INTRODUCTION

The U.S. Geological Survey is conducting a regional water-resources investigation of the Gulf Coast Regional Aquifer System, which includes the Mississippi embayment aquifer system in the southeast lowlands of Missouri (Grubb, 1986). The regional study will describe and evaluate the significant aquifer systems of Tertiary and younger age in parts of 10 States (Grubb, 1984). Paleozoic, Mesozoic, and Cenozoic geologic units in southeast Missouri have been described and mapped to define the aquifers of the area (Mesko, in press). This report describes aquifers in unconsolidated sediments of Cenozoic and Mesozoic age of southeast Missouri and presents geohydrologic and water-quality information collected during the study.

The southeast lowlands of Missouri is underlain by a multiaquifer ground-water system consisting of unconsolidated and consolidated sediment (table 1, sheet 2). Unconsolidated aquifers, from youngest to oldest, are the Mississippi River Valley alluvial aquifer, Claiborne and Wilcox aquifers (Cenozoic age), and the McNairy aquifer (Mesozoic age). Numerous geologic formations that primarily consist of sand and clay comprise these units. Consolidated aquifers underlying the region are the Ozark and St. Francois aquifers (Paleozoic age). These aquifers in Paleozoic rocks occur at greater depth and produce saline quality water (except near the margin of the embayment), and are not discussed in detail in this report.

PREVIOUS WORK

The study area is in a tectonically active setting and the geology and hydrology have been described in numerous reports. Boswell and others (1965) described aquifers in Cretaceous rocks, Boswell and others (1968) described aquifers in Quaternary deposits, and Hosman and others (1968) described aquifers in Tertiary sediments in the Mississippi embayment. Luckey and Fuller (1980) presented water-level and water-quality data for southeast Missouri, and Luckey (1985) discussed the water resources of the southeast lowlands with emphasis on the alluvial aquifer. Brahana and Mesko (1988) described the hydrogeology and assessed regional-flow patterns in Upper Cretaceous rocks and in adjacent aquifers in the northern embayment.

GEOHYDROLOGY

CENOZOIC UNITS

Mississippi River Valley Alluvial Aquifer

The Mississippi River Valley alluvial aquifer is the surficial unit in southeast Missouri, except where older units crop out on Crowley's Ridge, and is used extensively for irrigation, public, and domestic supplies. This unit consists of unconsolidated gravel, sand, silt, and clay. Thickness ranges from 0 to more than 250 ft (feet) (sheet 1) and commonly is 100–150 ft (Luckey, 1985). Transmissivity values can exceed 50,000 ft²/d (feet squared per day), which allows some wells to yield in excess of 3,000 gal/min (gallons per minute). Recharge occurs by upward movement of water from underlying bedrock near the margin of the embayment, stream-aquifer interaction, and 44–50 in (inches) per year of precipitation. Discharge is toward area streams, ditches, and the Mississippi River. Ground-water flow generally is from the north to south with local variations (Luckey, 1985). Generally, water-levels fluctuate 10–15 ft seasonally, with the highest water levels occurring in the spring. The shallow water surface commonly is within 10 ft of land surface and must be drained through a series of streams and man-made ditches to allow agricultural production. The potentiometric surface maps for this aquifer indicate no significant or permanent changes have occurred.

Hydrographs of wells in the alluvial aquifer (sheet 2) were digitized from continuously recorded water-level data collected by the Missouri Department of Natural Resources. These charts indicate cyclic oscillations occur in the water levels, which correlate to seasonal variations; however, no significant or permanent declines in water levels have been noted.

Claiborne and Wilcox Aquifers

The Claiborne and Wilcox aquifers in the Claiborne and Wilcox Groups of the Tertiary system directly underlie the alluvial aquifer east of Crowley's Ridge, crop out on the ridge, and are primarily used for public supplies. The two aquifers, combined for purposes of this report, consist of interbedded layers of sand, clay, and silt. The combined thickness of the aquifers exceeds 1,300 feet (sheet 1). Significant differences between the alluvial aquifer and the combined Claiborne and Wilcox aquifers are thickness, transmissivity, and well yields. Transmissivity values generally are smaller than those of the alluvial aquifer, about 17,000 ft²/day or less, which allows some wells to yield as much as 1,500 gal/min.

Recharge occurs from the overlying alluvial aquifer, precipitation on outcrop areas on Crowley's Ridge, and possibly upward movement of water from underlying aquifers through fracture zones. Discharge is toward overlying aquifers. Ground-water flow generally is from the north to the south.

The potentiometric-surface map constructed from reported data indicates flow patterns in the Claiborne and Wilcox aquifers are similar to those in the alluvial aquifer. Water levels are shown on the other maps, but are not contoured because the data are too sparse. Almost all wells completed in these aquifers are public-supply wells except on Crowley's Ridge. No significant regional declines in water levels have been noted; however, on a localized basis, some declines have occurred. Data at Sikeston, Missouri, during the fall of 1984 indicated water levels in the city's multiple-well field had a range of 31 ft between wells of similar construction referenced to land surface. This difference probably is caused by effects of recent pumping or nearby well interference. Water generally is unconfined in these aquifers except in eastern Mississippi, New Madrid, and Pemiscot Counties, where confining units of clay are present (Moore, 1965; Davis and others, 1973; Crone, 1981).

MESOZOIC UNIT

McNairy Aquifer

The McNairy aquifer in the McNairy Sand of the Cretaceous system consists of poorly consolidated sandstone, sand, and clay and is an important source of water for public supplies in southeast Missouri. This aquifer crops out on Crowley's Ridge, and subcrops beneath the alluvial aquifer in a narrow band 5 mi wide or less, paralleling the margin of the embayment. The aquifer is confined where the Porters Creek clay overlies it and is more than 300 ft thick with clay layers interbedded (sheet 1). Transmissivity values range from 1,500 ft²/d near Crowley's Ridge to over 4,000 ft²/d in Kentucky (Boswell and others, 1965). In extreme southeast Missouri, the aquifer becomes shaly, and yields to wells decrease substantially. Recharge occurs from underlying aquifers in Paleozoic rock and from precipitation on outcrop areas. Discharge occurs to overlying aquifers along facture zones or as base flow to streams near the western margin of the embayment. Ground-water flow generally is north to south except where flow is from recharge areas in Tennessee toward areas in southeast Missouri.

Wells completed in the McNairy aquifer generally are flowing, artesian wells with hydraulic heads as much as 30 ft above land surface and free-flowing yields of hundreds of gallons per minute. The exception to this is on Crowley's Ridge where the McNairy Aquifer crops out and water levels are below land surface. The potentiometric maps indicate some declines in water levels have occurred, and the potentiometric surface seems to be affected by pumping in Dunklin and New Madrid Counties. Hydrographs indicate a head decline of about 30 ft at Clarkton and a seasonal fluctuation of greater than 10 ft at Gideon.

Paleozoic units underlie the region, crop out on Crowley's Ridge, and are equivalent to the Ozark and St. Francois aquifers (fmes, in press) in the Ozark Plateaus region. These aquifers are not utilized in southeast Missouri except on and near Crowley's Ridge, because of their great depth and the saline water they contain.

WATER QUALITY

CENOZOIC UNITS

Mississippi River Valley Alluvial Aquifer

Water-quality data for the Mississippi River Valley alluvial aquifer were compiled from published reports and files of the Missouri Division of Geology and Land Survey. Stiff diagrams drawn using historic data (sheet 2) indicate water from this aquifer is a calcium magnesium bicarbonate type with a dissolved-solids concentration ranging from less than 150 (mg/L) milligrams per liter to about 500 mg/L. General trends indicate water has the smallest dissolved-solids concentration near the margin of the embayment and the concentration increases south and east toward the Mississippi River. On the east side of Crowley's Ridge, the dissolved-solids concentration decreases to less than 200 mg/L, then again increases toward the Mississippi River. This indicates Crowley's Ridge provides some freshwater recharge to the alluvial aquifer and effectively separates the alluvial aquifer on the west and east sides of the ridge. Graphs of dissolved-solids concentrations show fluctuations but no significant long-term changes have occurred. Specific conductance of water can give an indication of the dissolved-solids concentration of that water (Hem, 1985). Reported specific conductance values for water were plotted and contoured and ranged from less than 200 to more than 1,000 mg/L (sheet 2). Several zones having large conductance values were identified in southern Butler and central Pemiscot Counties. These zones of large conductance values may be caused by lithofacies changes in aquifer material, or they may represent zones where water from underlying aquifers discharge upwards into the alluvial aquifer.

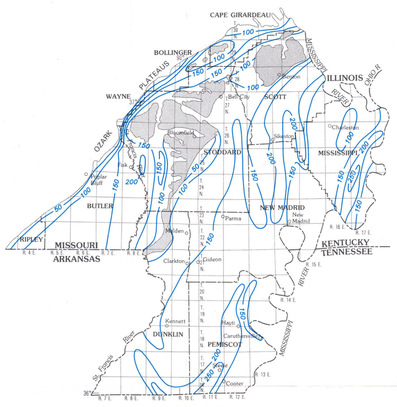
Claiborne and Wilcox Aquifers

Few water-quality data are available for the combined Claiborne and Wilcox aquifers. Five public supply wells that withdraw water from these aquifers were sampled during September 1984 (Brahana and others, 1985). Dissolved-solids concentrations ranged from about 100 mg/L at Steele to 175 mg/L at Parma. Water from wells sampled at Parma, Sikeston, and Charleston, was a calcium magnesium bicarbonate type. Water from wells at Hayti and Steele was a sodium barcarbonate type. The dissolved-solids concentration fluctuated; however, no significant long-term changes were noted.

MESOZOIC UNIT

McNairy Aquifer

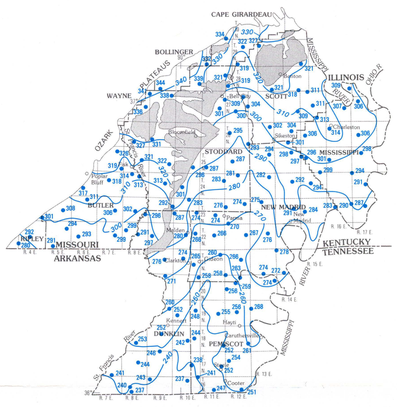
Water-quality data for wells completed in the McNairy aquifer were collected from 17 sites during 1983 and 1984 (Brahana and others, 1985). Stiff diagrams drawn using these data (sheet 2) indicate that water quality and type for the McNairy aquifer are variable throughout southeast Missouri. Dissolved-solids concentrations ranged from about 150 mg/L at Bloomfield, near the outcrop area of the aquifer, to more than 2,200 mg/L at a well near Bell City. Near the outcrop areas on Crowley's Ridge, water is a calcium magnesium bicarbonate type. As the aquifer dips under the embayment and becomes confined, water changes to a sodium bicarbonate type and chloride concentrations increase. An anomalous area of water quality is in the north central part of the study area. Dissolved-solids concentrations increase to more than 2,200 mg/L and water changes to a predominantly sodium chloride type (Brahana and Mesko, 1988). The source of this water probably is recharge from the underlying Paleozoic bedrock moving upward along fracture zones. Dissolved-solids concentration fluctuates; however, no significant long-term changes were noted.



(Modified from Luckey, 1985)

Thickness of the Mississippi River Valley alluvial aquifer

MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER



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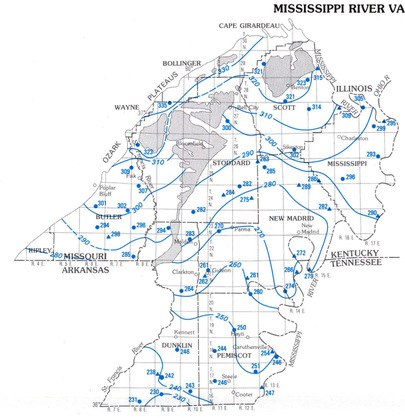

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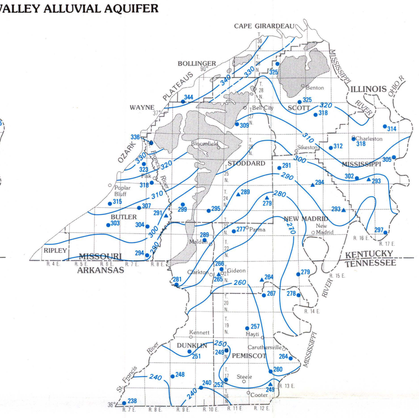

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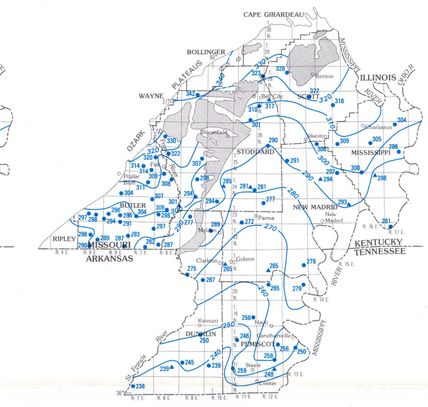

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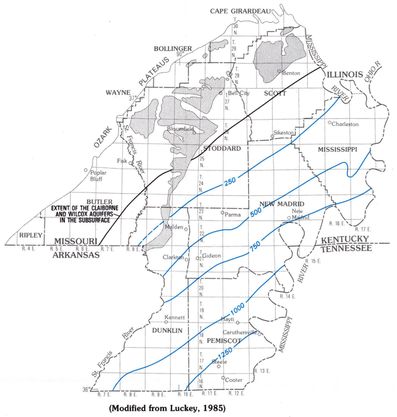
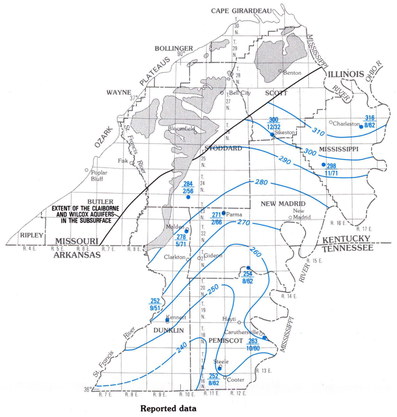
POTENTIOMETRIC SURFACE IN THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER



(Modified from Luckey, 1985)

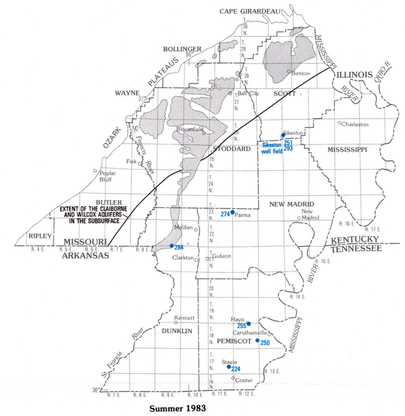
Thickness of the Claiborne and Wilcox aquifers

CLAIBORNE AND WILCOX AQUIFERS



Reported data

Potentiometric surface in the Claiborne and Wilcox aquifers



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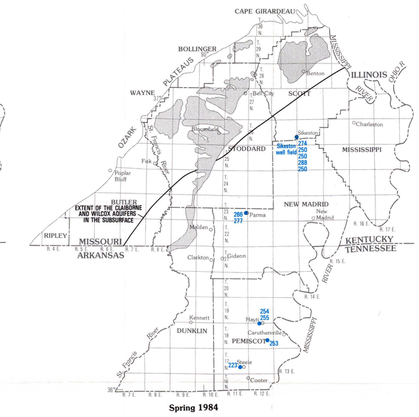

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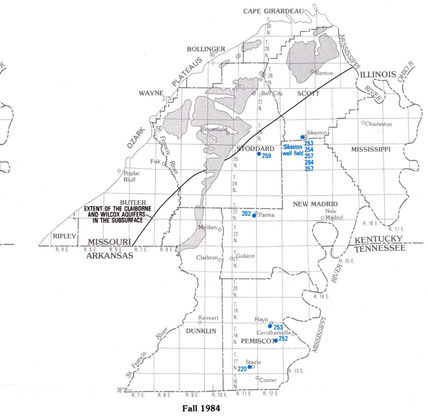
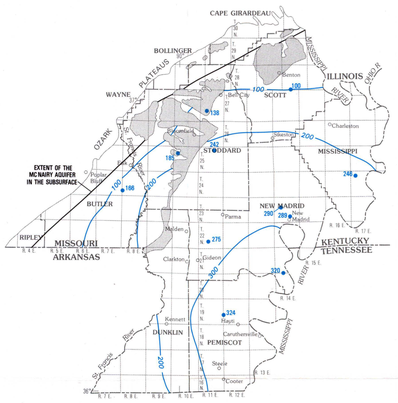


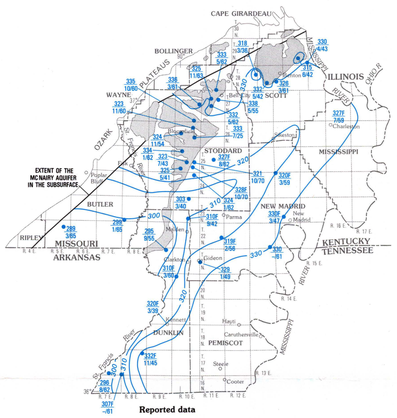
Fall 1984

LOCATION OF DATA SITES IN THE CLAIBORNE AND WILCOX AQUIFERS



Thickness of the McNairy aquifer

MCNAIRY AQUIFER



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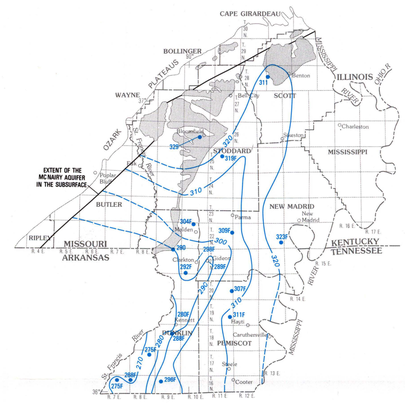

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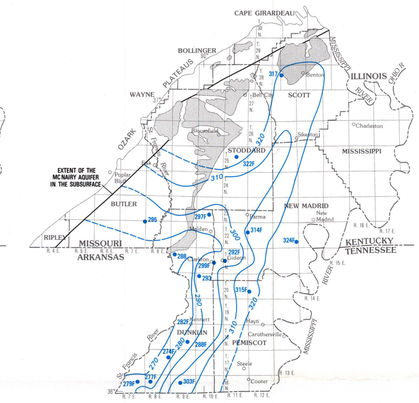

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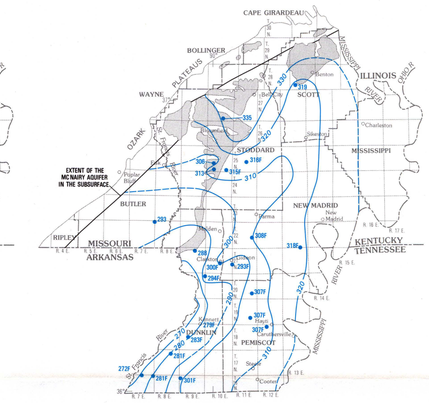

Fall 1984

POTENTIOMETRIC SURFACE IN THE MCNAIRY AQUIFER

CONVERSION FACTORS

For readers who prefer to use the International System of units (SI) rather than inch-pound units, the conversion factors for terms used in this report are listed below.

Multiply	By	To obtain
foot (ft)	0.3048	meter
foot squared per day (ft²/d)	0.0929	meter squared per day
gallon per minute (gal/min)	0.06308	liter per second
mile (mi)	1.609	meter

To convert temperature in °C (degrees Celsius) to °F (degrees Fahrenheit), add 32 and then multiply by 1.8.

Sea level: In this report "sea level" refers to the 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 "Sea Level Datum of 1929."

EXPLANATION

Outcrop—Area of Crowley's Ridge where Tertiary, upper Cretaceous, and Paleozoic rocks crop out

200 — Line of equal thickness—Interval, in feet, is variable

EXPLANATION

Outcrop—Area of Crowley's Ridge where Tertiary, upper Cretaceous, and Paleozoic rocks crop out

300 — Potentiometric contour—Shows altitude of water levels. Dashed where approximately located. Contour interval 10 feet. Datum is sea level

314 Well—Upper number is altitude of water level, in feet above sea level. F, indicates a flowing artesian well completed in the McNairy aquifer. Lower number (if shown) is month and year of reported measurements only. Reported data is from files of the U.S. Geological Survey and the Missouri Department of Natural Resources

285 Stream—Number is altitude of water level, in feet above sea level

Study area in the Gulf Coast Plain (Mississippi Embayment)

INDEX MAP

Base from Missouri Geological Survey, 1979

SCALE 1:1 000 000

25 0 25 50 75 100 MILES

25 0 25 50 75 100 KILOMETERS

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1990

GEOHYDROLOGY AND WATER QUALITY OF CENOZOIC AND MESOZOIC UNITS IN SOUTHEAST MISSOURI

By
T. O. Mesko

1990

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