INTRODUCTION

The Mississippi River alluvial aquifer, also referred to in this report as the alluvial aquifer, underlies about 7,000 square miles of the Mississippi River alluvial plain in all or parts of 19 counties in northwestern Mississippi (fig. 1). The Mississippi River alluvial plain in Mississippi, locally called the "Delta," and referred to in this report as the alluvial plain, is a lens-shaped area about 200 miles long, extending from the Tennessee border southward to Vicksburg, Mississippi. The widest section of the alluvial plain in Mississippi is about 66 miles and is bounded on the west by the Mississippi River and on the east by the Bluff Hills. The alluvial plain slopes about 1/2 foot per mile from north to south, and is about 100 feet above sea level at Vicksburg.

The Mississippi River alluvial aquifer is the most heavily pumped aquifer in the State. Withdrawal of water from the aquifer has increased from about 745 million gallons per day in 1975 to about 2,000 million gallons per day in 1994 (P.M. Johnson, U.S. Geological Survey, oral commun., 1994). Most of the pumpage from the alluvial aquifer is for crop irrigation and catfish farming.

In response to concern about declining water levels in the Mississippi River alluvial aquifer in northwestern Mississippi, the U.S. Geological Survey, in cooperation with the Yazoo Mississippi Delta Joint Water Management District (YMD), began a study in 1993 to investigate the potential for vertical recharge to the aquifer. The major component of the investigation is to determine the thickness of the upper and lower confining units of the alluvial aquifer.

This report presents maps showing the thickness of the upper and lower confining units of the Mississippi River alluvial aquifer in northwestern Mississippi (figs. 1 and 2, respectively). The vertical hydraulic conductivity of the confining units is very low. The confining units, therefore, partially impede the flow of water and the possible transport of contaminants from potential overlying and underlying sources to the alluvial aquifer. Recharge to the alluvial aquifer, as well as its susceptibility to potential contamination, are greatest where the confining units are thin or absent. These maps can be used to identify areas in northwestern Mississippi where the alluvial aquifer has the greatest potential for vertical recharge from precipitation, for contamination from surface-water sources, and for vertical recharge from underlying water-bearing units.

COMPILATION OF INFORMATION AND MAP CONSTRUCTION

Hydrogeologic information from more than 4,000 sites in the Mississippi River alluvial plain in northwestern Mississippi was reviewed during this study. The maps showing the thickness of the upper and lower confining units of the alluvial aquifer were constructed using information gathered and analyzed during the investigation. Most information came from the analysis of drillers' logs and borehole geophysical logs from the files of the Mississippi Department of Environmental Quality, Office of Land and Water Resources (OLWR), and the U.S. Geological Survey. The remainder of the information came from soil logs of corings made by the U.S. Army Corps of Engineers and the Mississippi Department of Transportation.

Hydrogeologic information and other identifying information were tabulated and entered into a computer data file. The file of attributed data consisted of:

- County identifier
- Well number
- Geophysical log number
- Land-surface altitude
- Upper confining unit thickness
- Depth-to-base of upper confining unit
- Depth-to-top of coarse sand and gravel
- Depth-to-base of alluvial aquifer
- Lower confining unit thickness
- Thickness of first Tertiary sand below base of alluvial aquifer
- Geologic unit directly underlying the alluvial aquifer
- Latitude
- Longitude

A complete array of data was not available for every site, but the minimum data for each site consisted of a county identifier, land-surface altitude, latitude, longitude, and at least one of the other attributes listed above.

The upper-confining-unit thickness map (fig. 1) was made using thickness values from 975 locations in the alluvial plain. Most of the data were clay thicknesses reported by water well drillers on drillers' logs submitted to the OLWR. The lower-confining-unit thickness map (fig. 2) was made using thickness values from 1,178 locations. Most of the data were clay thicknesses determined from analysis of borehole geophysical logs of wells made in aquifers underlying the alluvial aquifer.

The confining unit thickness maps were prepared by first developing a matrix of thickness values with each value in the matrix representing the thickness at the center of a 1-square-mile grid cell. The value at the center of each cell was determined by averaging the values at surrounding data points using a constrained distance-squared weighting function. The confining unit thickness maps were constructed by contouring the points of equal thickness and shading areas representing a selected range of thickness values.

GEOLOGIC DESCRIPTION

The Mississippi River alluvium of Quaternary age was deposited unconformably on an eroded Tertiary (Eocene) surface by the Mississippi River and its tributaries. The thickness of the alluvium averages about 140 feet and ranges from about 80 to 240 feet (Sumner and Wasson, 1990). The alluvium grades upward from coarse sand and gravel at the base of the alluvium to fine sand, silt, and clay in the upper part of the alluvium (fig. 3). The Mississippi River alluvial aquifer consists of the gravel and coarse sand in the alluvium and is thickest in the central part of the alluvial plain and becomes thinner toward the periphery of the Delta. The upper sequence of fine-grain alluvium confines the alluvial aquifer from the surface environment in most areas and is referred to in this report as the upper confining unit.

The geologic units of Tertiary age underlying the alluvium dip to the west in the northern two-thirds of the Delta and to the southwest and south in the southern one-third. The units directly underlying the Mississippi River alluvium from oldest to youngest are as follows: Zilpha Clay, Sparta Sand, Cook Mountain Formation, Cockfield Formation, and Jackson Group (fig. 4 and Sumner and Wasson, 1990). The underlying units consist of unconsolidated sand, silt, and clay beds of varying thicknesses. The Zilpha Clay and Jackson Group are predominantly clay; the Cook Mountain Formation is mostly clay but has significant sand thicknesses in the northern one-half of the study area. The Cockfield Formation and the Sparta Sand are predominantly sand, and the sand beds within these formations form two of the major aquifers in Mississippi.

UPPER CONFINING UNIT

The upper confining unit of the Mississippi River alluvial aquifer consists of various combinations of silt and clay that make up a low permeability top stratum (Fisk, 1944). Mixed with the silt and clay in the upper part of the alluvium is fine sand that may have little or no connection with the underlying coarse sand and gravel in the basal part of the alluvium.

The alluvium was deposited by braided-stream, meander-belt, or backswamp depositional processes which resulted in trends in thickness of the upper confining unit that generally parallel major drainage channels. Although areal trends in thickness are evident, the confining unit thickness varies greatly over small areas. At specific sites, the upper confining unit may be thin or absent in an area where the unit generally is thick; conversely, the confining unit may be relatively thick at a specific site in an area where the unit generally is thin or absent. The thickness of the upper confining unit presented in this report represents the aggregate thickness of the clay and silty-clay intervals overlying the coarse sand and gravel.

Over most of the southern part of the study area, the thickness of the upper confining unit ranges from 20 to 50 feet. In the extreme southern part of the Delta, the thickness of the unit ranges from 50 to 100 feet in a large area of Issaquena and Warren Counties. In the southern part of the study area, the largest area where the upper confining unit is less than 20 feet in thickness is in the eastern part of Washington County. In the southern part of the Delta, the upper confining unit is thinnest (less than 10 feet thick) in two small areas in Washington and Humphreys Counties.

The upper confining unit generally is not as thick in the northern part of the study area as in the southern part. Most of the areas in the northern part of the Delta where the confining unit thickness is less than 20 feet are near the Bogue Phalia, Tallahatchie, and Mississippi Rivers. There are many small areas in the northern part of the study area where the upper confining unit thickness is less than 10 feet, but the total area is small compared to the area of the Delta. Most of the areas where the upper confining unit thickness is less than 10 feet are in Bolivar, Coahoma, Sunflower, Quitman, and Tallahatchie Counties. Areas where the confining unit thickness is less than 10 feet have the greatest probability of recharge from precipitation to the alluvial aquifer. The alluvial aquifer also is more susceptible to surface contamination in these areas.

LOWER CONFINING UNIT

The lower confining unit of the Mississippi River alluvial aquifer, unlike the upper confining unit, is not within the alluvium. The lower confining unit consists of the clay and silty clay directly underlying the alluvium. The clay and silty clay are discontinuous and are in one of five principal geologic units directly beneath the alluvial aquifer in northwestern Mississippi. In areas where the lower confining unit is absent, the alluvial aquifer is in contact with Tertiary aquifers in the Cockfield Formation and the Sparta Sand geologic units. The Jackson Group and Zilpha Clay are predominantly clay. The Cook Mountain Formation is predominantly clay and sandy clay with minor sand beds, but is not considered an aquifer. The Cockfield Formation and Sparta Sand are predominantly sand but have interbedded clay and silty clay of varying thicknesses.

The thickness of the lower confining unit is related to characteristics of the geologic units directly underlying the alluvial aquifer. The lower confining unit is thickest (greater than 250 feet) in the extreme southern part of the study area. In this area the Jackson Group underlies the alluvial aquifer in southern Issaquena and northwestern Warren Counties. A large area where the lower confining unit thickness ranges from 50 to greater than 100 feet is in the west-central part of the Delta in Bolivar and northern Washington Counties. The lower confining unit is less than 10 feet thick in a large area in Quitman, southern Coahoma, western Panola, southern Tunica, and the northern one-half of Sunflower Counties. In parts of this area, the lower confining unit may be absent, resulting in the alluvial aquifer being in direct contact with aquifers in the Cockfield Formation and the Sparta Sand. Throughout most of the remainder of the study area, the lower confining unit thickness has great spatial variability. Within several miles of most areas where the confining unit thickness is less than 10 feet are areas where the thickness of the unit is more than 100 feet. Several smaller areas where the lower confining unit thickness is 10 feet or less exist in Leflore, southern Sunflower, Humphreys, southeastern Washington, and Sharkey Counties. In and adjacent to these areas, the lower confining unit may be locally absent. In the areas where the lower confining unit is absent or very thin, the alluvial aquifer may be receiving recharge from the underlying aquifers.

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
foot	0.3048	meter
foot per mile	0.18943	meter per kilometer
mile	1.609	kilometer
square miles	2.590	square kilometers
million gallons per day	0.04381	cubic meter per second

Sea Level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

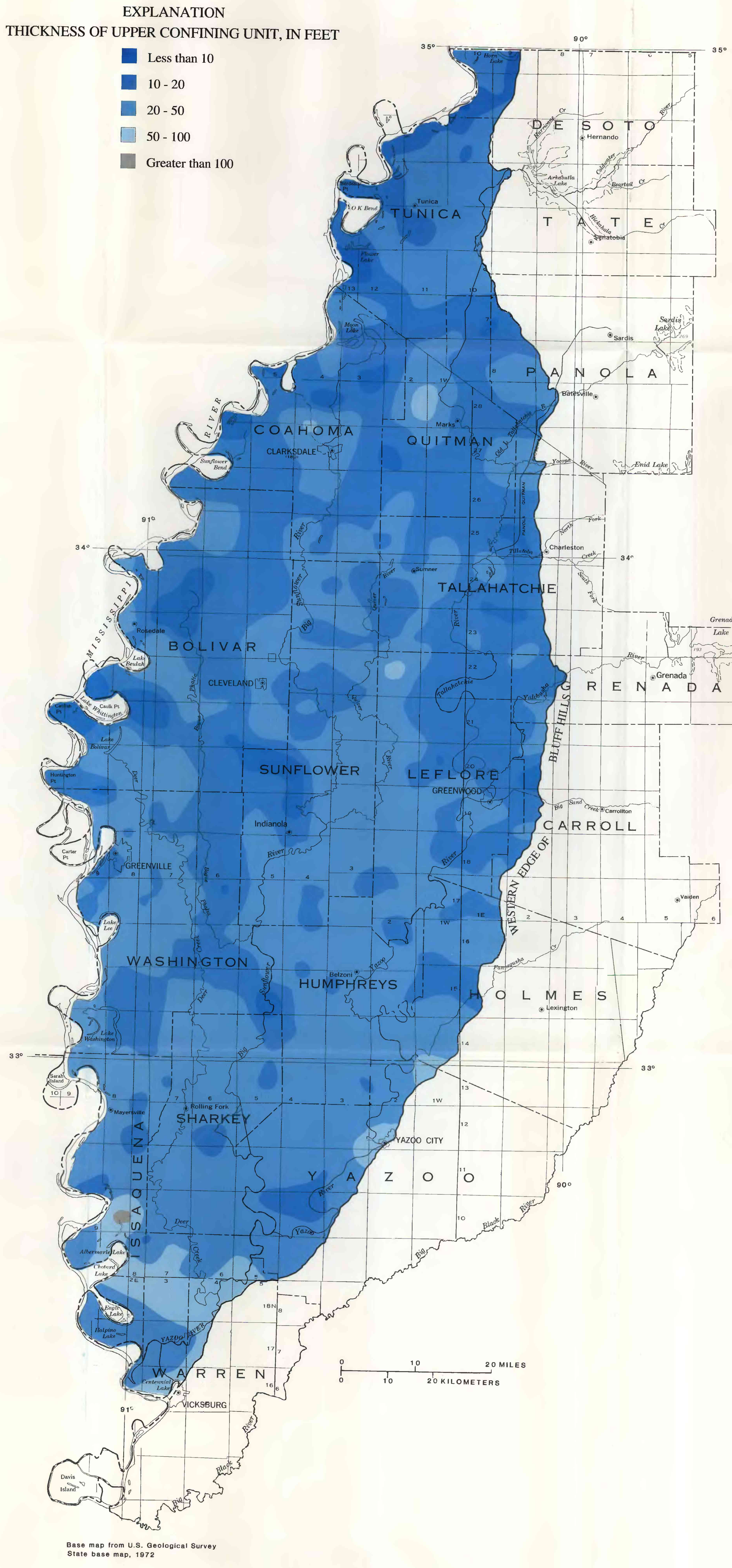


Figure 1. Thickness of the upper confining unit of the Mississippi River alluvial aquifer.

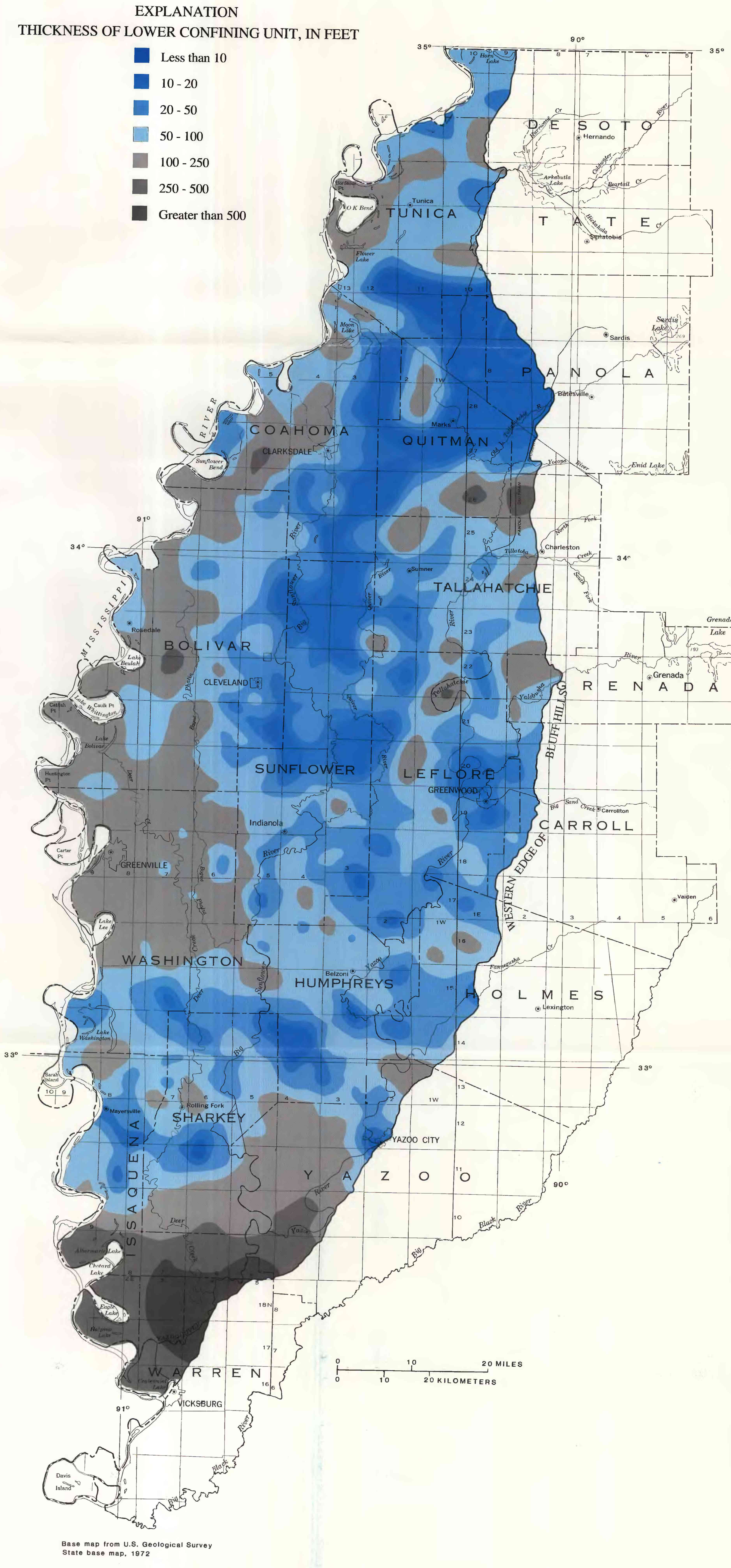
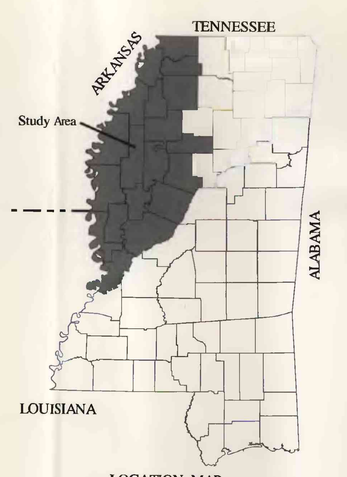


Figure 2. Thickness of the lower confining unit of the Mississippi River alluvial aquifer.



LOCATION MAP

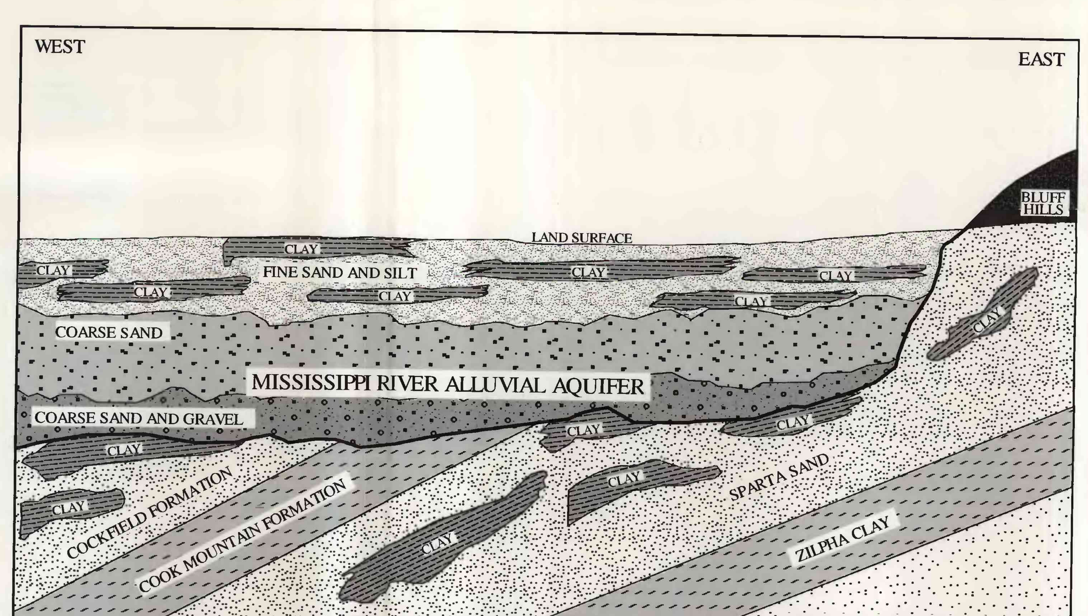
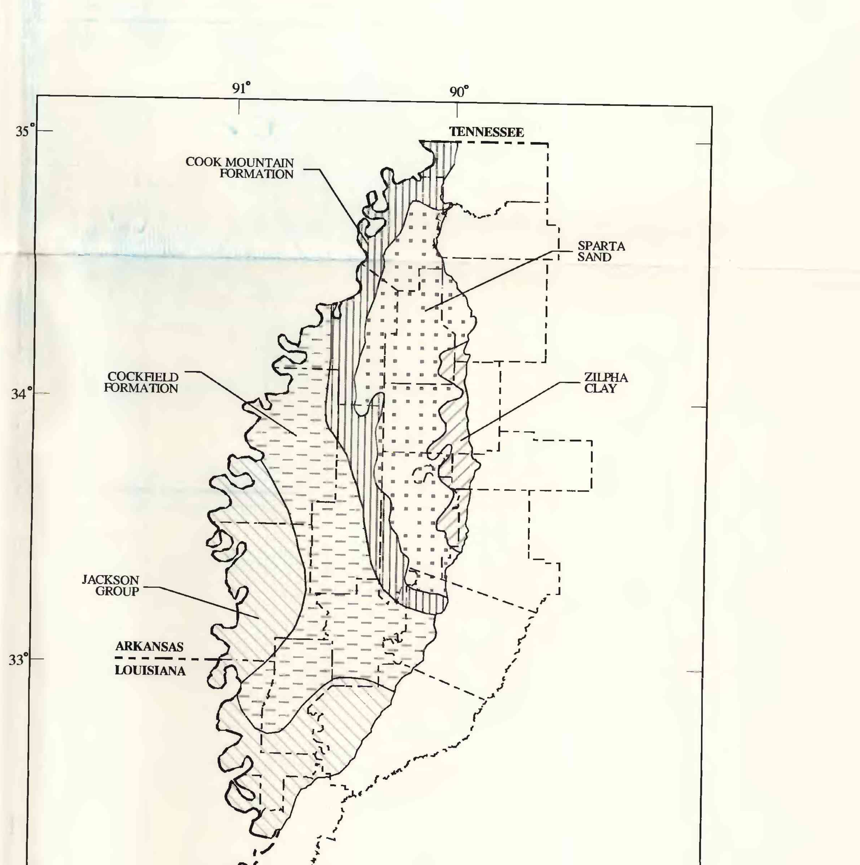


Figure 3. Generalized geohydrologic section of the Mississippi River alluvial aquifer and underlying units.



Geology modified from Boswell and others (1968), Dalsin (1978), Sumner and Wasson (1990).

Figure 4. Geologic units directly underlying the Mississippi River alluvial aquifer.

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Thickness of the Upper and Lower Confining Units of the Mississippi River Alluvial Aquifer in Northwestern Mississippi

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