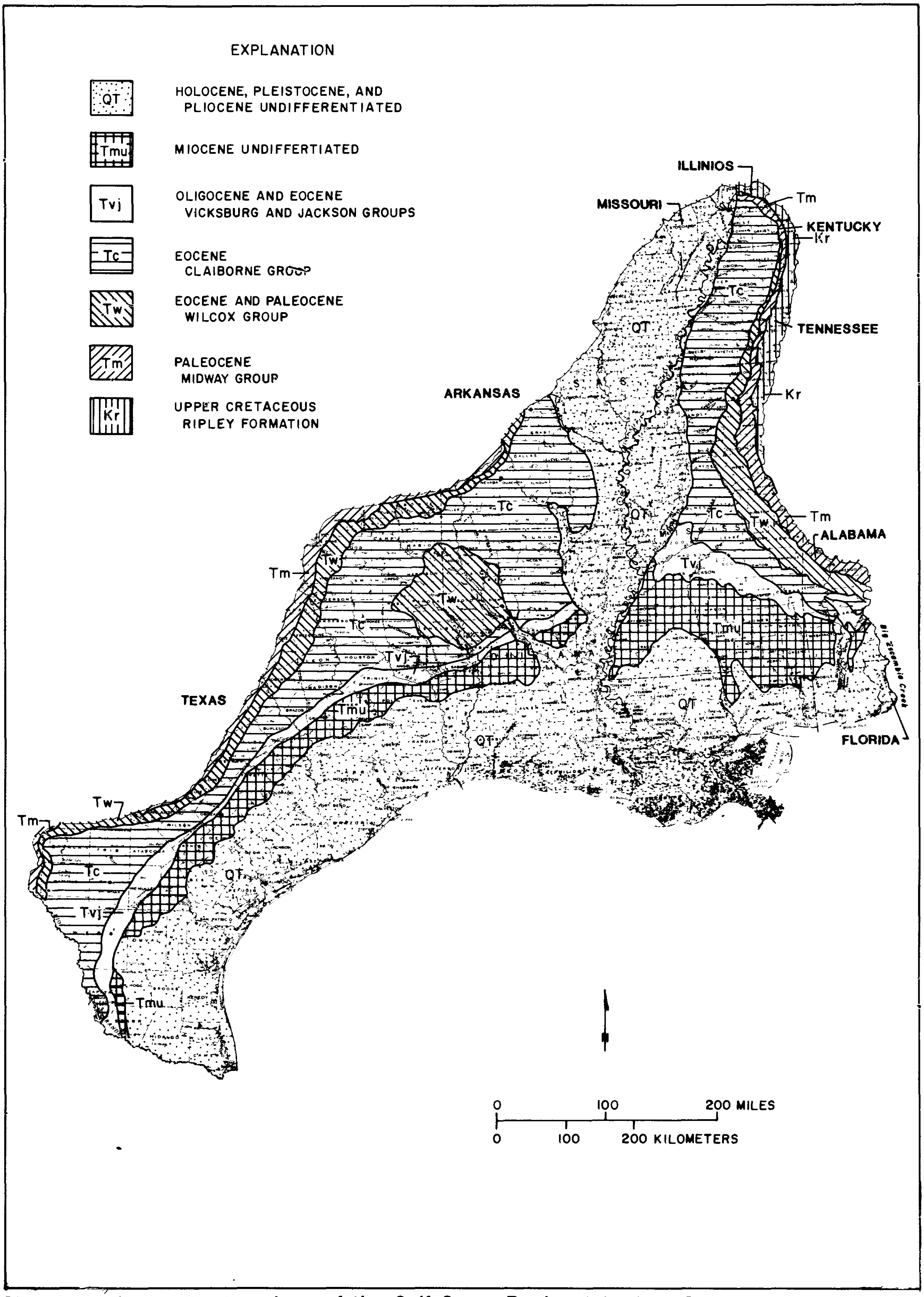

Figure 3.--Generalized geology of the Gulf Coast Regional Aquifer-System Analysis study area.

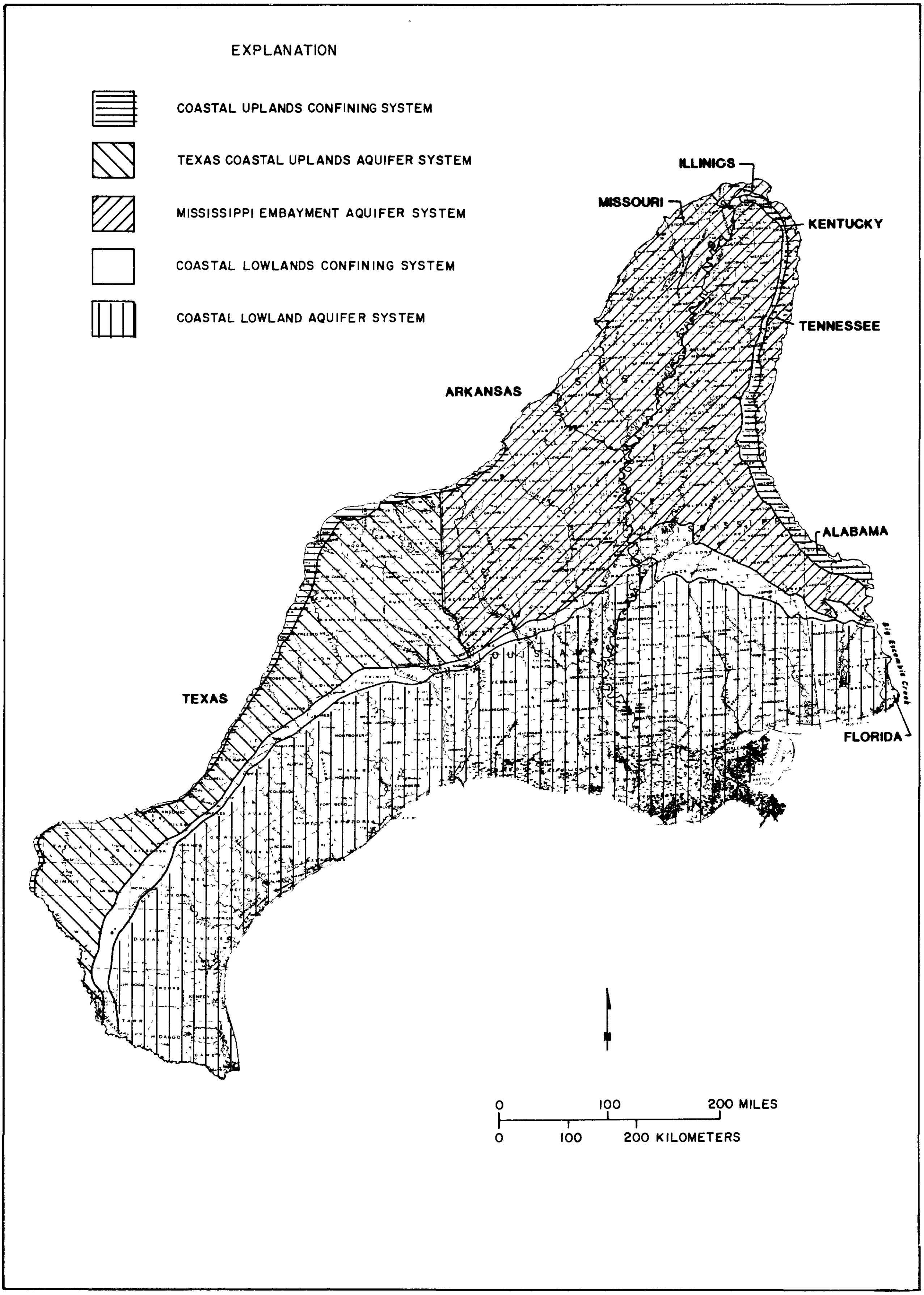

Figure 4.--Generalized outcrop of major aquifer systems and confining systems in the Gulf Coast Regional Aquifer-System Analysis study area

The differences in ground-water flow patterns and the distribution of fine-grained sediments illustrates the basis for delineating the three aquifer systems. The regional ground-water flow in the Mississippi Embayment aquifer system is generally from the outcrop areas around the margin of the Mississippi embayment toward the Mississippi River. In the Texas Coastal Uplands aquifer system the regional ground-water flow is generally from the outcrop areas toward the Gulf of Mexico. The bulk of fine-grained sediments in the Mississippi Embayment aquifer system and in the Texas Coastal Uplands aquifer system are generally found as massive clays that can be traced over large areas both at the surface and in the subsurface by use of geophysical well logs. The fine-grained sediments in the Coastal Lowlands aquifer system are typically thinner, cannot be traced over large areas and are dispersed throughout the aquifer.

Mississippi Embayment Aquifer System

The Mississippi Embayment aquifer system consists primarily of the sediments of Tertiary age above the upper-most massive marine clay of the Midway Group and below the lower-most massive marine clay of the Jackson Group or the Jackson and Vicksburg Groups where they are undifferentiated. Upper Cretaceous sediments that underlie the Midway Group in an area of about 25,000 square miles in the northern-most part of the Mississippi embayment are also included in the Mississippi embayment aquifer system. The Upper Cretaceous sands are hydraulically isolated from the extensive aquifers of Cretaceous age to the south and southeast by calcareous and clayey sediments of low permeability. The sediments that make up the Mississippi Embayment aquifer system are exposed at land surface from the southern tip of Illinois to the Jackson and Vicksburg outcrop belt in central Louisiana, central Mississippi and southwestern Alabama (fig. 2 and 3). The eastern limit of the aquifer system is the contact between sediments of Cretaceous and Paleozoic age in western Kentucky and the outcrop belt of the Ripley Formation of Cretaceous age in northeastern Mississippi and western Tennessee. The western limit of the system is the Texas-Louisiana State line, which runs in a north-south direction approximately through the center of the surface expression of the Sabine uplift, which disrupts the general outcrop pattern of Tertiary sediments (fig. 3).

Eight aquifers of regional significance have been mapped in the Mississippi embayment aquifer system, the oldest is the Ripley Formation in sediments of Upper Cretaceous age and the youngest is the Mississippi River Valley alluvial aquifer of Holocene and Pleistocene age (table 1). There is some overlap in the area mapped by the different investigators but none of the aquifers of Tertiary age has been mapped throughout its area of occurrence within the study area. The hydraulic conductivity is generally lowest in sediments of the Wilcox Group and highest in sediments of the Mississippi River alluvium (table 1).

Table 1.--Summary of the relationship and characteristics of previously mapped regional aquifers to geology and confining systems in the Mississippi Embayment aquifer system.

Geologic unit			Aquifers, reference containing maps and confining systems	Aquifer characteristics				Approximate area mapped in square miles								
System	Series	Group		Maximum mapped thickness (ft)	Hydraulic conductivity (ft/d)	Transmissivity (ft^2/d)	Storage coefficient	TOTAL	Alabama	Arkansas	Illinois	Kentucky	Louisiana	Mississippi	Missouri	Tennessee
Quaternary	Pleistocene and Holocene		Mississippi River Valley Alluvial aquifer (Boswell and others, 1968)	250	60-450	---	0.0003-0.14	40,000	[4]	25,900	200	200	4,100	5,700	3,300	600
Tertiary	Eocene and Oligocene	Jackson and Vicksburg	Coastal Lowlands confining system [1]													
	Eocene	Claiborne	Cockfield aquifer system (Payne, 1970)	1,150	10-70	1,300-13,000	---	22,000	[illegible]	[2]	[4]	[4]	7,400	14,600	[illegible]	[illegible]
			Cockfield Formation (Hosman and others, 1968)	700	30-120	---	0.0001-0.0008	28,000	[illegible]	11,200	[illegible]	[4]	5,900	11,100	[illegible]	[illegible]
			Memphis aquifer (Hosman and others, 1968)	870	30-270	---	0.0001-0.01	15,500	[illegible]	5,200	[3]	1,400	[4]	500	2,000	6,400
			Sparta Sand (Hosman and others, 1968)	1,100	10-170	---	0.0001 0.002	38,000	[3]	12,600	[4]	[4]	8,400	17,000	[4]	[4]
			Sparta hydraulic system (Payne, 1968)	1,200	30-80	3,300-33,000	---	41,100	[2]	6,300	[illegible]	[illegible]	14,400	20,400	[illegible]	
			Carrizo and Meridian Sand aquifer (Payne, 1975)	450	30-60	2,000-22,000	---	45,500		8,000	[4]	[4]	15,400	22,100	[4]	[illegible]
		Claiborne / Wilcox	Carrizo Sand and Meridian-Upper Wilcox aquifer (Hosman and others, 1968)	400	5-130	---	0.0001-0.003	34,800	[3]	12,600	[illegible]	[illegible]	4,000	18,200	[illegible]	[4]
		Wilcox	Wilcox Group (Hosman and others, 1968)	2,200	9-60	---	0.00002-0.0002	44,900	300	12,800	[3]	1,500	4,000	17,500	2,200	6,600
	Eocene / Paleocene		Lower Wilcox aquifer (Hosman and others, 1968)	---	70-170	---	0.0002-0.015	27,500	200	5,600	[3]	1,500	[4]	11,600	2,100	6,500
	Paleocene	Midway	Coastal Uplands confining system [1]													
Cretaceous	Upper Cretaceous		Ripley Formation (Boswell and others, 1968)	500	---	3,300-4,300	0.0001-0.0008	27,200	[illegible]	7,200	500	2,300	[4]	5,200	3,500	8,500

[1] The confining systems are defined as the massive clay section (with interbedded sand) of the Midway Group and the undifferentiated Jackson and Vicksburg Groups that are recognizable on geophysical well logs. The recognizable lithologic unit may not be exactly equivalent to the geologic unit as determined by fossils on 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.

[2] Aquifer present in the State but not mapped by this investigator.

[3] Less than 100 square miles.

[4] Aquifer not present in State.

Texas Coastal Uplands Aquifer System

The Texas Coastal Uplands aquifer system consists of the sediments of Tertiary age above the uppermost massive clay of the Midway Group and below the lower-most massive clay of the Jackson Group or the Jackson and Vicksburg Groups where they are undifferentiated. The sediments that make up the Texas Coastal Uplands aquifer system are exposed at land surface gulfward of the narrow band of Midway outcrop to a narrow outcrop band of the Jackson and Vicksburg Groups which is located about 100 miles inland from the Gulf of Mexico. The eastern limit of the aquifer system is the Texas-Louisiana State line. The southwestern limit of the aquifer system is the Rio Grande River.

Seven aquifers of regional significance have been identified in the Texas Coastal Uplands aquifer system, the oldest in sediments of the Wilcox Group and the youngest in sediments of the Yegua Formation of the Claiborne Group (table 2). The lowest estimates for hydraulic conductivity were reported for the Queen City Sand and the Reklaw Formation. Jones and others (1976) did not report estimates of hydraulic conductivity for sediments of the Wilcox Group, however the sediments are similar to the Wilcox Group mapped by Hosman and others (1968). The highest estimates for hydraulic conductivity are for the Sparta hydraulic system (table 2) although the upper estimate is only slightly higher than the highest estimates for the Carrizo-Wilcox aquifer and the Yegua aquifer system.

Coastal Lowlands Aquifer System

The Coastal Lowlands aquifer system consists of sediments of Miocene and younger age above the upper-most massive clay of the Vicksburg Group or the Jackson and Vicksburg Groups where they are undifferentiated. The sediments that make up the Coastal Lowlands aquifer system are exposed at the land surface in Alabama, Florida, Louisiana, Mississippi, and Texas gulfward of the Jackson and Vicksburg outcrop belt to the Gulf of Mexico. The eastern limit of the study area is the Escambia River in Florida and the Alabama River and Big Escambia Creek in southwestern Alabama. Sands of Miocene and younger age extend to the east beyond the Escambia River in Florida but they are thin and are not extensively used as a source of ground water. The western limit of the aquifer system is the Rio Grande River in southern Texas.

There are at least three aquifers of regional significance in the Coastal Lowlands aquifer system the oldest in sediments of Miocene age and the youngest in sediments of Pliocene and Pleistocene age. The Miocene aquifer system mapped by Gandl (1982) (table 3) includes the equivalent units that were mapped as the Jasper aquifer by Whitfield (1975) and the '2,000-foot' sand of the Baton Rouge area by Torak and Whiteman (1982). The greater maximum aquifer thickness in the Coastal Lowlands aquifer system is attributed to the interbedded clay and sands and the absence of areally extensive massive clays. The estimated hydraulic conductivity ranges from 30 to more than 300 feet per day (table 3).

Table 2.--Summary of the relationship and characteristics of previously mapped regional aquifers to geology and confining systems of the Texas Coastal Uplands aquifer system.

Geologic unit: System	Geologic unit: Series	Geologic unit: Group	Aquifers, reference containing maps and confining systems	Maximum mapped thickness (ft)	Hydraulic conductivity (ft/d)	Storage coefficient	Approximate area mapped (mi^2)
Tertiary	Eocene and Oligocene	Jackson and Vicksburg	Coastal Lowlands confining system [1]				
	Eocene	Claiborne	Yegua aquifer system (Payne, 1970)	1,750	10-70	---	22,300
			Sparta hydraulic system (Payne, 1968)	450	30-80	---	17,300
			Queen City Sand (Payne, 1972)	1,750	7-30	---	16,800
			Reklaw Formation (Payne, 1972)	800	7-30	---	17,100
			Carrizo Sand (Payne, 1975)	750	30-60	---	27,400
			Carrizo-Wilcox aquifer (Klemt and others, 1976)	2,000	10-70	0.0005-0.25	11,800
		Wilcox	Upper Wilcox (Jones and others, 1976)	1,300	---	---	100,000
			Lower Wilcox (Jones and others, 1976)	2,400	---	---	100,000
	Paleocene	Midway	Coastal Uplands confining system [1]				

[1] The confining systems 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.

Table 3.--Summary of the relationships and characteristics of previously mapped regional aquifers to geology and confining systems of the Coastal Lowlands aquifer system.

Geologic unit: System	Series	Group	Aquifers, reference containing maps and confining systems	Maximum mapped thickness (ft)	Hydraulic conductivity (ft/d)	Transmissivity (ft^2/d)	Storage coefficient	Approximate area mapped in square miles: Alabama	Florida	Louisiana	Mississippi	Texas
Quaternary	Pleistocene and Holocene		Chicot Reservoir (Jones and others, 1956)	800	200-300	---	0.0009-0.003	[2]	[2]	11,100	[2]	[2]
Quaternary	Pleistocene and Holocene		Chicot aquifer (Meyer and Carr, 1979)	1,200	---	3,000-15,000	0.0004-0.1	[2]	[2]	[2]	[2]	27,000
Tertiary	Pliocene		Evangeline aquifer (Whitfield, 1975)	3,000	30-100	---	0.0002	[2]	[2]	5,000	[2]	[2]
Tertiary	Pliocene		Evangeline aquifer (Meyer and Carr, 1979)	2,300	35- 75	3,000-15,000	0.0004-0.1	[2]	[2]	[2]	[2]	18,100
Tertiary	Miocene		Jasper aquifer (Whitfield, 1975)	3,500	30-130	---	---	[2]	[2]	4,500	[2]	[2]
Tertiary	Miocene		Miocene aquifer system (Gandl, 1982)	5,200	95	---	---	[2]	[2]	[2]	19,000	[2]
Tertiary	Miocene		'2,000-Foot' Sand of the Baton Rouge area (Torak and Whiteman, 1982)	500	---	---		[2]	[2]	15,200	2,600	[2]
Tertiary	Eocene and Oligocene	Jackson and Vicksburg	Coastal Lowlands confining system [1]									

[1] The confining system is defined as the massive clay section (with interbedded sands) of the undifferentiated Jackson and Vicksburg Groups that is recognizable on geophysical well logs. The recognizable lithologic unit may not be exactly equivalent to the geologic unit as determined by fossils or other means of correlation and dating because the upper or lower part of the undifferentiated Jackson and Vicksburg Groups may be sandy and therefore included in the adjacent aquifer.

[2] Equivalent regional aquifer present but not mapped by this investigator.

Regional Confining Systems

Two regional confining systems, the Coastal Uplands confining system and the Coastal Lowlands confining system, are believed to be major restrictions to the vertical movement of water in the study area. The Coastal Uplands confining system is comprised of the predominately fine-grained marine sediments of the Midway Group. The Coastal Uplands confining system is the base of the flow system in the overlying Texas Coastal Uplands aquifer system. The Coastal Lowlands confining system is comprised predominately of the thick marine clays of the undifferentiated Jackson and Vicksburg Groups which separate the Texas Coastal Uplands and Mississippi Embayment aquifer systems from the Coastal Lowlands aquifer system downdip of the Jackson and Vicksburg outcrop belt. Sand beds near the top of the Midway Group or near the top or base of the Jackson and Vicksburg Groups are considered to be part of the adjacent aquifer system. The top and base of these confining systems are determined by the lithology (clays being indicative of low permeability sediments) rather than by the geologic age of the sediments.

Most of the data available for mapping these confining systems are geophysical logs from wells drilled primarily for petroleum exploration or production. Therefore the confining systems are defined as the massive clay sections (with interbedded sands) of the Midway Group (Coastal Uplands confining system) and the undifferentiated Jackson and Vicksburg Groups (Coastal Lowlands confining system) that are recognizable on geophysical logs.

Two confining beds within the Texas Coastal Uplands and Mississippi Embayment aquifer systems can be correlated across the study area by use of geophysical logs. They correspond closely to the Cook Mountain Formation and part of the Cane River Formation of the Claiborne Group. These confining beds are defined in terms of lithology rather than being restricted to a geologic unit.

The vertical resistance to flow within the Coastal Lowlands aquifer system is typically due to numerous clays that are discontinuous and generally can not be correlated over large areas by use of geophysical logs. In the Houston, Texas area, Meyer and Carr (1979, p. 5) report that about one-half of the total thickness of the Chicot aquifer is discontinuous layers of clay.

Use Of Ground Water

The quantity of water withdrawn from the Gulf Coastal Plain regional aquifer systems has increased steadily for the past three decades as shown by water-use data for Louisiana (Cardwell and Walter, 1979). An average annual increase in total ground-water usage of about 30 Mgal/d (million gallons per day) is indicated for the period 1950-80 (fig. 5). Ground-water withdrawal for Louisiana is used here to

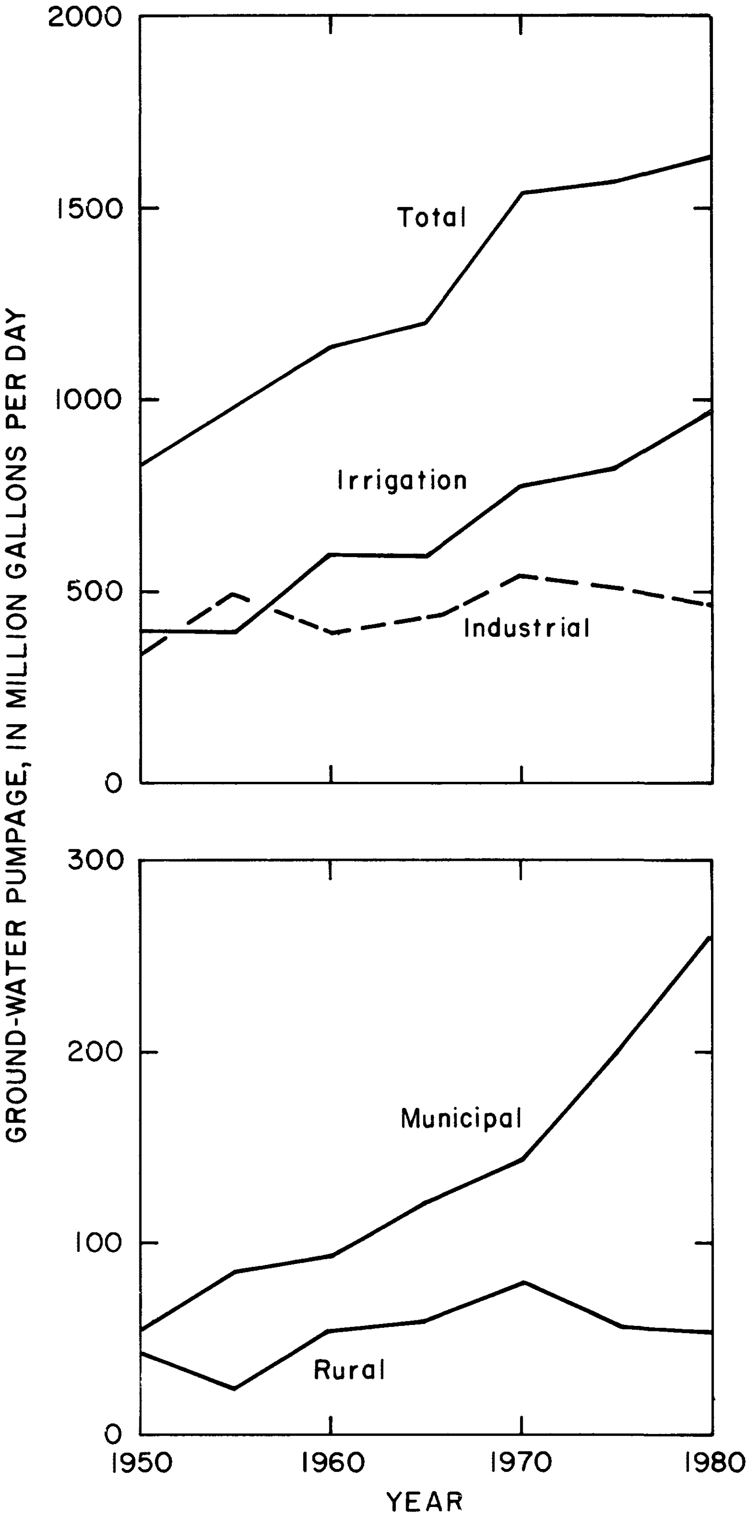

Figure 5.--Estimated ground-water pumpage in Louisiana 1950-80.

illustrate past ground-water demand because it is the only state totally within the study area. Ground-water withdrawal for irrigated agriculture in Arkansas increased dramatically, by about 1,300 Mgal/d, between 1970 and 1980 (Murray and Reeves, 1972, 1977, Solley and others, 1983, and fig. 6). Over 90 percent of the irrigated agriculture in Arkansas is in the Gulf Coastal Plain and most of the increase in water use was in the study area.

Irrigated agriculture uses the largest volume of ground water in the study area. The areas of largest irrigation withdrawals are in northwestern Mississippi, southwestern Louisiana, eastern Arkansas, southern and south-central Texas. Estimated ground-water withdrawals for irrigation in 1975 exceeded 10 Mgal/d in 25 eastern Arkansas counties, 12 northwestern Mississippi counties, 9 southwestern Louisiana parishes, 10 counties in southwestern Texas, and 11 counties in southeastern and south-central Texas (fig. 7). The total volume withdrawn probably exceeds 4,500 Mgal/d because several counties with less than 10 Mgal/d pumpage are not included in figure 7.

Ground water withdrawn in 1975 for municipal and industrial use was scattered throughout the study area (table 4) and totals about 1,300 Mgal/d or about one-fourth as much as was withdrawn for irrigation.

PLAN OF STUDY

A project planning and staffing stage began in fiscal year 1981. The 7-year investigation of the geohydrology of the Gulf Coastal Plain began in fiscal year 1982 (October 1, 1981) and is scheduled to end in fiscal year 1988 (September 30, 1988).

The major activities to be accomplished during the course of the study are discussed below relative to the three principal objectives and the schedule shown in figure 8. Results will be prepared for release as chapters in the U. S. Geological Survey's Professional Paper series of publications. A summary chapter will be prepared at the end of the study following the completion of individual chapters covering topics such as geology, ground-water hydrology, and ground-water chemistry. Reports will be prepared for release in a timely manner during the course of the study as Water Resources Investigations, Hydrologic Atlases, and scientific journals as appropriate to document methods and data.

Geohydrologic Framework

Sand thickness of each aquifer unit and clay thickness of each confining bed will be determined from geophysical well logs. Representative geophysical logs will be selected to define the regional geologic framework. A detailed interpretation will be made of one log for about every 400 square miles with additional logs and published geohydrologic sections used for correlation and to insure a regionally

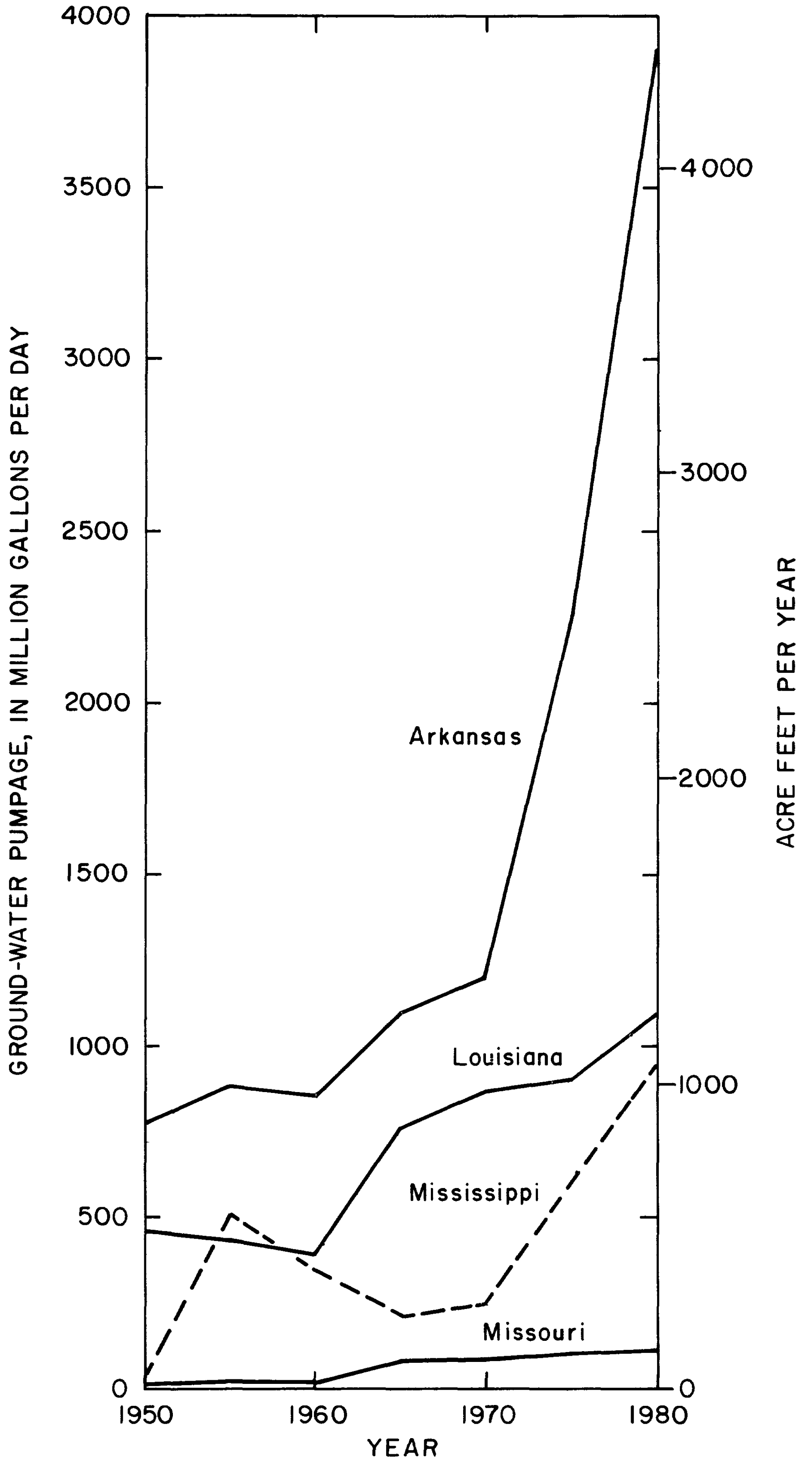

Figure 6.--Estimated quantity of ground water pumped for irrigation in Arkansas, Louisiana, Mississippi, and Missouri 1950-80.

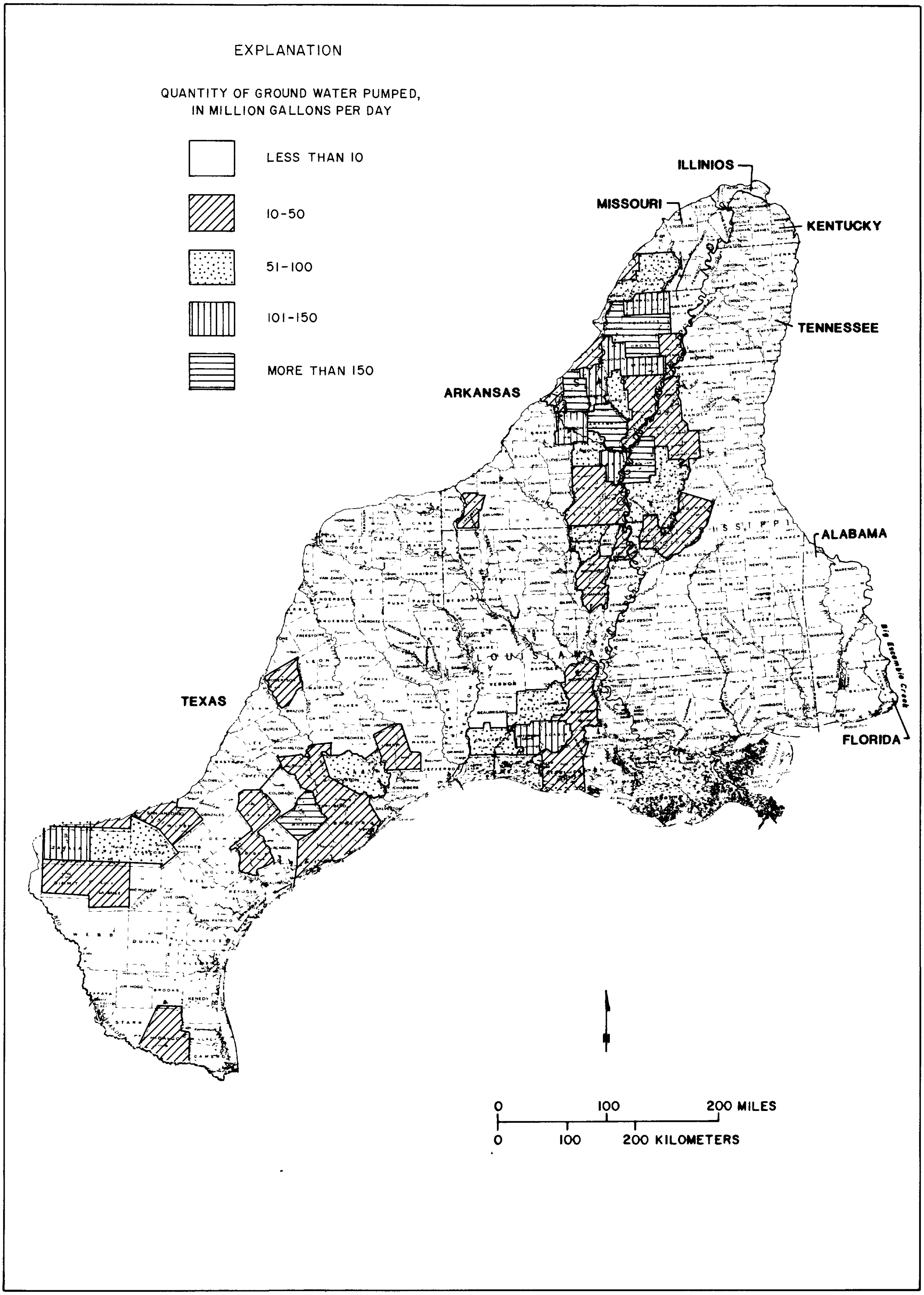

Figure 7.--Estimated quantity of ground water withdrawn for irrigation in the Gulf Coast Regional Aquifer-System Analysis study area for 1975.

Table 4.--Estimated quantity of ground water withdrawn in 1975 for counties with 10 million gallons per day or more pumpage for municipal and industrial use.

State and county or parish	Principal city or metropolitan area	Ground water withdrawal in million gallons per day	
		Municipal use	Industrial use
Arkansas			
Ashley	-	-	11
Jefferson	-	-	45
Union	-	-	12
Louisiana			
Allen	-	-	10
Beauregard	-	-	29
Calcasieu	Lake Charles	16	119
East Baton Rouge	Baton Rouge	40	85
Iberia	-	-	11
Iberville	-	-	30
Jackson	-	-	14
Lafayette	Lafayette	11	-
Morehouse	-	-	15
Orleans	-	-	19
Ouachita	-	-	13
Rapides	Alexandria	26	-
St. Charles	-	-	11
Mississippi			
Adams	-	-	44
Forrest	-	-	10
Harrison	Gulfport-Biloxi	14	-
Jackson	-	-	10
Jones	-	-	11
Washington	-	-	21
Yazoo	-	-	18
Tennessee			
Shelby	Memphis	110	78
Texas			
Angelina	-	-	20
Brazos	Bryan-College Station	13	-
Brazoria	Houston-Galveston	11	-
Colorado		-	18
Galveston	Houston-Galveston	18	-
Harris	Houston-Galveston	215	138
Jasper	-	-	40
Orange	-	-	14

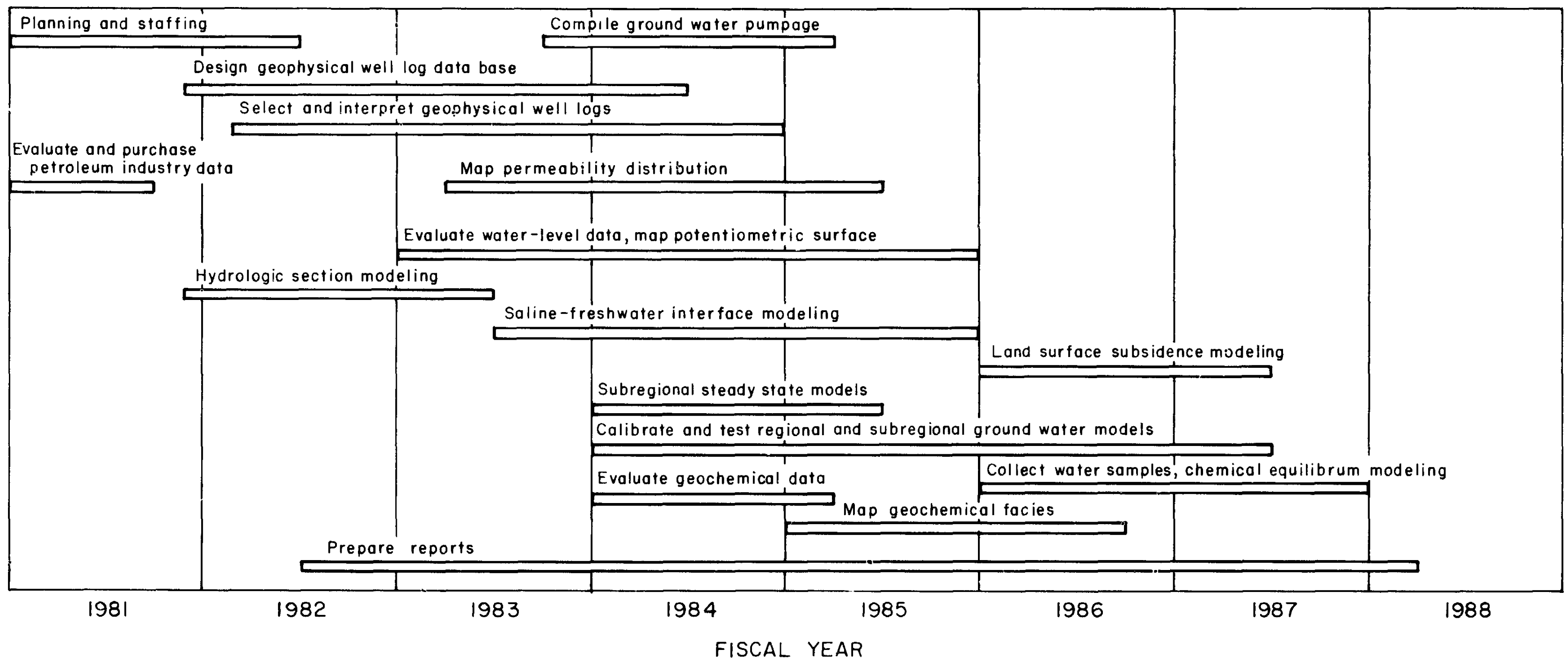

Figure 8.--Schedule of major work activities.

consistent definition of the geologic framework. The detailed interpretative data and log header information will be entered into a computer-based file to aid in construction of geohydrologic maps. Kriging or other interpolation methods and the information derived from the logs will be used to estimate values of aquifer parameters for the flow model.

Aquifer hydraulic conductivity and storage coefficient will be estimated from data in published reports and in the files of State and Federal agencies. Confining bed properties will be regionalized from the few available site studies that have been reported and from the results obtained from model simulations.

Ground-Water Chemistry

Chemical analyses of water samples in the WATSTORE file will be evaluated as to their suitability for construction of maps describing the quality of water in the various aquifers according to a set of criteria that will be developed. A computer based data file will be constructed and data that meet the established criteria will be included in the file. Additional data from files of the U.S. Geological Survey, State agencies, and other Federal agencies will be evaluated and included in the data file as appropriate. Additional data collected from wells in the saline part of the flow system will be acquired from sources in the petroleum industry and will also be included in the data file.

The data will be used to map the geochemical facies of each regional aquifer. Combined with interpretations from geophysical logs, the chemical data will also be used to map the dissolved solids and water temperature of each regional aquifer.

A sampling network probably will be designed to obtain data that can be used in conjunction with existing data for analyzing the geochemistry of the ground water system by application of chemical equilibrium and thermodynamic models. The geochemical models will be used to help evaluate the regional flow patterns and to develop explanations for the origin of the water in the various parts of the aquifers.

Flow System Analysis

Potentiometric surface maps will be constructed, and the spatial distribution of ground-water pumpage will be estimated for each regional aquifer from data in the files of the U.S. Geological Survey, State agencies and other Federal agencies. Fluid pressure data from the saline parts of the flow systems will be obtained from the petroleum industry, and from State, and Federal agencies to aid in the analysis of the regional flow patterns.

Regional ground-water flow will be simulated with two separate regional-scale, multi-layer flow models. The effects of variable density on the regional flow patterns will also be investigated by model simulations.

One model will be of the combined Mississippi Embayment and Texas Coastal Uplands aquifer systems. The base of the flow system is the Coastal Uplands confining system or the top of the geopressure zone in a narrow band roughly parallel to the coast where the Midway extends below the top of the geopressure zone. The upper flow boundary of the Mississippi Embayment and Texas Coastal Uplands aquifer systems is the water table in places where the aquifers are at land surface, the alluvial aquifer of the Mississippi River and its major tributaries where it is present, or the Coastal Lowlands confining system.

The other regional-scale model will be of the Coastal Lowlands aquifer system. The lower flow boundary is the Coastal Lowlands confining system or the top of the geopressure zone where the Jackson and Vicksburg Group extends below the top of the geopressure zone. The upper flow boundary of this aquifer system is the water-table onshore and the Gulf of Mexico beyond the coastline. The release of water to the aquifers from the interbedded clays will be simulated as function of decline in the potentiometric surface. The effects of variable water density on the regional flow patterns will also be investigated.

ORGANIZATION

The study will be directed by a project staff located in Austin, Texas, consisting of a project chief and several hydrologists specializing in various fields such as geohydrology, flow simulation, and geochemistry. Computer and clerical support will be provided by a computer specialist and a secretary. Special studies to develop methods and procedures for estimating dissolved solids and water temperature from geophysical logs will be conducted by specialists in the Water Resources Division of the U.S. Geological Survey.

A project team will be assigned to the study in each of the Water Resources Division Districts within the project area. In most cases the District team will consist of a full-time project chief with hydrologist and technician support as dictated by the quantity and complexity of the study.

DISTRICT WORK PLANS

The scope and complexity of the work that will be undertaken in the District will vary depending upon the problems associated with ground-water use, the complexity of the flow system within the various states and the scope and extent of previous studies. The work in Alabama, Illinois, Kentucky, and Florida will consist of data compilation because of either the small area involved or the lack of large scale ground-water development.

Arkansas

The geohydrologic framework of the Mississippi Embayment aquifer system within the State of Arkansas will be defined with data from geophysical well logs supplemented with data as needed from drillers' logs.

Potentiometric surface maps will be constructed for each of the aquifers of regional significance within the State.

A subregional scale ground-water flow model will be constructed of the Mississippi River alluvial aquifer throughout the Mississippi embayment north of the Miocene subcrop in Louisiana. Results will be prepared for publication as map reports, Water Resources Investigations, and Professional Papers as appropriate.

Louisiana

The geologic framework of the Coastal Lowlands and Mississippi Embayment aquifer systems within the State of Louisiana will be defined with data from geophysical logs.

Potentiometric surface maps will be prepared for each regionally significant aquifer within the State.

A subregional scale ground-water flow model will be constructed of the Coastal Lowlands aquifer system in Louisiana, Mississippi, Alabama, and Florida. Emphasis will be on the fresh to slightly saline part of the flow system. Result of the data analysis and the simulation of the ground-water flow system will be prepared for publication as a chapter in the Professional Paper series.

Mississippi

The geologic framework of the Coastal Lowlands and Mississippi Embayment aquifer systems within the State of Mississippi will be defined with data from geophysical logs.

The potentiometric surface of each regionally significant aquifer within the project area will be mapped.

A subregional scale ground-water flow model will be constructed for the Mississippi Embayment. Emphasis will be on the fresh to slightly saline part of the flow system. Results of data analysis and simulation of the ground-water flow within the Mississippi Embayment aquifer system will be prepared for inclusion in the Professional Paper series.

Missouri

The geohydrologic framework of the Mississippi Embayment aquifer system within the State of Missouri will be defined from data derived from geophysical and drillers' logs. Geohydrologic units will be correlated with adjacent states.

Potentiometric-surface maps will be prepared for each regionally significant aquifer.

Water samples will be collected to aid in the definition of flow patterns between sediments of Paleozoic, Cretaceous, and Tertiary age.

The results of the data collection and analysis will be prepared for publication as a map report on the hydrogeology of the Coastal Plain of Missouri.

Tennessee

The geohydrologic framework of the Mississippi Embayment aquifer system within the State of Tennessee will be defined with data from geophysical logs supplemented with data from drillers' logs.

An inventory of major public, municipal, and industrial water supply wells will be made to help define the aquifers and identify wells where water samples can be obtained for delineation of ground-water quality.

Potentiometric surface maps will be prepared for regionally significant aquifers in the Coastal Plain of Tennessee.

A ground-water flow model will be constructed of the Upper Cretaceous aquifer in the northern part of the Mississippi embayment. The results of data analysis and model simulation will be prepared for publication as map reports and as a chapter in the Professional Paper series.

Texas

The geologic framework of the Coastal Lowlands and Texas Coastal Uplands aquifer systems will be delineated from the interpretation of geophysical logs. The regional aquifers and confining beds in each of these systems will be correlated with equivalent units in Louisiana. A series of geologic sections will be prepared to show the relation of the Texas Coastal Uplands aquifer system to the younger Coastal Lowlands aquifer system.

Potentiometric surface maps will be prepared for each regionally significant aquifer.

Subregional-scale ground-water flow models will be prepared for the Texas Coastal Uplands aquifer system and for at least parts of the Coastal Lowlands aquifer system. Emphasis will be on the fresh to slightly saline part of the flow system.

Results of the definition of the aquifer system and the mapping of potentiometric surfaces will be presented in map-type reports. The results of aquifer simulation will be prepared for publication as a chapter in the Professional Paper series.

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