U.S. DEPARTMENT OF THE INTERIOR
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ARKANSAS SOIL AND WATER CONSERVATION COMMISSION

WATER-RESOURCES INVESTIGATIONS REPORT 92-4121
Confining unit, Northern section–SHEET 1 OF 4
Gonthier, G.J., and Mahon, G.L., 1993, Thickness of the Mississippi River Valley confining unit, eastern Arkansas

INTRODUCTION

The drought of the early 1980's resulted in water-level declines in the Mississippi River Valley alluvial aquifer in eastern Arkansas. Concern over the declining water levels led to the initiation of the Eastern Arkansas Water Conservation Project in 1983. This project was developed by the U.S. Department of Agriculture to provide a detailed evaluation and better understanding of water-level declines in the shallow ground-water system in eastern Arkansas. Concerns about the ground-water conditions in the area also led the U.S. Army Corps of Engineers, Memphis District, to become involved in an expanded Eastern Arkansas Region Comprehensive Study in 1985 to determine the feasibility of constructing hydraulic structures for surface-water diversion and artificial recharge in areas where ground-water supplies were deficient.

Concern arose in the late 1980's over the vulnerability of the Mississippi River Valley alluvial aquifer, herein referred to as the alluvial aquifer, to contamination from potential surface sources related to pesticide or fertilizer use, industrial activity, landfills, or livestock operations. The Arkansas Soil and Water Conservation Commission, in cooperation with the U.S. Environmental Protection Agency, began a study in 1990 to locate areas in Arkansas where the ground-water flow system is susceptible to contamination by surface contaminants. As a part of that effort, the U.S. Geological Survey, in cooperation with the Arkansas Soil and Water Conservation Commission, began in 1990 to map the thickness of the clay confining unit overlying the alluvial aquifer in eastern Arkansas.

The vertical hydraulic conductivity of the overlying Mississippi River Valley confining unit, herein referred to as the confining unit, is very low. The confining unit, therefore, impedes the flow of water and the possible transport of contaminants from potential surface sources to the alluvial aquifer. Recharge to the alluvial aquifer as well as its susceptibility to potential contamination are greatest where the overlying confining unit is thin or absent.

Purpose and Scope

This report depicts the thickness of the confining unit overlying the alluvial aquifer in eastern Arkansas through the use of maps and geologic sections. The information presented here can be used by State and Federal water-management agencies to describe the ground-water flow system, delineate areas of high recharge, and determine areas where the ground water is vulnerable to contamination from potential surface sources.

The study area includes all or parts of 27 counties in eastern Arkansas that are underlain by the alluvial aquifer and its overlying confining unit. The study area coincides with the Mississippi Alluvial Plain and is bounded on the north by the Missouri State line, on the south by the Louisiana State line, on the east by the Mississippi River, on the southwest by the West Gulf Coastal Plain, and on the northwest by the Interior Highlands.

Data Collection and Map Construction

Thickness of the confining unit was determined by analyzing driller's logs from more than 6,500 wells in eastern Arkansas provided by the Arkansas Geological Commission and the Arkansas Water Well Construction Committee. Each driller's log contains data on well location, altitude of land surface, depths of lithologic contacts (boundaries between clay beds, sand beds, and deposits of Tertiary age and older), and the depth of the well. U.S. Geological Survey personnel compiled the log data and determined the top of the alluvial aquifer (bottom of the confining unit), bottom of the alluvial aquifer, thickness of the confining unit, and thickness of the alluvial aquifer.

A data base of well attributes was compiled based on data from driller's logs and from data published by Krinitzsky and Wire (1964) and stored in computer files. The attributes for each well record included data-base-record number, township, range, section, quarter section, quarter-quarter section, quarter-quarter-quarter section, latitude, longitude, name of driller, well depth, altitude of land surface, thickness of the confining unit, thickness of the alluvial aquifer, depth to the bottom of the alluvial aquifer, altitude of the top of the alluvial aquifer, and altitude of the bottom of the alluvial aquifer.

A confining unit thickness map was created from the driller's log data base using Geographic Information Systems (GIS) technology. Latitude and longitude data were used to plot data points using the same map projection as that used for Arkansas State base maps. Confining unit thickness values for each data point were then used by the GIS to create a three-dimensional matrix that represented the thickness of the confining unit in eastern Arkansas. This matrix was smoothed slightly so that a contour coverage could be plotted to a scale of 1:250,000. A contouring program was then used to contour the matrix.

Acknowledgments

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GEOLOGIC DESCRIPTION

Eastern Arkansas contains a regional lowland called the Mississippi Alluvial Plain (Fenneman, 1938), herein referred to as the alluvial plain. The alluvial plain is about 90 miles wide and lies in a large structural trough called the Mississippi embayment, herein referred to as the embayment. The embayment extends 600 miles from the southern tip of Illinois to the Louisiana coast and increases in width to the south (Ackerman, 1989). Geologic units of Tertiary age and older dip toward the axis of the Mississippi embayment with a southward component of dip following the plunge of the axis (Hosman and others, 1968).

Rising above the alluvial plain in northeastern Arkansas is a north-south trending feature called Crowleys Ridge. Crowleys Ridge rises 100 to 250 feet above the surrounding alluvial plain and is 3 to 10 miles wide and 150 miles in length. This ridge is an erosional remnant of deposits of Tertiary age and older, capped by Quaternary deposits, that is a barrier to lateral ground-water flow in the alluvial aquifer (Broom and Lyford, 1981).

A slightly elevated feature called the Grand Prairie is located in the central part of the eastern Arkansas study area. The Grand Prairie extends from Arkansas County northwest to Lonoke County (Engler and others, 1945; Sniegocki, 1963). This area, which includes about 1,000 square miles of very productive farmland, has been used extensively for rice farming since the early 1900's. Large ground-water withdrawals from the alluvial aquifer to support rice farming and slow recharge rates caused by a thick underlying confining unit have helped to create a large cone of depression in this region (Fitzpatrick, 1990).

In the embayment, alluvial deposits of Quaternary age lie unconformably on the eroded surface of geologic units of Tertiary age and older. This erosional surface is depressed along the axis of the embayment and contains many smaller valleys and ridges, which generally trend north-south, (Krinitzsky and Wire, 1964). Most of the geologic units in contact with the base of the alluvium are unconsolidated sand, silt, and clay beds of Tertiary age.

The alluvium consists of two distinct but gradational lithologies: clays and silts overlie coarse sands and gravels forming a fining upward sequence (Ackerman, 1989). These two lithologies are used as a basis for subdividing the alluvium into the basal alluvial aquifer and the overlying confining unit. More detailed descriptions of hydrogeology of the alluvium in eastern Arkansas are discussed by Ackerman (1989), Broom and Lyford (1981), Fisk (1944; 1947), and Krinitzsky and Wire (1964).

THICKNESS OF THE MISSISSIPPI RIVER VALLEY CONFINING UNIT

Where the confining unit is present, it ranges in thickness from near 0 feet in many locations in the study area to 140 feet in northeastern Greene County and can vary substantially over short distances. The confining unit is absent at many locations in the study area. Areas where the confining unit is less than 10 feet thick are found in all 27 counties that are underlain by the alluvial aquifer and its confining unit. Because the alluvium was deposited by braided stream, meander belt, or backswamp depositional processes (Fisk, 1944; Krinitzsky and Wire, 1964), trends in the thickness of the confining unit tend to parallel major stream channels. The Grand Prairie, for example, is bounded on two sides by rivers and the confining unit in that area is relatively thick. The largest area where the confining unit is absent tends to follow the St. Francis River from northeastern Craighead County south into Poinsett County.

Although general trends in the thickness of the confining unit are apparent, confining unit thickness has great spatial variability. Locally, the confining unit may be thin or absent within an area where the unit generally is thick or, conversely, the confining unit may be relatively thick at a site within an area where the unit generally is thin or absent.

An apparent relation exists between thickness of the confining unit and spatial variability in thickness. In areas where the thickness of the confining unit is 40 feet or less, such as in Clay, eastern Craighead, northwestern Mississippi, and Woodruff Counties, thickness of the unit tends to be more uniform than in areas where the thickness of the unit generally exceeds 40 feet, such as in Arkansas, Lonoke, and Prairie Counties.

At some sites the confining unit is very thick compared to its thickness in the immediate surrounding area. These thick lenses of the confining unit are referred to as "clay plugs." The clay plugs are typically 50 to 100 feet thicker than the confining unit surrounding the plugs. Some of the areas with a relatively thick confining unit are located near the mouths of eroded inlets of Crowleys Ridge. Other small areas, where the confining unit is thick, are located in areas of filled oxbow lakes or abandoned meander channels (Fisk, 1944; Krinitzsky and Wire, 1964). Locations of abandoned meander channels adjacent to the Mississippi River mapped by Fisk (1947) and locations of abandoned meander channels farther away from the river (as shown on topographic maps) generally coincide with locations of locally thick confining unit shown on maps in this report.

The thickness of the confining unit with respect to land-surface altitude and thickness of the alluvial aquifer is shown in six geohydrologic sections. Deposition of the confining unit onto the coarser alluvial aquifer deposits has reduced the relief of the land surface. The altitude of the top of the alluvial aquifer varies more than the altitude of the land surface and is indicative of a depositional setting.

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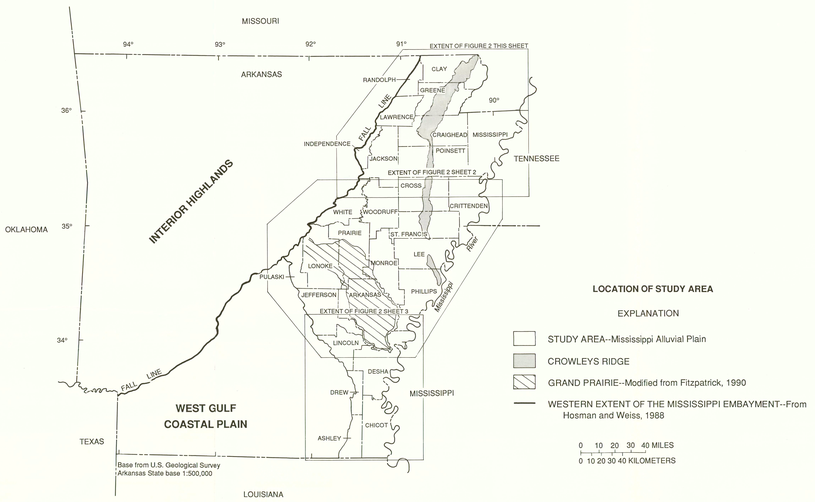
CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
foot	0.3048	meter
mile	1.609	kilometer
square mile	2.590	square kilometer

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 the United States and Canada, formerly called Sea Level Datum of 1929.

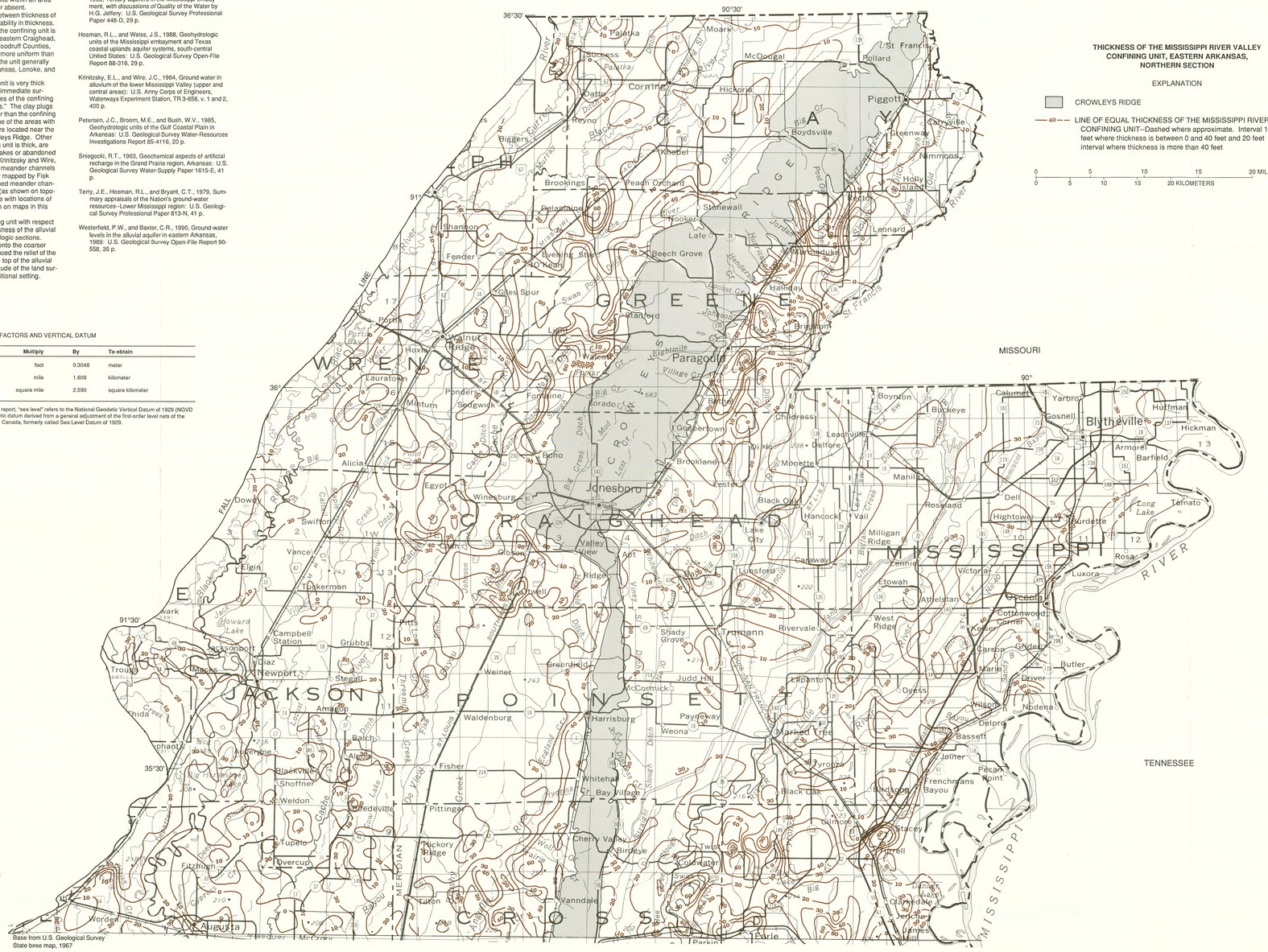


LOCATION OF STUDY AREA

EXPLANATION

- STUDY AREA--Mississippi Alluvial Plain
- CROWLEYS RIDGE
- GRAND PRAIRIE--Modified from Fitzpatrick, 1990
- WESTERN EXTENT OF THE MISSISSIPPI EMBAYMENT--From Hosman and Weiss, 1988

0 10 20 30 40 MILES
0 10 20 30 40 KILOMETERS



THICKNESS OF THE MISSISSIPPI RIVER VALLEY CONFINING UNIT–EASTERN ARKANSAS, NORTHERN SECTION

EXPLANATION

- CROWLEYS RIDGE
- 40 — LINE OF EQUAL THICKNESS OF THE MISSISSIPPI RIVER VALLEY CONFINING UNIT–Dashed where approximate. Interval 10 feet where thickness is between 0 and 40 feet and 20 feet interval where thickness is more than 40 feet

0 5 10 15 20 MILES
0 5 10 15 20 KILOMETERS

For additional information write to:

U.S. Geological Survey
2301 Federal Building
700 West Capitol Avenue
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THICKNESS OF THE MISSISSIPPI RIVER VALLEY CONFINING UNIT, EASTERN ARKANSAS

By
Gerard J. Gonthier and Gary L. Mahon
1993