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Thickness of the Quaternary alluvial and terrace deposits comprising the Mississippi River Valley alluvial aquifer in eastern Arkansas

INTRODUCTION

The Mississippi River Valley alluvial aquifer--herein referred to as the alluvial aquifer--encompasses an area of approximately 32,000 square miles and includes parts of Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee. Approximately 54 percent of the alluvial aquifer underlies the eastern one third of Arkansas. For this study, only the portion of the alluvial aquifer occurring in Arkansas was investigated. Within Arkansas, the alluvial aquifer extends from the Missouri State line, south to the Louisiana State line, and from the Mississippi River, west to the Fall Line (the physiographic boundary between the Coastal Plain and the Interior Highlands), the Monticello Ridge, and the Ouachita River Basin (see study area location map).

Since the turn of the century, the land use in eastern Arkansas has increasingly become more agricultural, consisting predominately of rice, soybeans, cotton, and in recent years aquaculture, all of which are highly dependent on the availability of water. Eastern Arkansas receives sufficient precipitation to support these crops, on average, receiving from 46 to 54 inches of precipitation annually (Freiwald, 1984). However, during a critical portion of the growing season from late spring through early summer most precipitation in eastern Arkansas falls in the form of widely scattered thunderstorms. Consequently, farmers are increasingly relying on irrigation water from the alluvial aquifer. In 1985, withdrawals from the alluvial aquifer in Arkansas totaled 3,546 million gallons of water per day (Mgal/d) (Baker, 1991), whereas in 1990 withdrawals totaled 4,340 Mgal/d (Holland, 1993), an increase of 18 percent over the 5-year period.

The U.S. Geological Survey (USGS) and the Arkansas Soil and Water Conservation Commission (ASWCC) mapped the thickness of the Quaternary alluvial and terrace deposits, which comprise the alluvial aquifer in eastern Arkansas to provide water managers with information necessary to assess current and future ground-water needs. This report presents the results of the mapping that defines the total thickness of the alluvial aquifer in eastern Arkansas.

AQUIFER DESCRIPTION

The alluvial aquifer is composed of alluvial and terrace deposits of Quaternary age (Ackerman, 1989). Lithologically, the Quaternary alluvial and terrace deposits are similar, consisting of unconsolidated sediments that grade from gravel and coarse sand in the lower sections to silt and clay in the upper sections (Boswell and others, 1968). The coarse sediments in the lower sections of the alluvial and terrace deposits are the materials that comprise the alluvial aquifer and lend the aquifer its productive hydraulic properties (Ackerman, 1989). The finer sediments in the upper sections of the alluvial and terrace deposits form a confining layer over much of the aquifer. These finer sediments are thin or have been completely removed by erosion in some areas, especially in areas near the Arkansas, White, St. Francis, and other large rivers within the study area (Gonthier and Mahon, 1993). Channel fill, point bar, and backswamp deposits associated with present or former channels of these rivers have produced abrupt changes in lithology and result in large spatial variations in the aquifer's hydraulic properties.

Sedimentary rocks and unconsolidated sediments of Tertiary age or older underlie the alluvial aquifer and have been deformed by geological processes into an undulating surface (Mahon and Poynter, 1993). In most areas, these undulating deposits are less permeable than the overlying Quaternary alluvial and terrace deposits and form the confining unit below the alluvial aquifer (Boswell and others, 1968).

The Quaternary alluvial and terrace deposits are bisected in the northern half of the study area by Crowleys Ridge, an erosional remnant of deposits of Tertiary age trending north to south from the Missouri-Arkansas border to northeastern Phillips County. Crowleys Ridge is a prominent topographic feature on the otherwise low-relief surface of the Mississippi Alluvial Plain and forms a hydrologic barrier to ground-water flow.

DATA ANALYSIS AND MAP CONSTRUCTION

Thickness of Quaternary alluvial and terrace deposits of the alluvial aquifer was determined by analyzing driller's logs from nearly 3,000 wells that fully penetrate the alluvial aquifer in eastern Arkansas. The driller's logs used for analysis were provided by the Arkansas Geological Commission and the Arkansas Well Construction Committee and are on file at their offices. Each driller's log contains information on well location, land-surface elevation, depths to lithologic contacts, and the total depth of the well. Well log data were compiled, placed into a digital data base, and the thickness determined at each well location by computing the difference between the elevation of the underlying Tertiary or older units and the elevation of the top of the alluvial aquifer as indicated by the well log data. These data were then contoured and plotted using a geographic information system. The resulting map was edited and modified to correct contouring errors and eliminate erroneous well log data.

The areal extent of the study area for this report was delineated using the Missouri State line for the northern boundary, the Mississippi River for the eastern boundary, the Louisiana State line for the southern boundary, and the western extent of Quaternary deposits within the Mississippi Embayment, as delineated on the 'Geologic map of Arkansas' (Haley and others, 1976), for the western boundary.

THICKNESS OF QUATERNARY ALLUVIAL AND TERRACE DEPOSITS COMPRISING THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER

Quaternary alluvial and terrace deposits of the alluvial aquifer have considerable variability in thickness over short distances, but on average are approximately 100 feet thick. These deposits are absent in the areas adjacent to Crowleys Ridge and near the western boundary of the study area where they have been removed by erosion or were never deposited, and are greater than 180 feet in an area east of Crowleys Ridge in Craighead and Mississippi Counties.

Because the deposits of the alluvial aquifer were deposited mostly in a braided stream environment (Fisk, 1944; Krinitzsky and Wire, 1964), trends in thickness tend to parallel major stream channels, particularly, in the Grand Prairie region of Arkansas, Jefferson, Lonoke, and Pulaski Counties. The Grand Prairie is bounded on the west and south by the Arkansas River and on the east by the White River. The deposits of the alluvial aquifer tend to be thickest in the center of the Grand Prairie and thin towards the present channel locations of these rivers.

There appears to be some correlation between the variations in the thickness of the alluvial and terrace deposits of the alluvial aquifer, primarily located east and west of Crowleys Ridge, and the thickness of the overlying confining layer. The confining layer in these areas tends to be thicker where the aquifer is thinner, possibly representing clay-filled depressions in the upper surface of the alluvial aquifer material.

Although general trends in the thickness of the alluvial and terrace deposits of the alluvial aquifer are apparent, locally these deposits may be thinner or thicker than indicated by the general thickness map presented here. These differences could be more prevalent along major rivers where the rivers have eroded or deposited sediments. Because of the variability in thickness over short distances and the scale at which this map was compiled, this map is not intended to indicate local variability in thickness, but is intended for smaller-scale (county or multicounty) uses.

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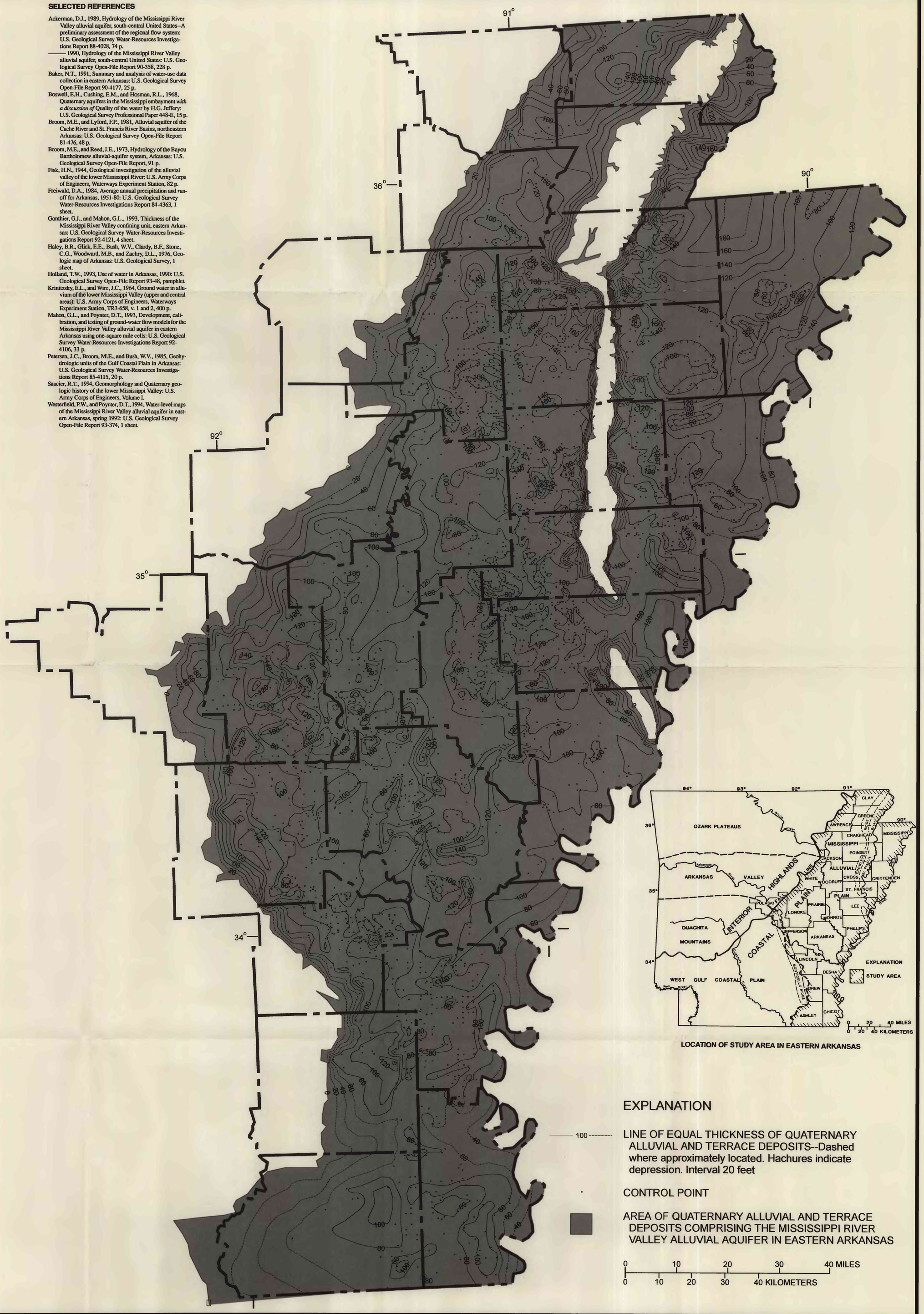

LOCATION OF STUDY AREA IN EASTERN ARKANSAS

EXPLANATION

100 LINE OF EQUAL THICKNESS OF QUATERNARY ALLUVIAL AND TERRACE DEPOSITS--Dashed where approximately located. Hachures indicate depression. Interval 20 feet

CONTROL POINT

AREA OF QUATERNARY ALLUVIAL AND TERRACE DEPOSITS COMPRISING THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER IN EASTERN ARKANSAS

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

THICKNESS OF THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER IN EASTERN ARKANSAS

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