GEOHYDROLOGIC UNITS OF THE GULF COASTAL PLAIN IN ARKANSAS

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CONVERSION FACTORS

For use of readers who prefer to use metric units, conversion factors for terms used in this report are listed below:

Multiply	By	To obtain
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
million gallons per day (Mgal/d)	0.0438	cubic meter per second (m^3/s)
gallon (gal)	3.785	liter (L)

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 the text of this report.

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ABSTRACT

This report describes geohydrologic units of the Quaternary, Tertiary, Cretaceous and Jurassic Systems and of the Paleozoic Erathem in the Gulf Coastal Plain in Arkansas. Structure contour maps of the top of the Sparta Sand, Cane River Formation, Carrizo Sand, Memphis Sand, Wilcox Group, Midway Group, Nacatoch Sand, Tokio Formation, Trinity Group and Paleozoic rocks are included. Thickness maps of the Sparta Sand, Cane River Formation, Carrizo Sand, Memphis Sand and the Wilcox Group and maps showing lines of equal dissolved-solids concentrations of the Sparta Sand, Cane River Formation, Carrizo Sand, Wilcox Group and Nacatoch Sand are also included. The dissolved-solids maps are approximately 1:2,000,000 scale. All other maps are 1:1,000,000 scale.

INTRODUCTION

The original impetus for the study was to compile geohydrologic information for use by the Arkansas Department of Pollution Control and Ecology in administering the Federal Underground Injection Control (UIC) program in Arkansas. The UIC program is concerned with the ability of geologic formations to receive and contain waste so that it cannot migrate to freshwater aquifers.

This study was conducted by the U.S. Geological Survey and the Arkansas Geological Commission in cooperation with the Arkansas Department of Pollution Control and Ecology.

Information included in this report is primarily structural information (tops and thicknesses of geohydrologic units) and dissolved-solids concentrations in aquifers. The suitability of a unit for waste storage was not considered and the ability of confining beds to retard fluid movement was considered only in very general terms.

The study area of the report was restricted to the Gulf Coastal Plain in Arkansas (fig. 1). General information about unit thickness, composition, and water yield is included for most units of Paleozoic age and younger. Detailed maps showing structural top altitudes of the Sparta Sand, Cane River Formation, Carrizo Sand, Memphis Sand, Wilcox Group, Midway Group, Nacatoch Sand, Tokio Formation, Trinity Group, and Paleozoic rocks are included where existing data were adequate. Maps showing unit thickness and dissolved-solids water quality of many of these units are also included.

Although the original impetus of the study was the data needs of the UIC program, the maps and discussions in this report should also be helpful to hydrologists and water managers studying other ground-water problems in Arkansas. Earlier publications (Cushing and others, 1964; Boswell and others, 1965; Hosman and others, 1968; Payne, 1968, 1972, 1975) included similar data and maps but were regional in scope and therefore were less detailed or did not include all of the Coastal Plain in Arkansas.

The dissolved-solids maps are approximately 1:2,000,000 scale. The structural top and thickness maps are 1:1,000,000 scale.

METHODS

Electric logs were used to establish control points for plotting structural contours of tops of units and for plotting lines of equal thickness of units. Supplemental thickness control points were plotted using intersections of appropriate structural contours. For example at Belfast (northwest of Sheridan in Grant County) the Wilcox Group structural contour (-600 feet, pl. 5) and the Midway Group structural contour (-800 feet, pl. 6) intersect. A supplemental point with a Wilcox Group thickness value of 200 feet was created by this intersection.

For purposes of this report, water containing less than 1,000 mg/L dissolved solids is termed fresh; water containing 1,000 to 10,000 mg/L dissolved solids is termed slightly to moderately saline; and water containing more than 10,000 mg/L dissolved solids is termed highly saline (Hem, 1970). In some areas the delineation of the salinity of the water was derived only from electric log interpretation. Lines of equal dissolved-solids concentrations were also partly derived from Cushing (1966) and Payne (1968, 1972, 1975). The plotted lines represent the minimum concentration that can be expected to

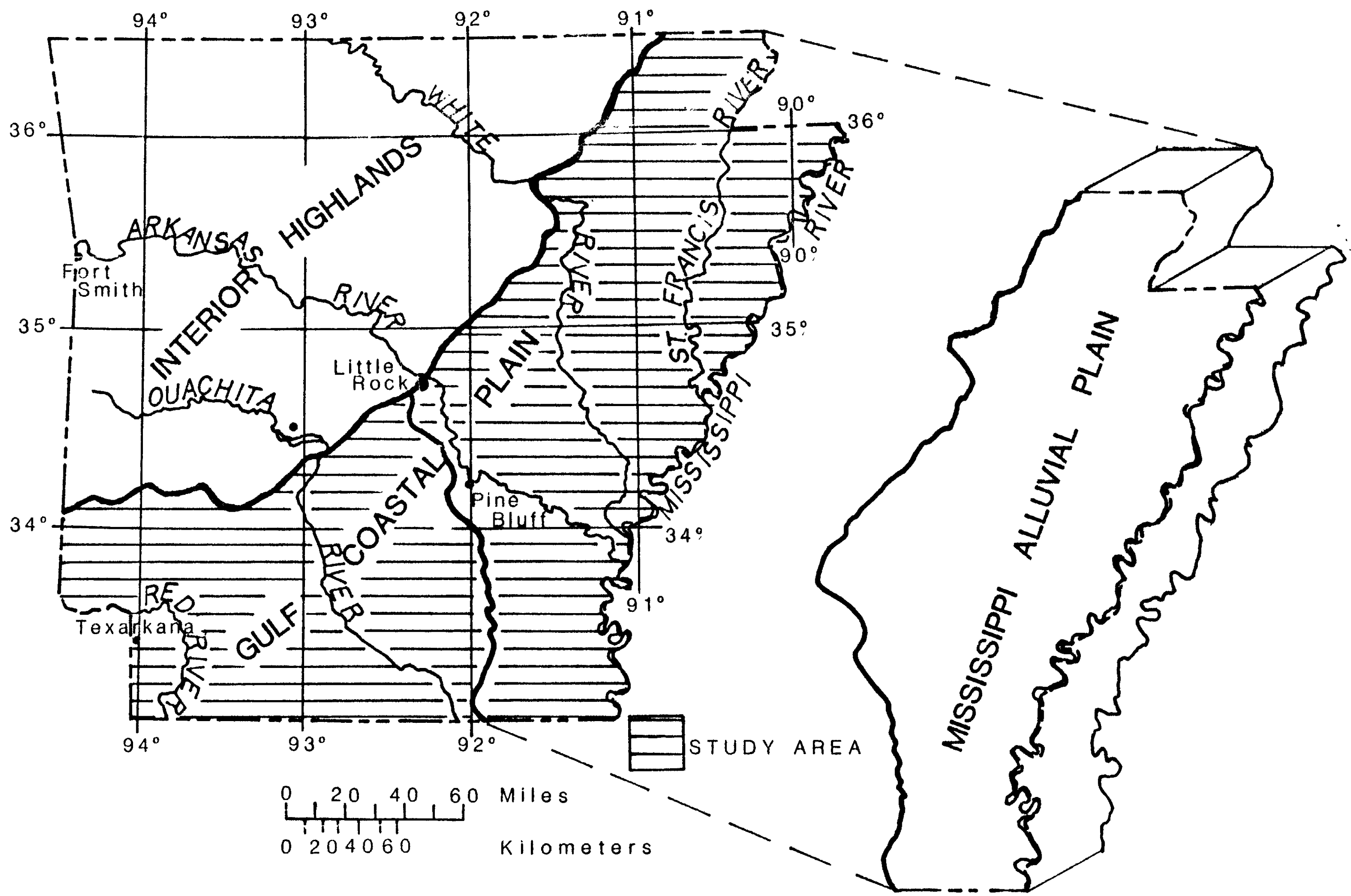

Figure 1.--Location of study area.

occur in a vertical profile in the geohydrologic unit. For example, where dissolved-solids concentrations range vertically from 1,000 to 10,000 mg/L, a 1,000 mg/L line was plotted.

STRUCTURAL AND STRATIGRAPHIC FRAMEWORK OF THE GEOHYDROLOGIC UNITS

The units described in this report are within the Mississippi Embayment, a structural basin of regional dimensions with its axis trending northward and roughly parallel to the Mississippi River (fig. 2). From outcrop areas along the periphery of the Embayment, the rock units (except the Quaternary deposits) generally slope downward toward the axis of the Embayment. Older units become overlain by younger units in the slope direction. Arkansas is situated mostly on the west flank of the Embayment, thus the units in the Gulf Coastal Plain in Arkansas generally slope southeastward. However, the general direction of slope is notably altered in the vicinity of the Sabine and Monroe Uplifts, the Desha Basin, and fault zones in southern Arkansas (fig. 2). The Jurassic units do not crop out in Arkansas, and in the subsurface the northern limits of these units represent their approximate depositional limits.

In the western part of the study area, Quaternary deposits (alluvium and terrace) which occur in stream valleys that cross outcrops of older deposits unconformably overlie the older units. The Quaternary deposits that underlie the Mississippi Alluvial Plain in the eastern part of the study area (fig. 1) form a nearly continuous layer over the older units. In following discussions, the term "subcrop" or "subcrop areas" will sometimes be used to refer to areas where units along their outcrop trend are overlain by Quaternary deposits. The stratigraphy, lithology, and water-supply characteristics of the units are summarized in table 1.

DESCRIPTION OF GEOHYDROLOGIC UNITS

Quaternary Alluvium

In the study area the Quaternary alluvium is present chiefly in the Mississippi Alluvial Plain, and in the valleys of the Red, Ouachita, and Saline Rivers. The alluvium generally ranges in composition from gravel and coarse sand at the bottom to silt and clay at the top. The gravel and sand components can make up greater than 50 percent of the thickness of the alluvium. The thickness of the alluvium in the Mississippi Alluvial Plain generally averages more than 100 feet and can be as much as 200 feet thick. The total thickness of the alluvium in the Red, Saline, and Ouachita River valleys generally is less than 100 feet. The Quaternary alluvium of the Mississippi Embayment and its aquifers are discussed in greater detail by Boswell and others (1968).

The sand and gravel comprise a number of different aquifers throughout Arkansas. The most productive one is the alluvial aquifer in the Mississippi Alluvial Plain. This aquifer commonly yields more than 1,000 gallons per minute of water to wells, and in some places, as much as 3,000 gallons per minute.

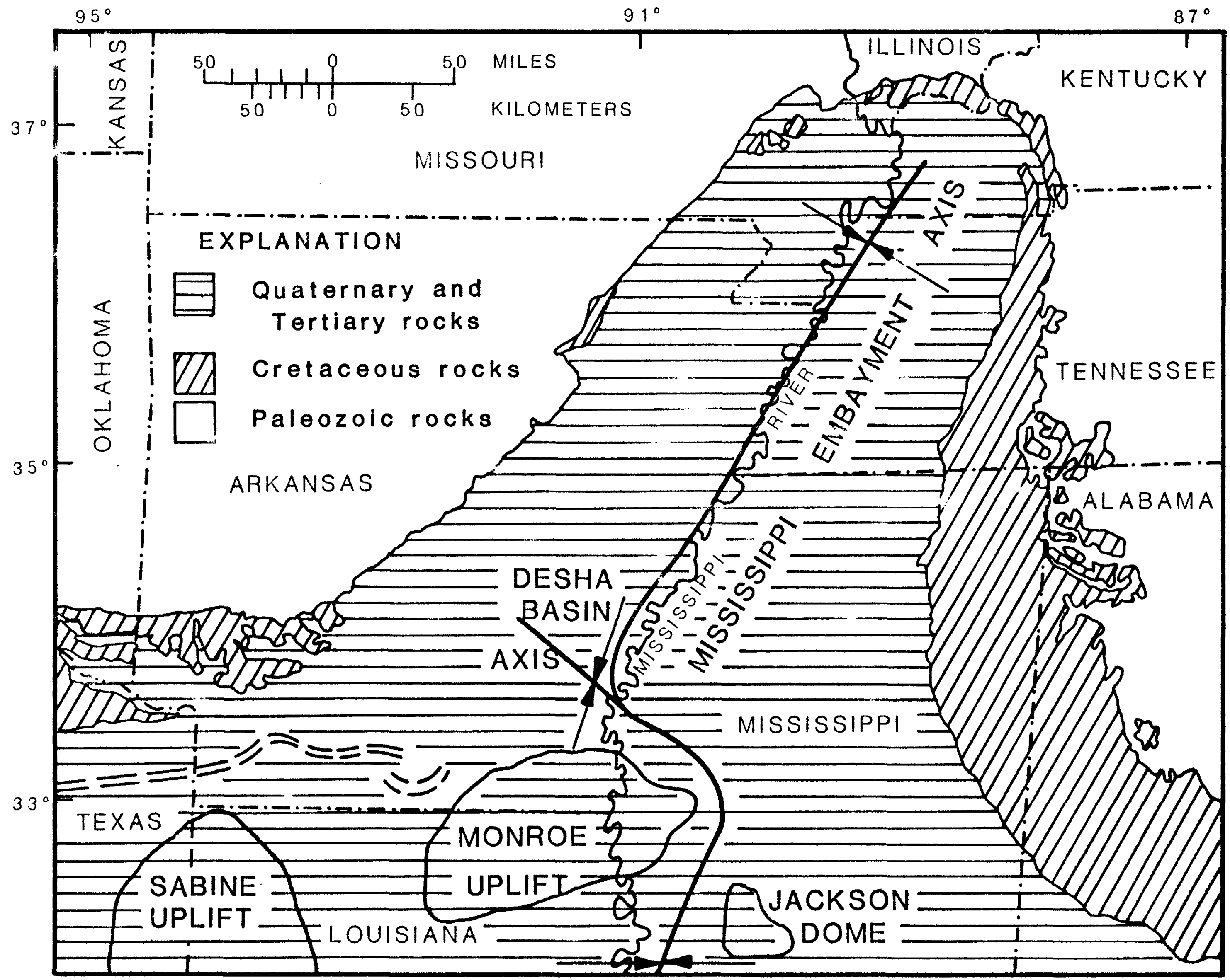

Figure 2.--Generalized structural and stratigraphic features of the Mississippi Embayment. (Modified from Cushing and others, 1964 and Boswell and others, 1965).

The natural regimens of recharge, discharge, and water movement relative to the alluvial aquifers are very similar in all the areas. The aquifers are recharged by percolation of rainfall through the silt and clay cover and by inflow from streams. The water moves in the direction of general land slope and toward streams that drain the alluvial lands. The aquifers discharge water to the streams that have channeled through the silt and clay cover; hence, discharge from the aquifers largely sustains streamflow during dry weather. During flood stage, the direction of flow commonly is reversed; hence, the streams are periodic sources of recharge to the aquifers. In areas of heavy withdrawals of water from the aquifers, the larger streams can be important year-round sources of aquifer recharge (see Broom and Lyford, 1981, p. 43). Also in areas of heavy withdrawals, the alluvial aquifers can receive substantial quantities of recharge from underlying aquifers (see discussion of Memphis Sand on page 14).

The alluvial aquifer of the Mississippi Alluvial Plain is the source of the largest withdrawals of ground water in the study area and in Arkansas. Of the nearly 3,700 Mgal/d withdrawn from the alluvial aquifers in the study area in 1980 (Ludwig and Holland, 1981, p. 28), 99 percent was withdrawn in the Mississippi Alluvial Plain. The use of the water was largely for rice irrigation. The effect of aquifer withdrawals on the potentiometric surface and the direction of water movement in the alluvial aquifer is illustrated by Edds and Fitzpatrick (1984b). An area of notable potentiometric surface depression can be seen in Arkansas, Lonoke, and Prairie Counties. Significant depression is also evident in Poinsett and Cross Counties. Edds (1984, p. 10-22) shows water levels in alluvial aquifer wells in the study area ranging from near land surfaces in areas unstressed by withdrawals to more than 100 feet below land surface in stressed areas in the Grand Prairie (Arkansas, Lonoke, and Prairie Counties).

The water in the alluvial aquifers is relatively low in mineral concentration. Dissolved solids concentrations are generally less than 500 mg/L. However, Ludwig (1972, p. 19) defines an area in the Red River Valley near Garland City (Miller County) where the alluvial aquifer has been locally contaminated by oilfield brine. Broom and Lyford (1981, p. 30) discuss a local area near Brinkley (Monroe County) where the alluvial aquifer contains as much as 1,500 mg/L dissolved solids. Broom and Reed (1973) report the occurrence of saltwater in Desha, Lincoln and Chicot Counties. A more detailed study of the occurrence of saltwater in Desha, Lincoln and Chicot Counties was conducted by Fitzpatrick (1985).

Tertiary System

Sediments of the Tertiary System contain freshwater in about 90 percent of the Gulf Coastal Plain in Arkansas. These aquifers are the source of more than 95 percent of all municipal, industrial, and domestic water supplies in the Gulf Coastal Plain.

Jackson Group and Cockfield and Cook Mountain Formations

Because of insufficient data, maps are not provided for the Jackson Group and Cockfield and Cook Mountain Formations. Potentiometric, structural top, thickness and water-quality maps of the Cockfield Formation for a part of the study area are illustrated in Terry and others (1979, pp. 129-131, 135). Maps showing the altitude of the base, thickness, and approximate downdip limit of freshwater of the Cockfield Formation and the thickness of the Cook Mountain Formation in part of southern Arkansas are included in Ryals (1984).

The Jackson Group and Cook Mountain Formation generally are composed chiefly of clay. These units are fairly effective confining beds. The Jackson Group (table 1), the uppermost unit of the Tertiary System, is a confining bed between the Cockfield Formation and the Quaternary alluvium. The Jackson Group is present in outcrop or subcrop throughout its extent in the study area. The Cook Mountain Formation (table 1) is a confining bed between the Sparta Sand and the Cockfield Formation.

The Cockfield Formation generally is composed of interbedded sand and clay. The unit is less than 200 feet thick at outcrop but thickens to about 300 feet in the slope direction (southeastward). The Cockfield Formation crops out extensively over south-central Arkansas. It is exposed over practically all of Union County and parts of Bradley, Cleveland, Dallas, Grant, and Saline Counties.

The Cockfield Formation is chiefly a source for domestic water supplies, but in some downslope areas the Cockfield Formation sands are sufficently thick to provide yields of a few hundred gallons per minute to some municipal and industrial wells. The Cockfield Formation is recharged in the outcrop and subcrop areas of the unit. The direction of water movement generally is southeastward, in the direction of unit slope.

Holland and Ludwig (1981, p. 28) show water withdrawals of about 7 Mgal/d from the Cockfield Formation during 1980. Edds (1984, p. 23-25) reports water levels in Cockfield Formation wells ranging from about 8 to 133 feet below land surface. The water in the Cockfield Formation is fresh generally throughout the extent of the unit in the study area.

Sparta Sand

The Sparta Sand is composed chiefly of sand in the lower half of the unit and interbedded sand and clay in the upper half of the unit. Hosman and others (1968, p. D18-20) and Payne (1968) provide a more detailed description of the lithologic and hydrologic characteristics of the Sparta Sand.

The Sparta Sand is recharged by precipitation on the outcrop and percolation through any permeable alluvium in the subcrop areas. Another source of natural recharge to the Sparta Sand is lateral flow from the Memphis Sand at the boundary of the Sparta Sand and the Memphis Sand. The regional gradient in the aquifer is towards the south and southeast. Locally, the gradient is towards centers of heavy water withdrawals. Cones of depression in the vicinities of Pine Bluff, El Dorado and Magnolia (Edds and Fitzpatrick, 1984a) correspond to centers of heavy water withdrawals from the Sparta Sand. Holland and Ludwig (1981, p. 28) show total withdrawals of about 178 Mgal/d from the Sparta Sand during 1980. The Sparta Sand becomes confined by overlying and

Table 1.--Generalized stratigraphic column of the Gulf Coastal Plain in Arkansas

Erathem	System	Series	Group	Formation	Description	Water Supply
Cenozoic	Quaternary	Holocene and Pleist-ocene		Alluvium and terrace deposits	Alluvial floodplain and terrace deposits; gravel at base, grading upward to sand, silt, and clay at the surface. Maximum thickness about 200 feet in the Mississippi Alluvial Plain.	Sand and gravel in the alluvial and terrace deposits comprise extensive aquifers throughout most of the Mississippi Alluvial Plain. Commonly yields 1,000 to 3,000 gallons per minute of water to wells.
	Tertiary	Eocene	Jackson		Chiefly composed of clay, some lenses of fine sand. Maximum thickness about 300 feet. Confining bed.	Non-water bearing.
			Clai-borne	Cockfield Formation	Fine lignitic sand and carbonaceous clay; Maximum thickness less than 300 feet.	Mainly a source of domestic water supply. Locally yields up to 400 gallons per minute of water to wells.
				Cook Mountain Formation	Carbonaceous clay and some lenses of fine lignitic sand Maximum thickness about 150 feet. Confining bed.	Non-water bearing.
				Sparta Sand / Memphis Sand	Fine to medium sand, some interbeds of clay. Maximum thickness nearly 900 feet. North of latitude 35 degrees, the Sparta Sand is part of the Memphis Sand.	Principal source of municipal and industrial water supply in its area of occurrence. In south-central Arkansas, the Sparta Sand is a nearly sole-source aquifer for municipal and industrial water supplies. Commonly yields up to 1,000 gallons per minute of water to wells.

Table 1.--Generalized stratigraphic column of the Gulf Coastal Plain in Arkansas-Continued

Erathem	System	Series	Group	Formation	Description	Water Supply
Cenozoic	Tertiary	Eocene	Claiborne	Cane River Formation (Memphis Sand)	Interbedded sand and clay in updip areas, mostly clay in downdip areas. Maximum thickness nearly 800 feet. Relatively uniform confining bed in downdip areas. North of about latitude 35 degrees, the Cane River Formation is sand and is part of the Memphis Sand.	Source of water supply in and near its outcrop area. Generally yields less than 500 gallons per minute.
				Carrizo Sand (Memphis Sand)	Fine to medium sand; locally discontinuous. Maximum thickness about 400 feet. North of about latitude 35 degrees, the Carrizo Sand is part of the Memphis Sand.	Source of domestic water supply in and near its outcrop area. Generally yields less than 50 gallons per minute.
		Eocene / Paleocene	Wilcox		Interbedded sand and clay, lignitic. Maximum thickness about 1,100 feet. East of Crowleys Ridge, the lower half of the Wilcox Group is composed of massively-bedded sand.	Source of domestic water supply in and near its outcrop area in southwestern Arkansas. Principal source of municipal and industrial water supply east of Crowleys Ridge where it yields 1,000 or more gallons per minute of water to wells.
		Paleocene	Midway		Composed generally of dense marine clay; locally contains calcareous sand in basal part in outcrop area. Maximum thickness about 600 feet. Extensive confining bed.	Yields water locally to wells in outcrop area in Hot Spring, Saline and Pulaski Counties. In other areas it generally does not yield water.

Table 1.--Generalized stratigraphic column of the Gulf Coastal Plain in Arkansas-Continued

Erathem	System	Series	Group	Formation	Description	Water Supply
Mesozoic	Cretaceous	Upper Cretaceous		Arkadelphia Marl	Calcareous clay, some interbedded limestone. Maximum thickness about 250 feet.	Non-water bearing.
				Nacatoch Sand	Interbedded clay, limestone, and fine sand in lower part grading upward to loose fine quartz sand in upper part. Maximum thickness about 600 feet.	Generally yields less than 300 gallons per minute. Yields water to wells for domestic, municipal, and industrial supply in and near outcrop area in southwestern Arkansas; also yields water to wells for municipal and industrial supplies in northeast Arkansas.
				Saratoga Chalk	Chalk and chalky marl. Maximum thickness about 150 ft.	Non-water bearing.
				Marlbrook Marl	Marl and chalky marl. Maximum thickness about 200 ft.	Non-water bearing.
				Annona Chalk	Massively-bedded chalk. Maximum thickness about 100 ft.	Non-water bearing.
				Ozan Formation	Interbedded sand, clay, and sandy marl. Maximum thickness about 300 feet.	Yields water for domestic supplies in outcrop area.

Table 1.--Generalized stratigraphic column of the Gulf Coastal Plain in Arkansas-Continued

Erathem	System	Series	Group	Formation	Description	Water Supply
Mesozoic	Cretaceous	Upper Creta-ceous		Brownstown Marl	Chiefly clay and marl in outcrop area; clay and some interbeds of fine sand in downdip areas. Maximum thickness about 250 feet.	Locally yields water to wells for domestic supply in outcrop area.
				Tokio Formation	Gravel and sand, some intertongues of clay and lignite. Maximum thickness about 350 feet.	Generally yields less than 300 gallons per minute. Yields water to wells for domestic, municipal and industrial supplies in and near its outcrop area.
				Woodbine Formation	Clay and sandstone. Maxi-mum thickness about 250 feet.	Yields water in small quantities for domestic supply in and near its outcrop area.
		Lower Creta-ceous	Trinity	Paluxy Sand Ultima Thule Gravel Mem-ber of Holly Creek Forma-tion Pike Gravel	Interbedded gravel, sand, limestone, and clay. Maximum thickness more than 2,500 feet.	Generally yields less than 200 gallons per minute. Yields water in moderate quantities to wells in and near its outcrop area.
	Jurassic	Upper Jurassic		Cotton Valley Formation	Interbedded sandstone and shale. Truncated updip by Lower Cretaceous units. Maximum thickness about 1,400 feet.	Yields water of unsuitable quality for most purposes.

Table 1.--Generalized stratigraphic column of the Gulf Coastal Plain in Arkansas-Continued

Erathem	System	Series	Group	Formation	Description	Water Supply
Mesozoic	Jurassic	Upper Jurassic		Buckner Formation	Anhydrite and shale. Truncated updip by Lower Cretaceous units. Maximum thickness about 250 feet.	Yields water of unsuitable quality for most purposes.
				Smackover Formation	Chiefly limestone, oolitic to finely crystalline. Truncated updip by Lower Cretaceous units. Maximum thickness about 700 feet.	Yields water of unsuitable quality for most purposes.
	Triassic	Upper Triassic		Eagle Mills Formation	Rock salt and anhydrite. Truncated updip by Lower Cretaceous units. Maximum thickness about 1,200 feet.	No data on water yield.
Paleozoic					Sandstone, shale, limestone, and dolomite in outcrop area. Few bore-hole data in coastal plain.	No data on water yield in Gulf Coastal Plain.

underlying clay beds downslope from the outcrop areas causing artesian conditions. Edds (1984, p. 26-39) reports water levels below land surface in Sparta Sand wells ranging from about 10 feet in recharge areas to about 290 feet in Jefferson County, about 350 feet in Columbia County, and about 440 feet in Union County.

The Sparta Sand contains freshwater throughout most of its extent in the study area (pl. 1) and contains the most extensive freshwater aquifer in the Tertiary System. In southern Arkansas the Sparta Sand is a multi-unit aquifer usually with several sand units and different dissolved-solids concentrations (Payne, 1968). For example, at one location northwest of Hamburg (Ashley County), Payne shows a minimum dissolved-solids concentration of 1,000 mg/L and a maximum concentration of 10,000 mg/L. Minimum dissolved-solids concentrations exceed 1,000 mg/L only in the southeast corner of the study area. Payne also reports maximum dissolved-solids concentrations exceeding 1,000 mg/L in parts or all of Union, Calhoun, Bradley, Cleveland, Lincoln, Drew, Desha, Ashley and Chicot Counties and exceeding 10,000 mg/L in an area extending about 13 miles east, 12 miles west and 6 miles north from Crossett.

Cane River Formation

The lithologic character of the Cane River Formation varies greatly in the Gulf Coastal Plain. Consisting chiefly of alternate beds of sand and clay in the outcrop, the Cane River Formation changes gradually downslope to a relatively uniform confining clay bed. Maps showing the altitude of the structural top, the thickness, and dissolved-solids concentration of the Cane River Formation are shown on plate 2. From about the Arkansas River northward the Cane River Formation tends to become substantially sandier; at about latitude 35 degrees it is a relatively uniform sand which is practically indistinguishable from the underlying Carrizo Sand and the overlying Sparta Sand. Hosman and others (1968, p. D15-18) and Payne (1972) describe the lithology and hydrology of the Cane River Formation in greater detail.

The Cane River Formation affords relatively thin sand aquifers in and near its outcrop areas. Aquifer recharge occurs in the outcrop and subcrop areas of the unit. The direction of water movement generally is southeastward or downslope from the outcrop and subcrop areas. Also, downslope the aquifers become confined by overlying and underlying clay beds; thus, the occurrence of water in the Cane River Formation changes from water-table conditions in the outcrop and subcrop areas to artesian conditions in the downslope areas. Edds (1984, p. 40) shows a tabulation of water levels in Cane River Formation wells. Holland and Ludwig (1981, p. 28) show water withdrawals of a little over 5 Mgal/d from the Cane River aquifer during 1980.

Carrizo Sand

The Carrizo Sand is the basal unit of the Claiborne Group. Maps showing the altitude of the structural top, the thickness and the dissolved-solids concentration are shown on plate 3. The Carrizo Sand is discontinuous in the study area as shown on plate 3 and may also be discontinuous in parts of Union, Ouachita, and Columbia Counties where thicknesses of 30 feet or less occur. Hosman and others (1968, p. D12-15) and Payne (1975) describe the lithology and hydrology of the Carrizo Sand in greater detail.

The Carrizo Sand is recharged in the outcrop and subcrop areas of the unit. The direction of water movement generally is southeastward or downslope from the outcrop and subcrop areas. The Carrizo Sand becomes confined by overlying and underlying clay beds downslope, thus, changing the condition of the aquifer to artesian. Where the aquifer is artesian, water levels in the Carrizo Sand wells can be close to land surface. Edds (1984, p. 41) shows a water level of about 24 feet below land surface in a Carrizo Sand well near Pine Bluff (Jefferson County). Holland and Ludwig (1981, p. 28) report water withdrawals of about 0.7 Mgal/d from the Carrizo Sand during 1980.

Memphis Sand

The Memphis Sand (pl. 4) is made up of undivided extensions of the Carrizo Sand, Cane River Formation, and Sparta Sand north of about latitude 35 degrees in the Gulf Coastal Plain. The Memphis Sand does not crop out in the area except for some exposed erosional remnants of the unit along Crowleys Ridge in Cross, Poinsett, and Craighead Counties. On both the east and west sides of the ridge exposures, the Memphis Sand has been eroded to form a relatively level erosional surface that is covered by Quaternary alluvium as much as 150 feet, or more, thick. The alluvium covers the eroded surface or subcrop of the Memphis Sand in most of the area between the updip extent of the Memphis Sand and where the stratigraphic top of the Memphis Sand is at sea level.

In the Memphis Sand subcrop area the Memphis Sand and the overlying alluvial aquifer are hydraulically connected. Therefore, heavy withdrawals of water from the alluvial aquifer for rice irrigation greatly alter natural patterns of water movement in the Memphis Sand. Heavy withdrawals from the alluvial aquifer west of Crowleys Ridge in Craighead, Poinsett, and Cross Counties induce considerable recharge to the alluvial aquifers in the form of underflow from the Memphis Sand. The subcrop area of the Memphis Sand east of Crowleys Ridge is a substantial recharge area for the Memphis Sand. The hydrologic relation of the alluvial aquifer and the Memphis Sand is presented in more detail by Broom and Lyford (1981).

Withdrawals of water by wells from the Memphis Sand are small; Holland and Ludwig (1981, p. 28) show water withdrawals of slightly more than 4 Mgal/d during 1980. This rate of discharge is negligible compared to the induced rate of "underflow discharge" from the Memphis Sand to the alluvial aquifer west of Crowleys Ridge.

The water in the Memphis Sand is fresh; it generally contains less than 500 mg/L disssolved solids throughout its extent in the Gulf Coastal Plain.

Wilcox Group

The composition of the Wilcox Group in most of its area of extent consists of relatively thin interbeds of lignitic sand and clay. Commonly, the beds of sand are lensing and discontinuous. However, the character of the Wilcox Group is substantially different in the Mississsippi Alluvial Plain east of Crowleys Ridge (pl. 5). Here, the Wilcox Group contains a sand bed 200 feet (or more) thick in the middle to lower part of the unit. This sand bed is variously referred to as the "1,400-foot sand" (Ryling, 1960, p. 17 and Plebuch, 1961, p. 22), and as the "lower Wilcox aquifer" (Hosman and others, 1968, p. D8).

The sand beds in the Wilcox Group are recharged in the outcrop and subcrop areas of the unit. Water in the unit moves generally southeastward or downslope from the outcrop and subcrop areas. In the outcrop and subcrop areas the aquifer is under water-table conditions whereas in the downdip areas the aquifer is under artesian conditions where it becomes confined by overlying and underlying claybeds. In the area of artesian conditions, water levels in Wilcox wells can be close to, or above, land surface. Edds (1984, p. 42-45) reports water levels ranging from about 8 to 150 feet below land surface. Holland and Ludwig (1981, p. 28) show water withdrawal of more than 0.50 Mgal/d from the Wilcox Group during 1980.

Maps showing the altitude of the structural top, the thickness, and the dissolved-solids concentration of the Wilcox Group are shown on plate 5.

Midway Group

The Midway Group (pl. 6) is the basal unit of the Tertiary System (table 1) throughout the Gulf Coastal Plain in Arkansas. This unit, which is as much as 600 feet thick, is a substantially impervious, confining clay bed. The Midway Group is of particular hydrologic importance because, over a large area of the Gulf Coastal Plain, its confining character greatly retards the upward movement of highly saline water from aquifers in the Cretaceous System. The structural top of the Midway Group is shown on plate 6.

Cretaceous System

The principal aquifers in the Cretaceous System are in the Nacatoch Sand, the Tokio Formation, and the Trinity Group. With the exception of an area of freshwater in the Nacatoch Sand in northeastern Arkansas, freshwater is found only in and near the outcrop areas of these three units.

Nacatoch Sand

One of the principal aquifers in the Upper Cretaceous Series is in the Nacatoch Sand. Maps of the structural top and dissolved-solids concentrations of the Nacatoch Sand are shown on plate 7.

The aquifer is recharged at its outcrop and subcrop areas, and water moves generally southeast in the direction of aquifer slope. Freshwater withdrawals from the Nacatoch Sand in 1980 were nearly 6.5 Mgal/d (Holland and Ludwig, 1981, p. 28).

Tokio Formation

The other principal aquifer in the Upper Cretaceous Series is in the Tokio Formation which occurs near the bottom of the series. Counts and others (1955, p. 24-28) describe the Tokio Formation and other Upper Cretaceous units in more detail.

The Tokio Formation is recharged in its outcrop area (pl. 8) and flow in the aquifer is southeastward. Except in its outcrop area, water in the Tokio Formation is under artesian conditions. The Tokio Formation yields freshwater in the outcrop area and downdip to within a few miles of Ashdown (Little River County). The water in the Tokio Formation becomes slightly to moderately saline downdip from near Prescott to the fault zone trending across Nevada County (pl. 8). The water becomes highly saline immediately south of the fault zone; Fancher and Mackay (1946, p. 149) showed dissolved-solids concentrations of nearly 40,000 mg/L in the Troy oil field in southeastern Nevada County. Freshwater withdrawals from the Tokio Formation in 1980 were slightly more than 6 Mgal/d (Holland and Ludwig, 1981, p. 28).

Trinity Group

The Lower Cretaceous Series consists almost entirely of the Trinity Group (table 1). Because of northeastward truncation by younger series, the Trinity Group is present only in southwest Arkansas, west of a line extending from near Antoine (Pike County) to near Strong (Union County) (pl. 8). Structural contours of the top of the Trinity Group are shown on plate 8.

The Trinity Group contains several aquifers that yield freshwater mainly in the outcrop area. These aquifers, chiefly in the Paluxy Sand, Ultima Thule Gravel Member of the Holly Creek Formation, and the Pike Gravel, are discussed in some detail by Counts and others (1955) and Boswell and others (1965). The recharge area for these aquifers is the outcrop area of the Trinity Group (pl. 8) and the direction of water movement generally is southward. The aquifers are sources largely of domestic water supply in Sevier, Howard, and Pike Counties. In 1980, freshwater withdrawals from the Trinity Group were slightly more than 1 Mgal/d (Holland and Ludwig, 1981, p. 28).

The water in all of the aquifers of the Trinity Group becomes slightly to moderately saline within about 10 miles downdip of the outcrop area. Counts and others (1955, p. 30) reported slightly saline water from a well in the upper Trinity in north-central Little River County. Highly saline water probably occurs in all of the Trinity Group south of Little River and Hempstead Counties. Fancher and Mackay (1946, p. 45) showed water from the upper Trinity Group near Garland (Miller County) to contain dissolved solids of about 88,000 mg/L.

Jurassic System

The Jurassic units (table 1) are present only in the subsurface in southern Arkansas. The northward depositional limits of the Jurassic units coincides approximately with a line trending northeasterly through Hope (Hempstead County) and Prescott (Nevada County), and then southeasterly through Hampton (Dallas County).

The Smackover Formation is a commercially important formation in the Jurassic System in southern Arkansas as a source of oil, gas and bromide-rich brine. Structural contours of the top of the Smackover Formation (Fancher and Mackay, 1946 p. 24) indicate that the Jurassic units slope to the southwest. Altitudes of the top of the Smackover Formation range from about 3,000 feet below sea level in Ouachita County to about 10,000 feet below sea level in Lafayette County. Maximum thickness of the Smackover Formation is about 700 feet.

All water in the Jurassic units is highly saline. Trout (1974) reports that dissolved-solids concentrations in the Smackover Formation in southern Arkansas range from about 250,000 to 350,000 mg/L.

Paleozoic Erathem

The Paleozoic sequence in the Gulf Coastal Plain (table 1) is a thick body of consolidated rock, the top of which can be considered an impervious basement floor for the overlying fluid-bearing units of the Jurassic, Cretaceous, Tertiary, and Quaternary Systems. The altitude of the top of the Paleozoic rocks is shown in plate 9. In Hempstead, Ouachita, Drew, and Ashley Counties, where data were few, plate 9 shows specific altitudes on the top of the Paleozoic rocks.

Data provide no thickness values for the Paleozoic rocks in the Gulf Coastal Plain. However, Caplan (1954, p. 44) estimated that the Paleozoic rocks in the Mississippi Embayment may attain a total thickness of about 18,500 feet. Subsequent data suggest it could be in excess of this figure (W. M. Caplan, Arkansas Geological Commission, oral commun., 1983).

SUMMARY

The Quaternary alluvium is the source of the largest withdrawals of ground water in Arkansas. Nearly 3,700 Mgal/d were withdrawn in 1980. Thicknesses range from less than 100 feet to 200 feet. Water in the alluvium is relatively dilute, generally containing less than 500 mg/L dissolved solids.

Sediments of the Tertiary System afford freshwater sand aquifers in about 90 percent of the Gulf Coastal Plain in Arkansas. The Sparta Sand affords the most extensive freshwater aquifer in the Tertiary System. It contains freshwater throughout most of its extent in the study area and is also the most used aquifer in the Tertiary System with approximately 178 Mgal/d withdrawn in 1980. The Sparta Sand generally slopes southeastward (southwestward in some areas along the Mississippi River) and deepens to about 600 feet below sea level in the Desha Basin. The basal unit (Midway Group), which is as much as 600 feet thick, is substantially an impervious clay bed. The Midway Group is of particular hydrologic importance because it greatly retards over a large area the upward movement of highly saline water from the Cretaceous System into the Tertiary System.

The main aquifers of the Cretaceous System are in the Nacatoch Sand, the Tokio Formation, and the Trinity Group. These aquifers all yield freshwater near their outcrops and highly saline water further downdip. The Nacatoch Sand and Tokio Formation slope southeastward while the Trinity Group slopes southward. Altitudes of structural tops of the three units decrease to about 3,800 to 4,400 feet below sea level.

Units of the Jurassic System are present only in southern Arkansas because of northern depositional limits. All water in the units is highly saline. The Smackover Formation slopes to the southwest.

The rocks of the Paleozoic Erathem can be conceptualized as a thick body of consolidated rock. Altitudes of the top of the Paleozoic rocks range from 400 feet above sea level to more than 9,000 feet below sea level. Slope of these rocks is southeast, south and southwest. There are no data on water yield.

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