THE DEPARTMENT OF ENVIRONMENTAL QUALITY

mississippi geology

Office of Geology
P. O. Box 20307
Jackson, Mississippi 39289-1307

Volume 13, Number 4
December 1992

THE 50TH ISSUE OF *MISSISSIPPI GEOLOGY*

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This is the 50th issue of *Mississippi Geology*, a journal the Mississippi Office (formerly Bureau) of Geology has published four times a year since September 1980. Issues of this series include 129 articles written by 94 authors representing 40 different institutions in 15 different states and 2 foreign countries. All of these articles relate to the geology, palentology, or mineral resources of Mississippi. Most are too short or specialized to have been published in any of our other series, such as bulletins or circulars, and perhaps would not have been published elsewhere because of their limited geographic interest. Many of the articles were written especially for *Mississippi Geology* and provide information that otherwise might not have been available. By publishing works of outside authors, we receive the benefits of their knowledge, expertise, and labor, thereby advancing the knowledge of Mississippi's geology at no expense to this agency.

The original mailing list for *Mississippi Geology* was a compilation of prospective readers (geologists and rock and fossil collectors) who were interested in the geology, mineral resources, and paleontology of Mississippi. Over the years the mailing list grew to nearly 2200 names as people requested almost daily to be added to the list. In 1988, during the downsizing of the petroleum exploration industry, the list had become encumbered with many out-of-date addresses. At this time a subscription renewal notice was printed that purged the list of all who did not renew. The total mailout dropped considerably, but has since grown to over 700.

This journal would not have been possible without the work and skills of many people to whom I owe a debt of gratitude. Dora Devery, formerly a geologist with this agency, provided the spark and enthusiasm to help create a journal out of an idea. David Dockery, co-editor since 1981, has prepared dummy layouts, brought in many manuscripts from outside authors, and written quite a few articles himself. Not a single issue would have been produced without the skills and assistance of the secretaries who have typed manuscripts, maintained the mailing list, and helped with labels and sorting for bulk mailing. Marilyn Ellis has done a great job on the layout of each issue, especially during the transition from conventional typesetting to desktop publishing. Bill Howard, operator of the department's print shop, has done a great job printing every issue to our specifications. No journal could exist without articles to print, and *Mississippi Geology* has been fortunate to have received so many contributions from our staff geologists and from authors in other states and even other countries.

Concurrently with publication of this 50th issue, the Office of Geology is making available an index to *Mississippi Geology*. Indexes were published after five years (volume 6, number 1) and ten years (volume 10, number 4), but these soon became outdated. The new index will be updated after publication of each issue and made available as an open file report. "Current Index to *Mississippi Geology*," Open File Report 15, will contain author and title indexes of all articles for which an author's name was printed, a list of back issues showing availability, date mailed, and number of copies mailed, and format instructions for submission of a manuscript. Copies of Open File Report 15 may be purchased for $2.00 ($2.50 by mail) from the Office of Geology's Map Sales office at Southport Center. This report is a photocopy of a printout of the current index, updated as of the latest issue.

MISSISSIPPI EARTHQUAKE EPICENTERS

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INTRODUCTION

We live on a dynamic, geologically active planet. Signs of this activity include the slow but relentless movement of huge crustal plates at the planetary scale and earthquakes and volcanoes at a more local scale. No place on Earth is immune from the effects of this activity, not even Mississippi. What is now Mississippi has had its share of volcanoes; they last erupted some 70 million years ago. However, earthquakes are occurring today. They have been experienced in all parts of Mississippi, in our neighboring states of Louisiana, Arkansas, Tennessee, and Alabama, and to the south of us in the Gulf of Mexico. Presented here is a list of the known earthquakes with Mississippi epicenters, that is, those that originated within the borders of the State of Mississippi.

EARTHQUAKE HISTORY OF MISSISSIPPI

The list of Mississippi earthquake epicenters includes 35 events known to have occurred either from felt reports or records of seismic instruments. For dates before the 1970s, only those earthquakes strong enough to be felt by people at the surface (and recorded for posterity) are listed. Since then seismic instruments, primarily those operated by the Center for Earthquake Research and Information at Memphis State University, have detected a number of small events that were not felt at the surface. As already mentioned, earthquakes have been reported from all parts of Mississippi. The earliest report of an earthquake that may have been felt in what is now Mississippi was on Christmas Day, 1699, by a party of French missionaries camped near the site of Memphis. Several shocks in the great New Madrid earthquake series of 1811-1812 (with epicenters in Missouri and Arkansas) were felt throughout Mississippi. The first report of a Mississippi earthquake comes from a small event felt at Biloxi in 1853. The two strongest in-state earthquakes occurred in northern Mississippi in 1931 and 1967, and a fairly good shake was felt along the coast in 1955. The most recent earthquakes as of this writing were two felt around Belzoni, Humphreys County, on December 11, 1992. The list of Mississippi earthquakes would be longer if more seismographs were available. An unknown number of events too small to be noticed at the surface are occurring; if recorded by seismic instruments, these events could give us valuable information about the ongoing geological activity beneath our feet.

EARTHQUAKE RISK

It is believed that an earthquake of magnitude 5.5 can occur anyplace on Earth. If so, then no place is free of the risk of a potentially damaging earthquake. The strongest recorded earthquake with an epicenter in Mississippi caused only minor damage. No deaths or serious injuries are known to have been caused by a Mississippi earthquake; we have been lucky.

The greatest risk to Mississippi from damage or injury from an earthquake comes from the New Madrid seismic zone of southeastern Missouri, northeastern Arkansas, and western Tennessee. During the winter of 1811-1812, a series of earthquakes occurred in the Bootheel of Missouri, around the little community of New Madrid, and in adjacent northeastern Arkansas (as the state boundaries now exist). Among the thousands of tremors in this series were three shocks felt throughout the eastern United States and believed to be the strongest known earthquakes in North America. There are reports of these earthquakes being felt strongly as far south in Mississippi (then a territory) as Natchez. A recurrence of shocks this strong today would cause tremendous damage from Memphis to St. Louis and thousands of casualties. The recurrence interval for New Madrid earthquakes of this magnitude (8 and above) is not known but has been estimated to be on the order of 600-700 years. Nevertheless, small earthquakes occur almost daily in the New Madrid seismic zone, and the damaging earthquakes of 1843 and 1895 were felt in most of Mississippi. Thus, the greatest risk of earthquake damage to Mississippi would be from a magnitude 6.5 temblor in the New Madrid seismic zone.

A NOTE ABOUT MAGNITUDE AND INTENSITY

Magnitude is a measure of the amount of energy released by an earthquake. Its measure, commonly referred to as the Richter scale, is calculated from the records of calibrated seismic instruments. Magnitudes are given in Arabic numerals. Another way of measuring an earthquake is by gauging its intensity by human observation and by looking at the effects of the shaking on the ground and on man-made structures. Intensities are taken from the Modified Mercalli Intensity Scale, which is given in Roman numerals from I (not felt except under especially favorable circumstances) to XII (practically all works of construction are damaged greatly or destroyed). An earthquake has only one magnitude, but it can have several intensities, with the greatest around the epicenter and values decreasing with distance. Values for magnitude and intensity given for the earthquakes listed in this report are taken from the previously published reports cited.

LIST OF MISSISSIPPI EARTHQUAKE EPICENTERS

1853, September 11 Biloxi, Harrison County

Felt at several places in Biloxi, where it shook the trees and houses and alarmed the inhabitants.

Source: article in the *New Orleans Daily Crescent* (September 13, 1853); information collected by M. James Stevens, local historian, and sent to the writer by Wade Guice, Harrison County Civil Defense Director, by letter of July 3, 1981.

1923, March 27 Wyatte, Tate County

One shock was felt by many at Wyatte in eastern Tate County; the maximum intensity was IV.

Sources: Branner and Hansell (1932), Docekal (1970), MATCOG (1974), Moneymaker (1957), and Stearns and Wilson (1972).

1927, November 13 Jackson, Hinds County

Dishes rattled and objects fell from tables at Jackson; maximum intensity was IV. Felt by a few people at Meridian; also reported from Jefferson Davis, Rankin, and Simpson counties.

Sources: Branner and Hansell (1932) and Docekal (1970).

1931, December 16 Batesville-Charleston area

This is the strongest known earthquake with an epicenter in Mississippi. It was felt over 65,000 square miles in northern Mississippi and parts of Alabama, Arkansas, and Tennessee. The maximum intensity of VI-VII was felt at Charleston, where the walls and foundation of the agricultural high school cracked and several chimneys were thrown down. It was also felt at intensity VI, with damage to plaster and chimneys, at Belzoni, Tillatoba, and Water Valley. Intensity V effects were felt at Batesville, Cleveland, Hernando, Holly Springs, Indianola, Taylor, and Tupelo, Mississippi; Marianna, Arkansas; and Raleigh, Tennessee.

Sources: Branner and Hansell (1932), Coffman and von Hake (1973), Docekal (1970), Heck (1938), Heinrich (1941), Krinitzsky (1950), MATCOG (1974), Moneymaker (1958), Neumann (1932), Stearns and Wilson (1972), and von Hake (1974).

1941, June 28 Vicksburg, Warren County

A light shock of intensity III-IV was felt by a few persons at Vicksburg at 12:30 p.m.

Sources: Docekal (1970), Moneymaker (1958), Neumann (1943), and Sheets (1947).

1955, February 1 Gulfport, Harrison County

An earthquake of intensity V centered at Gulfport was felt along the Mississippi Coast from Biloxi to Bay St. Louis. Houses shook, windows and dishes rattled, and deep rumbling sounds were heard.

Sources: article in the Jackson *Daily News* (February 2, 1955), Coffman and von Hake (1973), Docekal (1970), Murphy and Cloud (1957), and von Hake (1974).

1967, June 4 Greenville, Washington County

This intensity VI earthquake, centered about 18 miles northeast of Greenville, was felt over an area of 25,000 square miles in Mississippi, Arkansas, and parts of Louisiana and Tennessee. Residents were alarmed, but the only damage was cracked plaster. Magnitude 3.8; focal depth 33 km.

Sources: article in the Jackson *Clarion-Ledger* (June 5, 1967), Coffman and von Hake (1973), Docekal (1970), Stearns and Wilson (1972), and von Hake (1974).

1967, June 29 Greenville, Washington County

This second earthquake in a month had the same epicenter as that of June 4. The intensity V shock was felt only in Bolivar, Washington, and Sunflower counties. Magnitude 3.4.

Sources: Coffman and von Hake (1973), Docekal (1970), Stearns and Wilson (1972), and von Hake (1974).

1973, January 8 Sunflower County

This minor earthquake occurred in northern Sunflower County and was not felt. Magnitude 3.5; focal depth 7 km.

Sources: Coffman et al. (1975) and PDE Monthly Listing, January 1973.

1973, May 25 Bolivar County

A minor earthquake was felt at Bolivar, Cleveland, and Merigold. Focal depth 6 km.

Sources: Coffman et al. (1975) and PDE Monthly Listing, May 1973.

1975, September 9 Hancock County

This intensity IV earthquake shook railroad boxcars at Pearlington and was felt at Bay St. Louis. Magnitude 2.9; focal depth 5 km.

Sources: Coffman and Stover (1977), Person (1976), and Stover et al. (1977).

1976, October 23 Clarke County

This small event in northern Clarke County may not have been felt at the surface. Magnitude 3.0; focal depth 5 km.

Sources: Minsch et al. (1978) and PDE Monthly Listing, October 1976.

1977, May 3 Clarke County - Alabama border
The earthquake was felt in both states, with a maximum intensity of V at Melvin, Alabama. Magnitude 3.6; focal depth 5 km.
Sources: Coffman and Stover (1979), Minsch, Stover, and Simon (1979), Person (1977), and PDE Monthly Listing, May 1977.

1977, November 4 Vardaman, Calhoun County
An intensity V-VI earthquake was felt in the vicinity of Vardaman. Magnitude 3.4; focal depth 5 km.
Sources: Coffman and Stover (1979), Person (1978), Stover, Minsch, and Simon (1979), and PDE Monthly Listing, November 1977.

1978, January 8 Kemper County - Alabama border
This small event may not have been felt at the surface. Magnitude 3.0; focal depth 5 km.
Sources: Stover and von Hake (1980), Stover, Minsch, and Reagor (1980), and PDE Monthly Listing, January 1978.

1978, June 9 Clarke County
This small event in east-central Clarke County may not have been felt at the surface. Magnitude 3.3; focal depth 10 km.
Sources: Minsch, Stover, and Hubiak (1980), Stover and von Hake (1980), and PDE Monthly Listing, June 1978.

1978, December 10 Clarke County - Alabama border
An earthquake was felt in the Clarke County - Alabama border region. It was felt at intensity V at Gilbertown and Melvin, Alabama, and at lesser intensities at Carmichael, Mississippi, and surrounding areas. Magnitude 3.5; focal depth 5 km.
Sources: article in the Jackson *Clarion-Ledger* (December 12, 1978), Person (1979), Reagor et al. (1980), Stover and von Hake (1980), and PDE Monthly Listing, December 1978.

1980, October 12 NW Pontotoc County
This minor event in northeastern Mississippi was not felt. Magnitude 2.1; focal depth 10.6 km.
Sources: Tennessee Earthquake Information Center, Preliminary Seismological Bulletin, v. 1, no. 1, and Center for Earthquake Research and Information, Quarterly Seismological Bulletin, v. 12, no. 1 (cumulative listing).

1981, February 15 Clarke County
This minor event in northern Clarke County was not felt. Magnitude 2.4; focal depth 5 km.
Sources: Tennessee Earthquake Information Center, Preliminary Seismological Bulletin, v. 2, no. 2, and Center for Earthquake Research and Information, Quarterly Seismological Bulletin, v. 12, no. 1 (cumulative listing).

1983, January 29 NE Prentiss County
The first of two small earthquakes that occurred a week apart in northeastern Prentiss County, this event was not felt at the surface. Magnitude 2.4; focal depth 5.0 km.
Sources: Metzger (1983), Tennessee Earthquake Information Center, Quarterly Seismological Bulletin, v. 4, no. 1, and Center for Earthquake Research and Information, Quarterly Seismological Bulletin, v. 12, no. 1 (cumulative listing).

1983, February 5 NE Prentiss County
Following the previous event by one week, this earthquake was felt over approximately 730 square km with a maximum intensity of V. Magnitude 2.9; focal depth 1.4 km.
Sources: Metzger (1983); Person (1983); Stover (1987); Tennessee Earthquake Information Center, Quarterly Seismological Bulletin, v. 4, no. 1; Center for Earthquake Research and Information, Quarterly Seismological Bulletin, v. 12, no. 1 (cumulative listing); and PDE Monthly Listing, February 1983.

1983, April 25 Tunica County
This minor event in northwestern Mississippi was not felt. Magnitude 1.6; focal depth 2.0 km.
Sources: Tennessee Earthquake Information Center, Quarterly Seismological Bulletin, v. 4, no. 2, and Center for Earthquake Research and Information, Quarterly Seismological Bulletin, v. 12, no. 1 (cumulative listing).

1983, May 30 Clarke County
This minor event in western Clarke County was not reported to have been felt. Magnitude 2.4; focal depth 0.4 km.
Sources: Tennessee Earthquake Information Center, Quarterly Seismological Bulletin, v. 4, no. 2, and Center for Earthquake Research and Information, Quarterly Seismological Bulletin, v. 12, no. 1 (cumulative listing).

1984, March 23 Tishomingo County - Alabama border
This small event on the Tishomingo County - Alabama border was not felt. Magnitude 2.0; focal depth 0.9 km.
Source: Tennessee Earthquake Information Center, Quarterly Seismological Bulletin, v. 5, no. 1.

1984, September 24 NW Yalobusha County
This minor event, probably located under Yalobusha County, was not felt. Magnitude 2.5; focal depth 6.4 km.
Sources: Stover (1988) and Tennessee Earthquake Information Center, Quarterly Seismological Bulletin, v. 5, no. 3.

1986, May 11 NE Tunica County
This small event in northwestern Mississippi was not felt. Magnitude 1.6; focal depth 6.7 km.
Source: Tennessee Earthquake Information Center, Quarterly Seismological Bulletin, v. 7, no. 2.

1988, August 1 Quitman County
A small event under Quitman County was not felt. Magnitude 2.1; focal depth 15.19 km.
Source: Center for Earthquake Research and Information, Quarterly Seismological Bulletin, v. 9, no. 3.

1989, August 23 (2 events) Pachuta, Clarke County
Two slight tremors were felt in the vicinity of Pachuta.
Source: newspaper account in the *Meridian Star*, Meridian, Mississippi (August 30, 1989).

1989, August 25 Pachuta, Clarke County
A tremor was felt in the vicinity of Pachuta.
Source: newspaper account in the *Meridian Star*, Meridian, Mississippi (August 30, 1989).

1989, November 26 (2 events) Pachuta, Clarke County
A light tremor was felt at 3:31 p.m. and a strong tremor at 7:45 p.m. in the Pachuta area; the second shock knocked dishes off shelves.
Sources: article in the *Clarke County Tribune*, Quitman, Mississippi (November 29, 1989) and telephone conversation (November 27, 1989) with Bill Ford, Clarke County civil defense.

1991, February 11 Clarksdale, Coahoma County
A magnitude 2.7 event near Clarksdale was not felt at the surface.
Sources: personal communication (February 12, 1991) with Arch Johnston, director, Center for Earthquake Research and Information, and CERI Quarterly Seismological Bulletin, v. 12, no. 1.

1992, December 11 (2 events) Belzoni, Humphreys County
Two small shocks rattled dishes, furniture, and windows in Belzoni and western Humphreys County. The magnitude 2.4 quake at 6:06 a.m. was followed by a smaller one about 15 minutes later.
Sources: article in the Jackson *Clarion-Ledger* (December 12, 1992) and Weekly Earthquake Summary for December 10 - December 17, 1992, compiled by the Center for Earthquake Research and Information.

REFERENCES CITED

Branner, G. C., and J. M. Hansell, 1932, Earthquake risks in Arkansas; a statistical study covering the period from 1811 to 1931, 2nd edition 1937: Arkansas Geological Survey, Information Circular 4, 16 p.

Coffman, J. L., and C. W. Stover, editors, 1977, United States earthquakes, 1975: published jointly by National Oceanic and Atmospheric Administration and U. S. Geological Survey, 136 p.

Coffman, J. L., and C. W. Stover, editors, 1979, United States earthquakes, 1977: published jointly by National Oceanic and Atmospheric Administration and U. S. Geological Survey, 81 p.

Coffman, J. L., and C. A. von Hake, editors, 1973, Earthquake history of the United States: U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Publication 41-1, revised edition (through 1970), 208 p.

Coffman, J. L., et al., 1975, United States earthquakes, 1973: published jointly by National Oceanic and Atmospheric Administration and U. S. Geological Survey, 112 p.

Docekal, J., 1970, Earthquakes of the stable interior, with emphasis on the midcontinent: Ph.D. dissertation, University of Nebraska, 2 volumes.

Heck, N. H., 1938, Earthquake history of the United States. Part I. Continental United States (exclusive of California and western Nevada) and Alaska: U. S. Coast and Geodetic Survey, Serial No. 609, 83 p.

Heinrich, R. R., 1941, A contribution to the seismic history of Missouri: Bulletin of the Seismological Society of America, v. 31, no. 3, p. 187-224.

Krinitzsky, E. L., 1950, Geological investigation of faulting in the Lower Mississippi Valley: U. S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Technical Memorandum no. 3-311, pagination not continuous.

MATCOG (Mississippi-Arkansas-Tennessee Council of Governments / Memphis Delta Development District), 1974, Regional earthquake risk study: prepared for Department of Housing and Urban Development by M & H Engineering and Memphis State University, available from NTIS, pagination not continuous.

Metzger, A. G., 1983, The northeast Mississippi earthquakes of 29 January and 5 February, 1983: Mississippi Geology, v. 3, no. 4, p. 8-9.

Minsch, J. H., et al., 1978, Earthquakes in the United States, October-December 1976: U. S. Geological Survey, Circular 766-D, 31 p.

Minsch, J. H., C. W. Stover, and R. B. Simon, 1979, Earthquakes in the United States, April-June 1977: U. S. Geological Survey, Circular 788-B, 22 p.

Minsch, J. H., C. W. Stover, and P. Hubiak, 1980, Earthquakes in the United States, April-June 1978: U. S. Geological Survey, Circular 819-B, 27 p.

Moneymaker, B. C., 1957, Earthquakes in Tennessee and nearby sections of neighboring states - 1901-1925: Journal of the Tennessee Academy of Science, v. 32, no. 2, p. 91-105.

Moneymaker, B. C., 1958, Earthquakes in Tennessee and nearby sections of neighboring states - 1926-1950: Journal of the Tennessee Academy of Science, v. 33, no. 3, p. 224-239.

Murphy, L. M., and W. K. Cloud, 1957, United States earthquakes, 1955: U. S. Coast and Geodetic Survey, p. 9-10.

Neumann, Frank, 1932, United States earthquakes, 1931: U. S. Coast and Geodetic Survey, Serial No. 553.

Neumann, Frank, 1943, United States earthquakes, 1941: U. S. Coast and Geodetic Survey, Serial No. 655.

PDE (Preliminary Determination of Epicenters) Monthly Listing, various dates: U. S. Geological Survey, National Earthquake Information Center.

Person, W. J., 1976, Earthquakes, September 1975: Earthquake Information Bulletin, v. 8, no. 1, p. 26-27.

Person, W. J., 1977, Earthquakes, May-June 1977: Earthquake Information Bulletin, v. 9, no. 6, p. 26-27.

Person, W. J., 1978, Earthquakes, November-December 1977: Earthquake Information Bulletin, v. 10, no. 3, p. 97-99.

Person, W. J., 1979, Earthquakes, November-December 1978: Earthquake Information Bulletin, v. 11, no. 3, p. 110-112.

Person, W. J., 1983, Earthquakes, January-February 1983: Earthquake Information Bulletin, v. 15, no. 4, p. 150-156.

Reagor, B. G., et al., 1980, Earthquakes in the United States, October-December 1978: U. S. Geological Survey, Circular 819-D, 31 p.

Sheets, M. M., 1947, Diastrophism during historic time in Gulf Coastal Plain: American Association of Petroleum Geologists Bulletin, v. 31, no. 2, p. 201-226.

Stearns, R. G., and C. W. Wilson, Jr., 1972, Relationships of earthquakes and geology in west Tennessee and adjacent areas: unpublished report for Tennessee Valley Authority.

Stover, C. W., editor, 1987, United States earthquakes, 1983: U. S. Geological Survey, Bulletin 1698, 196 p.

Stover, C. W., 1988, United States earthquakes, 1984: U. S. Geological Survey, Bulletin 1862, 179 p.

Stover, C. W., and C. A. von Hake, editors, 1980, United States earthquakes, 1978: published jointly by U. S. Geological Survey and National Oceanic and Atmospheric Administration, 112 p.

Stover, C. W., et al., 1977, Earthquakes in the United States, July-September 1975: U. S. Geological Survey, Circular 749-C, 29 p.

Stover, C. W., J. H. Minsch, and R. B. Simon, 1979, Earthquakes in the United States, October-December 1977: U. S. Geological Survey, Circular 788-D, 35 p.

Stover, C. W., J. H. Minsch, and B. G. Reagor, 1980, Earthquakes in the United States, January-March 1978: U. S. Geological Survey, Circular 819-A, 27 p.

von Hake, C. A., 1974, Earthquake history of Mississippi: Earthquake Information Bulletin, v. 6, no. 2, p. 20-21.

FOUR LEVELS OF TERRACE DEPOSITS AND REMNANTS OF HIGH-LEVEL FLUVIAL DEPOSITS IN THE HATCHIE RIVER VALLEY, HEBRON AREA, HARDEMAN COUNTY, TENNESSEE

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ABSTRACT

Four levels of Pleistocene terrace deposits occur on the southwestern valley wall of the Hatchie River in the Hebron area, Hardeman County, Tennessee. The lower surfaces of the terrace deposits are remarkably flat and slope gently toward the Hatchie River. High-level fluvial deposits also occur at higher altitudes near the ridge tops farther southwest from the river. The terrace deposits and fluvial deposits consist chiefly of quartz sand with local scatterings or lenses of quartz, quartzite, and sandstone gravel in the lower part and silt in the upper part. The silt locally may be a fluvial deposit or colluviated and eolian loess.

The terraces associated with the three highest terrace deposits are eroded and are not easily distinguished. However, the terrace associated with the lowest terrace deposit forms a distinct, gently undulating topographic feature. This lower terrace is correlated with the Hatchie Terrace recently named and described in western Tennessee. The high-level fluvial deposits may be of late Pliocene age.

INTRODUCTION

Cretaceous and Tertiary formations are covered by Tertiary(?) and Quaternary surficial deposits (fluvial deposits, loess, and alluvium) in extensive areas in western Tennessee. At many places, the fluvial deposits extend from the tops of the highest hills and ridges down to the present alluvial plains. To map the fluvial deposits accurately and consistently, their areal distribution patterns, local configurations, lithologic characteristics, and erosional features need to be understood.

On the valley walls of the larger streams in western Tennessee, the fluvial deposits include extensive Pleistocene terrace deposits. Because the associated terraces are deeply eroded and not easily distinguished, an understanding of the stratigraphic relations of the bases and lithologic characteristics of the terrace deposits is needed to determine their origins and geologic history. The terrace deposits drape down the valley walls as blanket deposits, and stratigraphic relations are obscured because outcrops of their bases are not common. Determination of stratigraphic relations is further complicated where the terrace deposits overlie sediments with similar lithologic characteristics or where terrace deposits of tributary streams merge with those of the larger streams.

For an investigation of the stratigraphy of the outcropping Paleocene and lower Eocene in western Tennessee (Russell and Parks, 1975) by the U. S. Geological Survey (USGS) in cooperation with the Tennessee Division of Geology, shallow holes were augered by the USGS at several locations to verify the thicknesses of the alluvium and fluvial (or terrace) deposits. These auger holes were located where the basal sands of the alluvium or the fluvial (or terrace) deposits were expected to overlie a Paleocene or Eocene formation with a distinctly different lithology (clay or silt) (Table 1). Thus, when the Paleocene or Eocene formation was encountered, it could be recognized in the auger returns, and the base of the alluvium or fluvial (or terrace) deposits could be determined with some certainty.

An area on the southwestern valley wall of the Hatchie River in the Hebron area, Hardeman County, Tennessee (Figure 1), was selected to investigate the terrace deposits in some detail. At this location, the terrace deposits overlie the Clayton Formation or the Porters Creek Clay, which consist of distinctive, marine clays, silts, and sands of Paleocene age (Table 1). Passing through Hebron is a rural road that traverses the southwestern valley wall of the Hatchie River almost perpendicular to the Hatchie River flood plain. Eight auger borings (Figure 1) were made along and near this road.

This paper makes available to geologists and geomorphologists the stratigraphic and lithologic information from the auger-boring investigation conducted on the southwestern valley wall of the Hatchie River in the Hebron area, Tennessee. This information may be useful in making stratigraphic interpretations of terrace deposits along other reaches of the Hatchie River and other streams in western Tennessee and northern Mississippi.

GEOMORPHIC PROCESSES

Geomorphic processes that resulted in the present topography in the area of the investigation possibly began in the late Tertiary (Pliocene?) and continued through the Quaternary. This topography is the result of complex cycles of degradation and aggradation by the Hatchie River and its tributaries. The river has produced an asymmetrical valley of about 200 feet in relief in the Cretaceous and Tertiary "bedrock" (Figure 1) during several periods of downcutting

Table 1. Post-Cretaceous geologic units in the Hebron area, Hardeman County, Tennessee

[Condensed and modified from Parks (1968) and Jones (1973)]

System	Series	Group	Stratigraphic unit	Thickness (in feet)	Lithology
Quaternary	Holocene and Pleistocene		Alluvium	0-35	Quartz sand, silt, and clay. Generally consists of silt and clay in the upper part and sand in the lower part.
Quaternary and Tertiary(?)	Pleistocene and Pliocene(?)		Fluvial deposits (includes terrace deposits and loess)	0-80	Quartz sand, silt, and gravel. Generally consists of silt in the upper part and sand in the lower part. Locally, the sand contains scatterings and lenses of quartz, quartzite, and sandstone pebbles. The silt locally may be a fluvial deposit or colluviated and eolian loess.
Tertiary	Eocene		Claiborne Formation	0-100	Quartz sand, clay, and gravel. Generally consits of a thick body of sand with clay as interstitial material, balls, pebbles, and small irregular lenses. Locally, the sand may contain scatterings and lenses of quartz, quartzite, and sandstone pebbles.
	—?—		Wilcox Formation	40-100	Quartz sand, silt, clay, and lignite. Generally consists of a heterogeneous unit of sand, silt, and clay in which the sediments are variously interbedded and interlensed. No sequence is laterally persistent over any great distance. Distinctive lithologies include "clay-ball conglomerates" and "sawdust sand."
	Paleocene	Midway	Porters Creek Clay	60-170	Clay with minor sand and claystone. Generally consists of a widespread, thick body of clay with some interbeds and lenses of fine sand. Clay is typically dark brownish gray to olive gray and has a conchoidal to hackly fracture.
			Clayton Formation	80	Clay, silt, sand, and limestone. Generally consists of glauconitic sand in the upper part, interbedded clay, silt, and fine sand in the middle part, and glauconitic, fossiliferous sand and limestone in the lower part. Underlain by the Owl Creek Formation and McNairy Sand of Late Cretaceous age.

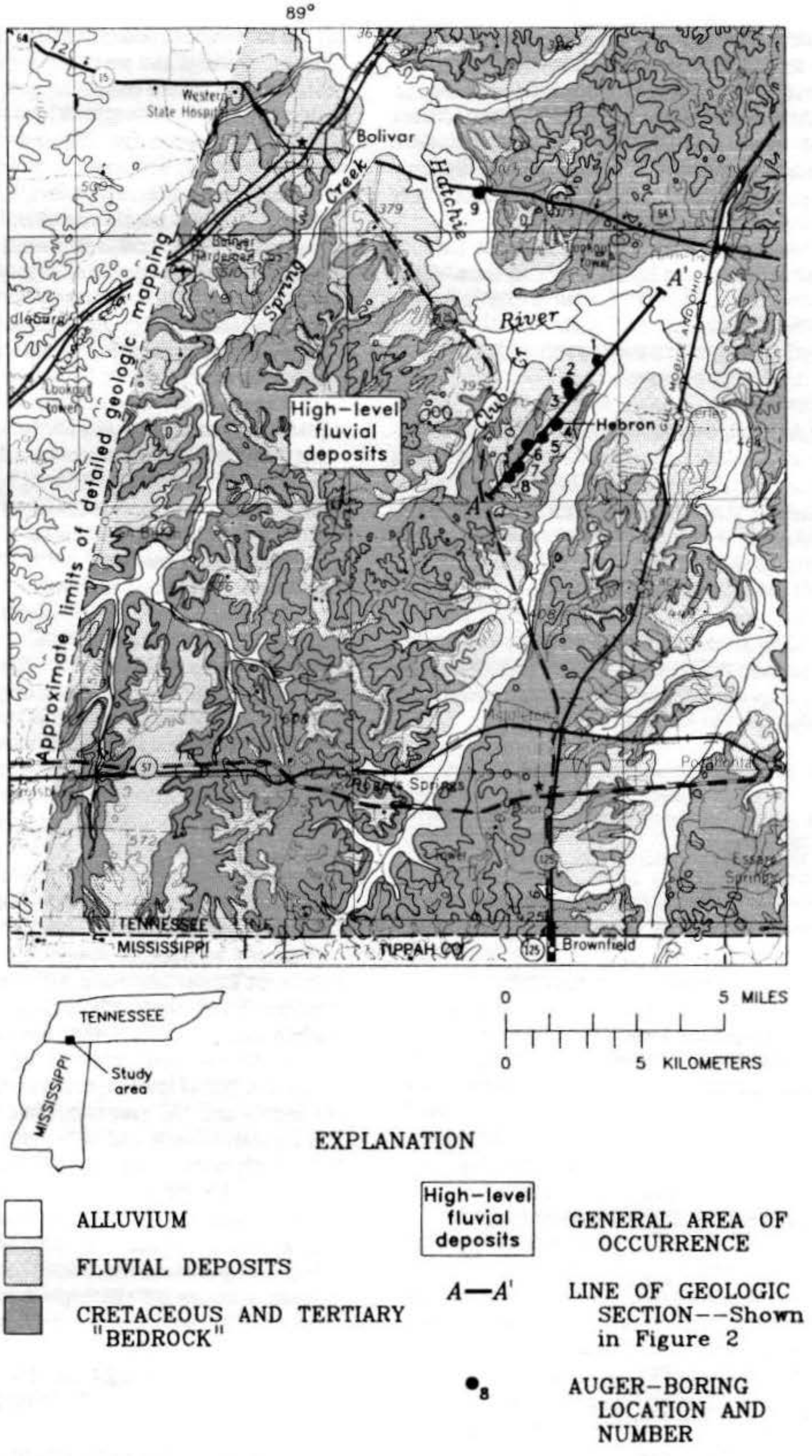


Figure 1. Geologic map of the Hebron area, Hardeman County, Tennessee, and location of geologic section A-A', auger borings, and area of high-level fluvial deposits. Modified from Parks and Russell (1975).

and lateral planation. The left or southwestern valley wall is the slip-off slope and ascends gradually from the flood plain. The southwestern valley wall is covered by extensive terrace deposits. The right or northeastern valley wall is the undercut slope and ascends more or less abruptly. The northeastern valley wall consists largely of Cretaceous and Tertiary "bedrock," except where tributaries to the Hatchie River have left terrace deposits. The Hatchie River meanders across a broad flood plain, which averages about 1 to 1.5 miles in width. The river seems underfit for this broad flood plain.

LITHOLOGIC CHARACTER OF THE TERRACE DEPOSITS

Auger borings through the terrace deposits on the southwestern valley wall of the Hatchie River in the Hebron area showed that these deposits consist of three levels and the remnant of a fourth (Figure 2). These terrace deposits are informally designated herein as "A" through "D," from youngest to oldest (lowest to highest). The auger borings indicate that the lower surfaces of the terrace deposits are remarkably flat and slope gently toward the Hatchie River. "Average" altitudes of the eroded tops (not necessarily terraces) and bases and the remnant thicknesses of the four levels of terrace deposits (Table 2) were estimated from auger-boring logs.

Table 2. "Average" altitudes of the tops and bases and the remnant thicknesses of the terrace deposits on the southwestern valley wall of the Hatchie River in the Hebron area, Hardeman County, Tennessee

[Listed from topographically highest (oldest) to lowest (youngest)]

Geologic unit	Altitude of tops and bases above sea level, in feet	Remnant thickness, in feet
Terrace deposit "D"	535 490	45
Terrace deposit "C"	495 445	50
Terrace deposit "B"	450 390	60
Terrace deposit "A"	385 345	40

The terrace deposits consist chiefly of sand that contains local scatterings and small lenses of gravel with a cap of silt (Figure 3). Where fresh, the sand is light gray, yellowish gray, and grayish orange. Where weathered, it is yellowish orange, reddish orange, light brown, yellowish brown, and reddish brown. The sand consists chiefly of fine- to very coarse-grained quartz that locally contains granules. The sand generally is poorly sorted and locally contains variable amounts of silt and clay. The sand commonly is cleaner and coarser in the lower parts of the terrace deposits. In outcrops, bedding generally is poor or indistinct, but the sand locally is cross-bedded. On the southwestern valley wall of the Hatchie River in the Hebron area, sand in the terrace deposits ranges from about 10 to 70 feet in thickness (Figure 3).

Gravel in the sand consists of well-rounded pebbles of quartz, quartzite, and sandstone. Auger borings indicated that the gravel is most concentrated in the basal part of terrace deposit "D" (Figure 3). Although gravel was observed only in the auger-boring returns from terrace deposits "B" and "D" (Figure 3), scattered quartz, quartzite, and sandstone pebbles are common in outcrops of "B" through "D." Pebbles in outcrops are as much as 2 inches in their longest dimension.

Silt in the upper part of the terrace deposits is yellowish brown, grayish orange, and light gray and weathers to light brown and reddish brown. The silt commonly contains variable amounts of sand and clay, and the lowermost part grades downward into sand. In outcrops, the silt commonly is mottled, and bedding generally is absent or indistinct. The semblance of bedding and occurrence of sand in the silt indicate colluvial or fluvial deposition. Some of the uppermost silt that forms a thin cap on outcrops resembles eolian loess.

The silt varies greatly in thickness from place to place (Figure 3). The thin silt capping terrace deposit "D" (Figure 3, auger boring 8) and "C" (auger boring 7) may be a remnant of deeply weathered, noncalcareous loess blown eastward from the Lower Mississippi Valley (Leighton and Willman, 1950). Wascher and others (1947) indicated that the loess in a belt across the Hardeman County, Tennessee, area has a total thickness of about 3 to 4 feet. The thicker silt in terrace deposits "C" (Figure 3, auger boring 6), "B" (auger borings 3 and 4), and "A" (auger borings 1 and 2) probably is a mix of fluvial deposits and colluviated or eolian loess.

Only terrace deposit "A" has an upper surface that is recognizable as a distinctive topographic feature. This terrace occurs at many other places along the Hatchie River as a paired terrace. Terrace deposit "A" has a gently undulating surface that slopes gently toward the river. The upper surfaces of the higher level terrace deposits "B" through "D" are eroded and are not easily distinguished.

AGE AND CORRELATION OF THE TERRACE DEPOSITS

On the basis of the present understanding of coastal plain geology in the area of the Hatchie River terrace deposits (Russell and Parks, 1975) and of the Quaternary geology of the Lower Mississippi Valley (Autin and others, 1991), the terrace deposits on the southwestern valley wall of the Hatchie River in the Hebron area are of Pleistocene age.

Saucier (1987) recently published findings of a study of terraces along the Mississippi River tributaries in western Tennessee. Saucier's work was based on geomorphological analysis of the terraces from detailed examination of maps and aerial photographs of the area. Saucier named and described four lower level terraces along the Obion, Forked Deer, Hatchie, Loosahatchie, and Wolf rivers in western Tennessee. These terraces, from oldest to youngest (highest to lowest), are: (1) the Henderson Terrace, (2) the Humboldt Terrace, (3) the Hatchie Terrace, and (4) the Finley Terrace. The Humboldt, Hatchie, and Finley terraces were recognized along the Hatchie River, particularly along its lower reaches (Saucier, 1987, fig. 4). Only the Hatchie Terrace was recognized on the Hatchie River as far upstream as the vicinity of Hebron.

Considering the areal distribution of the terraces, Saucier (1987) reported that the Hatchie Terrace was the best-preserved terrace in the five river systems in western Tennessee. He described the Hatchie Terrace along the Hatchie River as "dramatic," and stated that it can be traced well upstream toward the headwaters on the Hatchie River and two other streams studied. A profile of the Hatchie Terrace shows an altitude of about 385 feet above sea level for the Hatchie Terrace in the vicinity of Hebron (Saucier, 1987, fig. 6). This is in agreement with the altitude of the terrace associated with terrace deposit "A." In addition, the distinctiveness of the terrace associated with terrace deposit "A" leaves no doubt that it is the Hatchie Terrace as described by Saucier (1987). The eroded, upper surfaces of terrace deposits "B" and "C" (Figure 2) may correlate with the Humboldt and Henderson terraces of Saucier (1987). The upper surface of terrace deposit "D" may represent a fifth terrace that was not recognized because it may be eroded beyond recognition at most places.

The terrace deposits on the southwestern valley wall of the Hatchie River are too isolated from the Lower Mississippi Valley where terrace formations have been mapped to allow direct comparisons or correlations. The classic terrace formations recognized in the Lower Mississippi Valley by Fisk (1938, 1944, 1951) and Krinitzsky (1949), from oldest to youngest (highest to lowest), are as follows: (1) the Williana Formation, (2) the Bentley Formation, (3) the Montgomery Formation, and (4) the Prairie Formation. Terraces associated with these formations were given the same names as the formations.

Age and correlation of the Lower Mississippi Valley terraces and terrace formations are now in some dispute (Saucier and Fleetwood, 1970; Saucier, 1974, 1987; Autin and others, 1991). However, Saucier (1987, p. 17) postulated that the Hatchie Terrace is the stratigraphic equivalent of the Prairie Terrace (Prairie Complex, in Autin and others, 1991).

HIGH-LEVEL FLUVIAL DEPOSITS

High-level fluvial deposits, consisting of sand and gravel, occur several miles west of Hebron near the tops of ridges in the highly dissected terrane between Spring Creek and Club Creek (tributaries of the Hatchie River) (Figure 1). The gravel consists largely of well-rounded quartz, quartzite, and sandstone pebbles. These pebbles are commonly as much as 2 inches or more in their longest dimension. Locally, the sand and gravel are cemented to form irregular masses of ferruginous sandstone or conglomerate.

Pebbles in the high-level fluvial deposits resemble those in the Hatchie River terrace deposits at lower altitudes. However, the ridge gravel makes up lenses locally as much as 5 feet thick (Parks, 1968) and is more concentrated than the gravel in the Hatchie River terrace deposits. This ridge sand and gravel (and possibly similar pre-existing deposits farther up the Hatchie River valley) undoubtedly are the source of the gravel in the terrace deposits. Some outcrops indicate that the high-level fluvial deposits were derived from erosion and redeposition of similar sand and gravel in the Claiborne Formation (Table 1).

The ridge tops in the gravel terrane reach a maximum altitude of about 600 feet. The highest gravel observed in outcrops occurs at altitudes that range from about 560 to 580 feet. This is 70 to 90 feet higher than the base of terrace deposit "D" (altitude 490 feet). Therefore, based on topographic position, the ridge sand and gravel may represent the remnant of a Pliocene fluvial deposit.

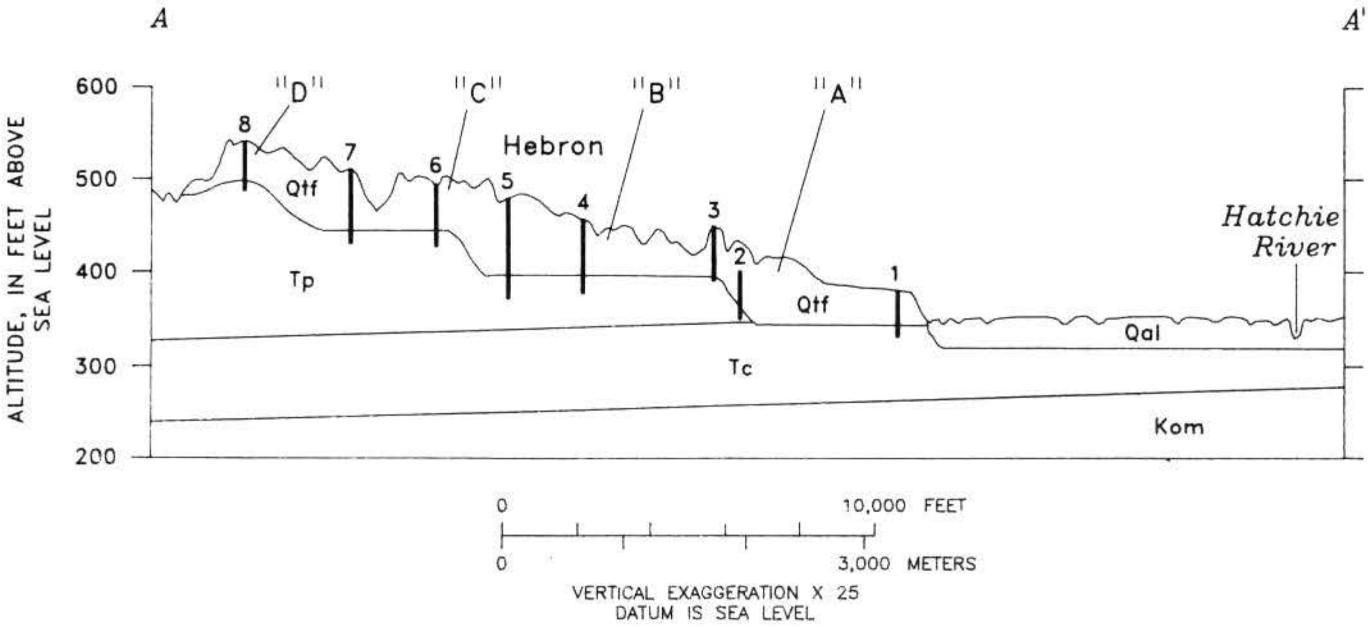
SUMMARY AND CONCLUSIONS

Auger borings indicated that four levels of terrace deposits occur on the southwestern valley wall of the Hatchie River in the Hebron area, Hardeman County, Tennessee. The terrace deposits consist chiefly of quartz sand with local scatterings or lenses of quartz, quartzite, and sandstone gravel in the lower part and of silt in the upper part. Locally, the silt may be a fluvial deposit or colluviated and eolian loess.

Auger borings also indicated that the lower surfaces of the terrace deposits are remarkably flat and slope gently toward the Hatchie River. The terraces associated with the three higher terrace deposits are eroded and are not easily distinguished. However, the terrace associated with the lowest terrace deposit forms a distinct, gently undulating topographic feature. This terrace is correlated with the Hatchie Terrace, which recently was named and described in western Tennessee.

Much additional work is needed to even suggest correlations of the terrace deposits on the southwestern valley wall of the Hatchie River in the Hebron area with the classic terrace formations that have long been recognized in the Lower Mississippi Valley. However, the similarity in occurrence of the four levels of terrace deposits in the Hatchie River valley and the four Lower Mississippi Valley terrace formations of Fisk and Krinitzsky cannot be ignored.

High-level fluvial deposits, similar in lithology to the terrace deposits, occur near the tops of the highest ridges southwest of the Hatchie River. These deposits may be of Pliocene age.



EXPLANATION

GEOLOGIC UNITS

Qal	ALLUVIUM	*A*—*A*'	GEOLOGIC SECTION-- Location shown on Figure 1
Qtf	FLUVIAL DEPOSITS		
Tp	PORTERS CREEK CLAY	"A"	INFORMAL DESIGNATION FOR HATCHIE RIVER TERRACE DEPOSIT
Tc	CLAYTON FORMATION		
Kom	OWL CREEK FORMATION AND McNAIRY SAND	2 ❘	AUGER BORING AND NUMBER

Note: Thickness of Qal is based on auger boring 9, located just west of the Hatchie River on Hwy. 64 east of Boliver, Tenn. (Figure 1). Kom–Tc and Tc–Tp contacts are based on projections from outcrops and well logs.

Figure 2. Geologic section A-A' through the southwestern valley wall of the Hatchie River in the Hebron area, Tennessee.

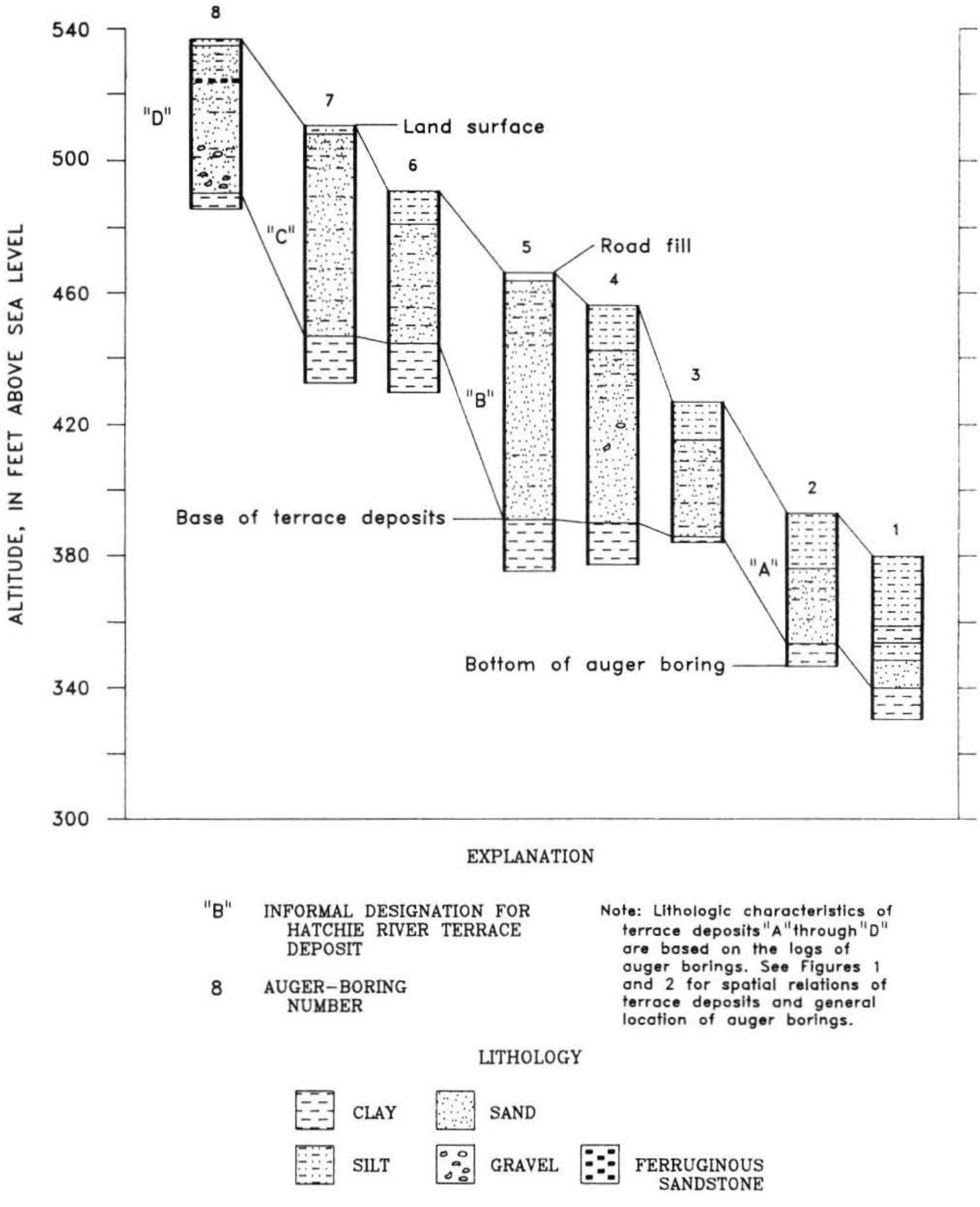


Figure 3. Generalized lithologic characteristics of the four levels of terrace deposits and their vertical relations on the southwestern valley wall of the Hatchie River in the Hebron area, Tennessee.

ACKNOWLEDGMENTS

Dr. June E. Mirecki, Assistant Professor of Geology in the Department of Geological Sciences at Memphis State University, encouraged the author to prepare this paper in view of the recent investigation of the terraces in western Tennessee. Dr. Mirecki also shared ideas and provided advice during the preparation of this paper based on her knowledge of Quaternary geology.

REFERENCES CITED

Autin, W. J., S. F. Burns, B. J. Miller, R. T. Saucier, and J. I. Snead, 1991, Quaternary geology of the Lower Mississippi Valley, *in* R. B. Morrison, ed., Quaternary nonglacial geology; Conterminous U. S.: Boulder, Colorado, Geological Society of America, The Geology of North America, v. K-2, p. 547-582.

Fisk, H. N., 1938, Geology of Grant and La Salle Parishes: Louisiana Geological Survey, Geological Bulletin 10, 246 p.

Fisk, H. N., 1944, Geological investigation of the alluvial valley of the lower Mississippi River: U. S. Department of the Army, Mississippi River Commission, 78 p.

Fisk, H. N., 1951, Loess and Quaternary geology of the Lower Mississippi Valley: Journal of Geology, v. 59, no. 4, p. 333-336.

Jones, Clarke, 1973, Geologic map of the Hornsby quadrangle, Tennessee: Tennessee Division of Geology, Geologic Map GM 409-SW, scale 1:24,000.

Krinitzsky, E. L., 1949, Geological investigation of gravel deposits in the Lower Mississippi Valley and adjacent uplands: U. S. Army Corps of Engineers, Waterways Experiment Station, Technical Memorandum no. 3-273, 58 p.

Leighton, M. M., and H. B. Willman, 1950, Loess formations of the Mississippi Valley: Journal of Geology, v. 58, no. 6, p. 599-623.

Parks, W. S., 1968, Geologic map of the Hebron quadrangle, Tennessee: Tennessee Division of Geology, Geologic Map GM 440-NW, scale 1:24,000.

Parks, W. S., and E. E. Russell, 1975, Geologic map showing Upper Cretaceous, Paleocene, and lower and middle Eocene units and distribution of younger fluvial deposits in western Tennessee: U. S. Geological Survey, Miscellaneous Investigations Map I-916, scale 1:250,000.

Russell, E. E., and W. S. Parks, 1975, Stratigraphy of the outcropping Upper Cretaceous, Paleocene, and lower Eocene in western Tennessee (including descriptions of younger fluvial deposits): Tennessee Division of Geology, Bulletin 75, 113 p.

Saucier, R. T., 1974, Quaternary geology of the lower Mississippi Valley: Arkansas Archeological Survey Research Series, v. 6, 26 p.

Saucier, R. T., 1987, Geomorphological interpretations of late Quaternary terraces in western Tennessee and their regional tectonic implications: U. S. Geological Survey, Professional Paper 1336-A, 19 p.

Saucier, R. T., and A. R. Fleetwood, 1970, Origin and chronologic significance of late Quaternary terraces, Ouachita River, Arkansas and Louisiana: Geological Society of America Bulletin, v. 81, no. 3, p. 869-890.

Wascher, H. L., R. P. Humbert, and J. G. Cady, 1947, Loess in the southern Mississippi Valley: Identification and distribution of loess sheets: Soil Science Society of America Proceedings, v. 12, p. 389-399.

A CORE HOLE DRILLED TO EVALUATE THE PENNSYLVANIAN COALBED METHANE POTENTIAL IN CLAY COUNTY, MISSISSIPPI

Rick L. Ericksen
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INTRODUCTION

A wireline, 2 1/2 inch diameter, continuous core was cut in the undifferentiated, Pennsylvanian age Pottsville Formation in the western portion of the Black Warrior Basin, northeastern Clay County, Mississippi (Figure 1). The core hole well, the Plantation Petroleum, No. 1 Allen, located 160 feet from the west line and 1460 feet from the north line of Section 27, Township 16 South, Range 6 East, Clay County, was begun on April 4, 1992, and reached a total corrected depth of 3382 feet on April 25, 1992. The well was drilled and cased with 4 1/2 inch casing to a depth of 1860 feet by a Midsouth Drilling Company rotary rig. At this point the rotary rig was moved and a Longyear core hole rig was moved in to drill and continuous core the well to its total depth (Figure 2). The core hole was conceived, proposed and operated by Plantation Petroleum Corporation (Mr. Robert Stroud, President), Shreveport, Louisiana. It was drilled as a cooperative effort with several government and private agencies, including the Mississippi Department of Economic and Community Development, which paid for a portion of the project with a grant from the federal oil overcharge fund. Some of the other agencies and companies which were involved in the coring project included the Mississippi Office of Geology, Mississippi State Oil & Gas Board, Midsouth Drilling Company, Longyear, and Geomet. The purpose of the core hole was to investigate the cumulative thickness of the coal seams and determine the quantity and quality of methane found within the coal seams of the West Point Coalbeds (Figure 3) of the Pottsville Formation in the southwestern portion of the Black Warrior Basin. The coal seams of the Pottsville Formation in Tuscaloosa and Jefferson counties, Alabama, located in the southeastern portion of the Black Warrior Basin, are currently the site of several coal degasification projects.

By determining the thickness and quality of the coal, the feasibility of commercial coalbed methane production in this portion of Mississippi may be ascertained. The core hole penetrated the West Point Coalbed coal seams found within the coal groups termed the West Point, Sand Creek, and Houlka Creek (Figure 3) (Henderson and Gazzier, 1989; Rogers, 1991). The total thickness of the Pottsville section cored was 1522 feet.

PURPOSE

The production of natural gas from coal seams contained within the Pennsylvanian age Pottsville Formation of the Alabama portion of the Black Warrior Basin, located approximately 60 miles east of the Mississippi core hole project, has been developed over the past several years. Similar potential also appears to exist within the Mississippi portion of the Black Warrior. A core hole project was proposed by Plantation Petroleum Corporation to evaluate the West Point, Sand Creek, and Houlka Creek coal groups. The core hole was drilled for many reasons. Critical to determining the feasibility of coal degasification are:

(1) the total thickness of the coal seams;
(2) the gas content of the coals;
(3) the relative permeability of the coals; and
(4) the depth of the seams.

As a result of the drilling of this core hole, all of the above factors were determined. Correlation of the visually observed lithology in the core, in particular the coal, with that interpreted by the examination of petrophysical log responses was examined. Additional considerations which were not addressed in this project were: (1) the salinity and quantity of the water which would be produced in association with the production of coal gas; and (2) the coal rank by vitrinite reflectance.

STRATIGRAPHY

The Pennsylvanian age Pottsville Formation of Mississippi consists of an undifferentiated sequence of shales, siltstones, sandstones, limestones, and conglomerates (Figure 4), as well as at least one differentiated sequence of coal groups, the West Point Coalbeds. It appears that this undifferentiated sequence represents deposition within an interdistributary basin in a marginal, fluvial-marine-delta complex (Tarbutton, 1980). Sediment influx was the result of several mechanisms including overbank deposits, storm surges, and crevasse splays. Periods of little or nondeposition of sediments are marked by a presumed marsh environment with varying amounts of organic accumulation which ultimately resulted in the formation of the coal measures contained in the Pottsville Formation.

The following is a generalized description of the lithologies encountered in the core. The shales are light gray to black, and generally fissile. They contain laminations of highly contorted, bioturbated(?), light gray siltstone to very fine-grained, light gray sandstones. The siltstones are light to medium gray and are present within the shales as previously described and as gradational contacts between shale

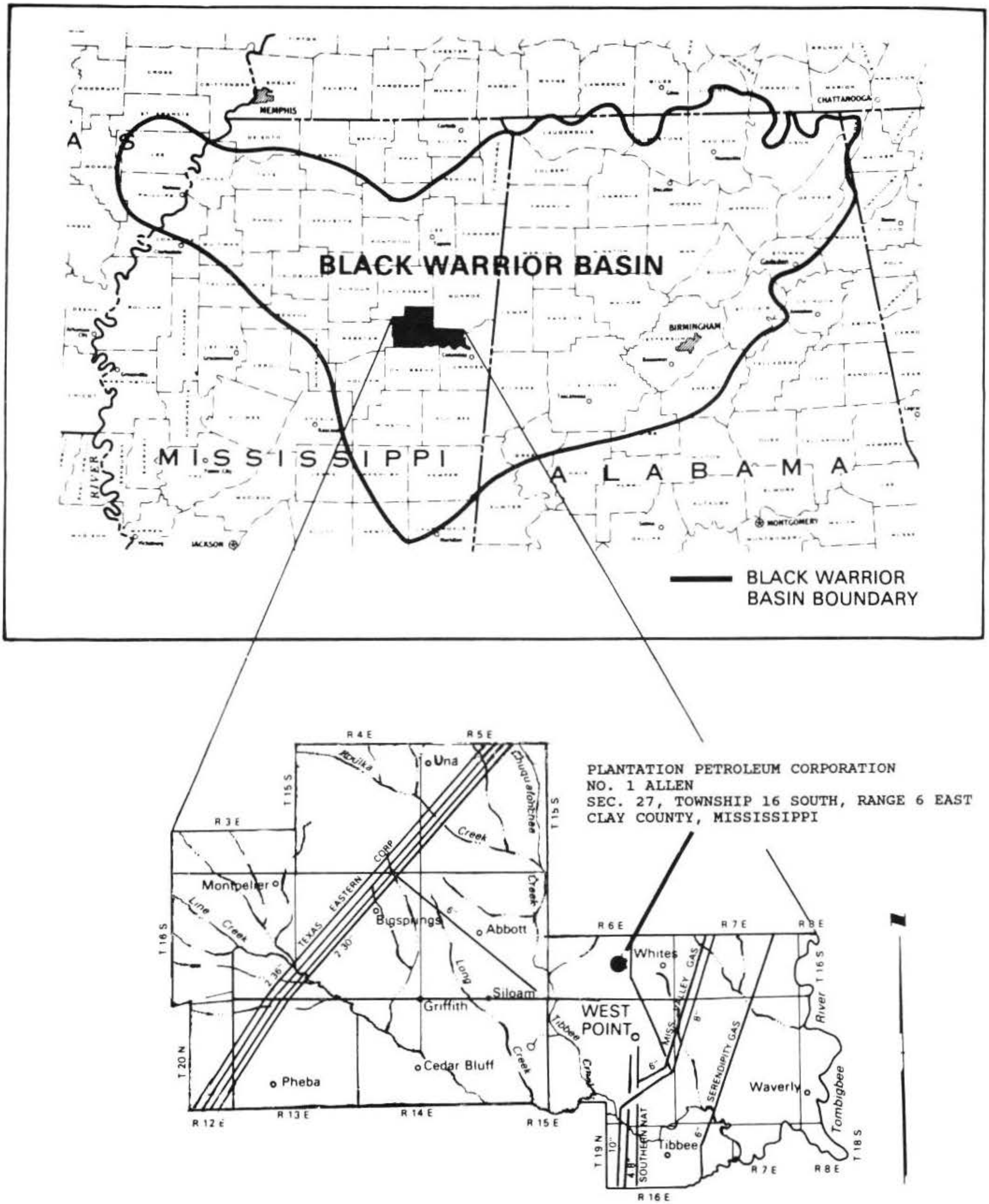

Figure 1. Black Warrior Basin index map showing location of Clay County, Mississippi, area and location of the Plantation Petroleum Company, No. 1 Allen, core hole well (modified from Henderson and Gazzier, 1989).

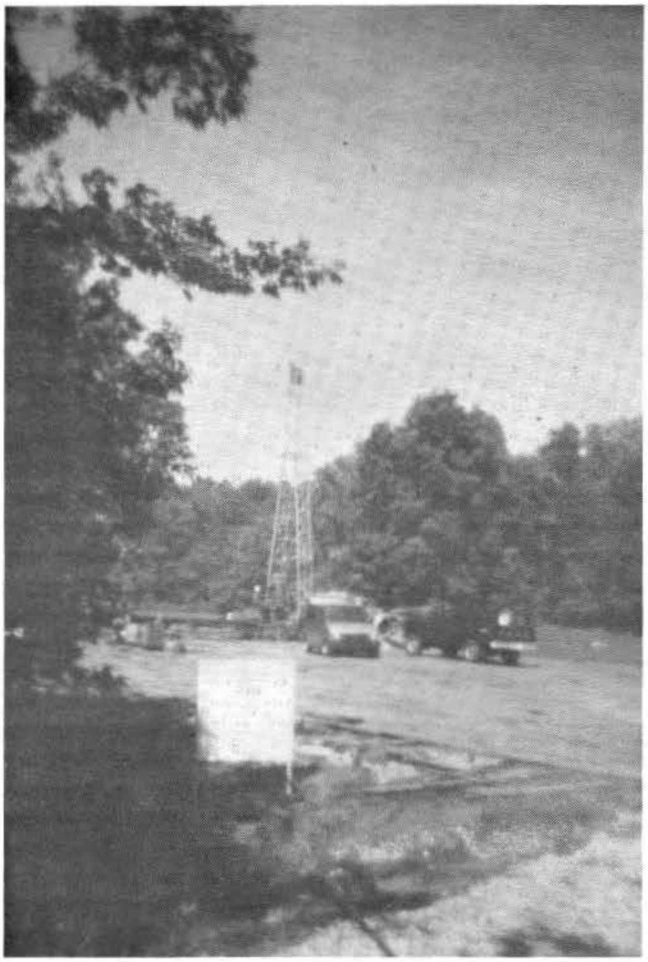

Figure 2. The Plantation Petroleum Company, No. 1 Allen, core hole drillsite and Longyear core hole drilling rig.

and very fine-grained sandstones. The sandstones which were encountered are generally noncalcareous, well cemented, very fine-grained and rarely medium-grained, angular to subangular, and light to medium gray in color. These sandstones generally exhibit shale and siltstone laminations that are conformable to highly contorted, but disconformable to the overall bedding planes (e.g., plume and flame structures, apparent burrowing). Some of these disconformable relationships may be the result of crevasse splays and/or storm surges. A complete sequence of fining upward sediments was found which consisted of a basal conglomerate member grading into coarse, medium, fine, and very fine-grained sandstones, siltstone, and lastly into a shale upper end member. Only one limestone unit was recognized, which was approximately one and one-half feet thick, dark to medium gray, crystalline, and nonfossiliferous. The coal groups which were encountered, from youngest to oldest are the West Point, Sand Creek, and Houlka Creek groups. The coals which were retrieved have undergone gas desorption tests. The residual coal materials will be archived by the Mississippi Office of Geology.

RESULTS

Visual examination of the core and petrophysical log analysis over the interval from 1860 to 3383 feet both indicate the total thickness of coal seams to be approximately seven feet. Individual seams ranged from just over three feet (one coal seam) to generally around one foot in thickness. The petrophysical log analysis utilized the bulk density readings as described below. Factors which may account for the thinner than anticipated total coal thicknesses at this location are:

(1)Localized variability in the environment of deposition which led to a thinner sequence of coal beds where the core hole was sited,

(2)The petrophysical methodology used by Henderson and Gazzier (1989), i.e. "mid-point method," is inaccurate. A more suitable and accurate method utilized by this writer and the industry involved with degasification of coals within the Black Warrior Basin uses the actual bulk density recorded by the density log and designates lithologies with a density of 2.0 gm/cc or less as coal (Streets, 1992).

Analyses indicate that the coals which were recovered are bituminous, high volatile A to B in rank, with a probable high ash content (Smith, 1992). The gas content originally anticipated by Henderson and Gazzier (1989) to be contained in these coals was 200 standard cubic feet of gas per ton of coal. The desorption data obtained on the coals recovered from the Plantation core hole indicate that 100 to 110 standard cubic feet of gas per ton is present (Smith, 1992; Stroud, 1992), or roughly one-half as much gas as initially projected.

SUMMARY

Based on the thin cumulative thickness, uncertain natural gas prices, and lower than anticipated gas content of the coal seams encountered in the Plantation Petroleum core hole, it is unlikely that the potential of coal degasification in the West Point Coalbeds of the Mississippi portion of the Black Warrior Basin will be exploited at the present time. This may be demonstrated by calculating the cost of the drilling and completion of a 3300-foot coal degasification well, the amount of estimated natural gas reserves which would be recovered, and the gross revenue which would be generated by said well - all of which are based on accepted industry standards. This calculation is based on the following criteria:

(1) well spacing: 80 acres/well
(2) methane/ton of coal: 100 SCFG
(3) methane recovery factor: 75 %
(4) cumulative coal thickness: 7 feet
(5) amount of coal per acre-foot (est.): 1800 tons/acre-foot (Averitt, 1975)
(6) net revenue interest: 1/8 royalty burden or an 87.5% net revenue interest

Based upon the above criteria the following results may be anticipated if the subject core hole were to be completed:

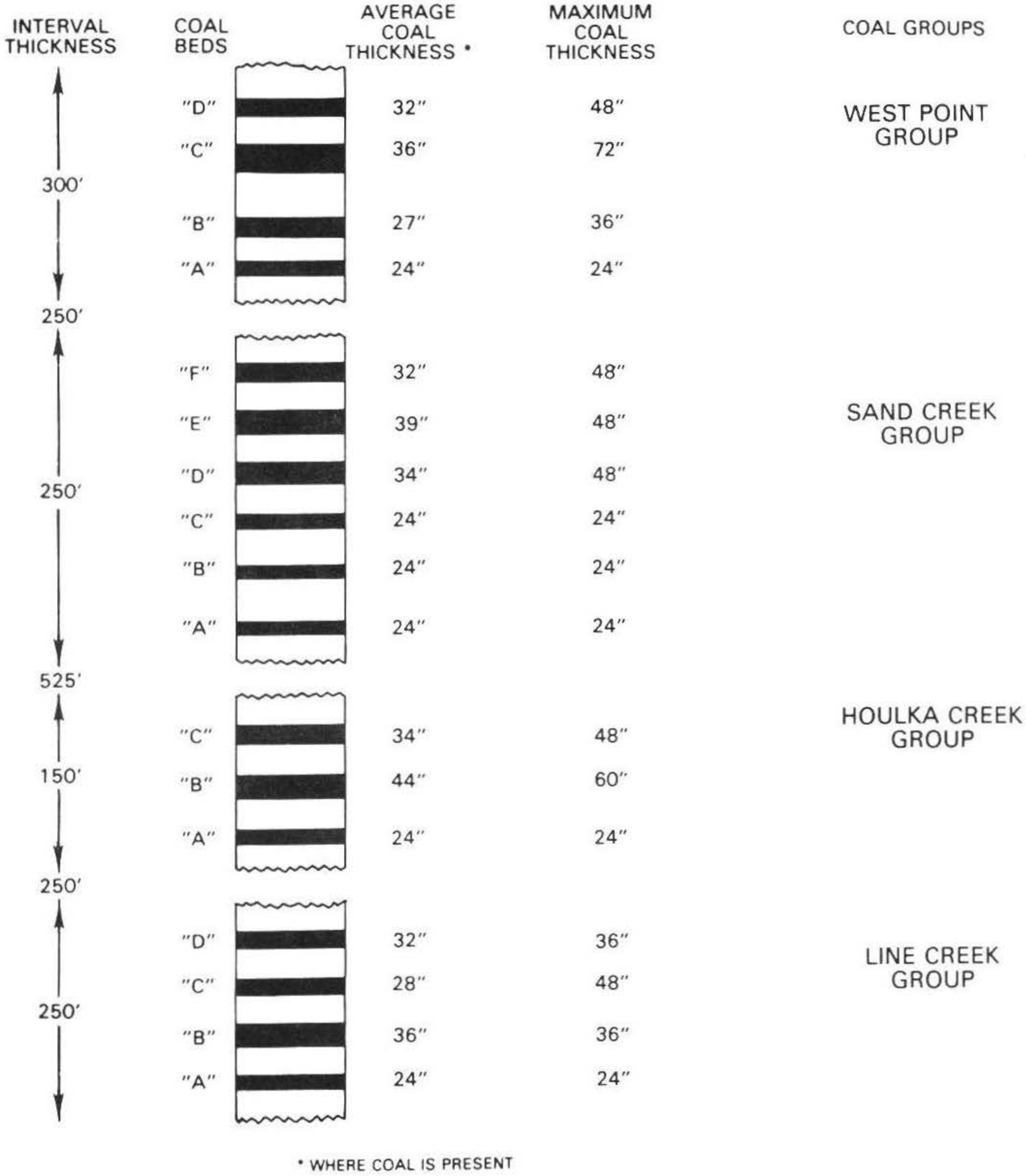

Figure 3. Generalized stratigraphic column of coal groups identified in western Clay County, Mississippi (from Henderson and Gazzier, 1989).

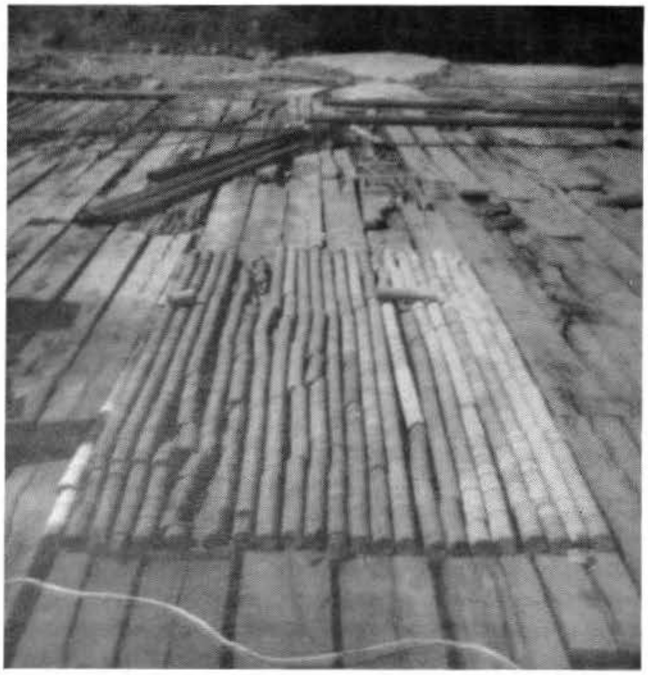

Figure 4. Core recovered from the No. 1 Allen well. Note the core is 2 1/2 inches in diameter and approximately 10 feet in length. The darker portions of the cores are shales and siltstones and the lighter, white to gray tones, are sandstones.

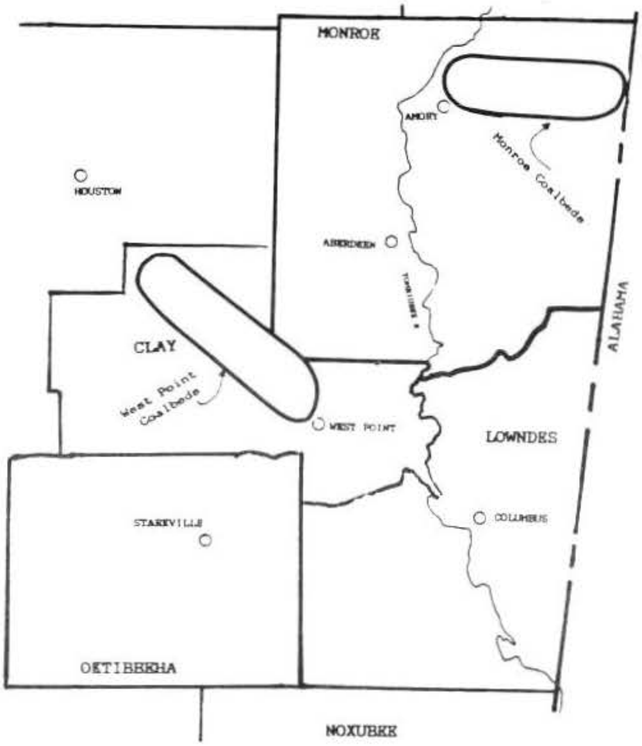

Figure 5. Index map showing the location of the West Point Coalbed area and the Monroe County Coalbed area.

RECOVERABLE RESERVES -
(80 acres/well)X(100 SCFG/ton)X(7 feet coal)X(75% recovery)X(1800 tons/acre-foot) = 75.6 MMCFG
Further, assuming an average gas price of $1.50/MCFG and an average net revenue of 87.5% (1/8 royalty burden), would generate gross revenues as follows:
($1.50/MCFG)X(75.6 MMCF)X(87.5%) = $99,225.00 *
Drill and complete a 3300-foot well = $180,000.00 (est.)
RETURN ON INVESTMENT = 0.55 TO 1 *
(* Note that these figures do not include local, state or federal taxes, operating costs, workover costs, lease costs, administrative overhead, etc., or federal tax credits which may be applied. All figures are undiscounted.)

In conclusion, unless a reexamination of the existing subsurface well control and/or new well control indicates the unexpected presence of thicker and/or gassier coal seams within the West Point Coalbed area of the Black Warrior Basin, it appears that this area does not hold the promise of the commercial production of coalbed methane gas under current economic conditions. Should any of these factors change, additional evaluations may be warranted. However, another coalbed area, termed the Monroe Coalbeds, warrants additional studies. The coals contained within this area (Figure 5) are shallower than the West Point Coalbeds and hence the salinity of the water produced should be lower and more easily disposed of by conventional methods. Further, the Monroe Coalbeds also appear to be thicker and more analogous to the coal degasification projects within the Alabama portion of the Black Warrior Basin.

REFERENCES CITED

Averitt, P., 1975, Coal resources of the United States, January 1, 1974: U. S. Geological Survey, Bulletin 1412, 131 p.

Henderson, K. S., and C. A. Gazzier, 1989, Preliminary evaluation of coal and coalbed gas resource potential of western Clay County, Mississippi: Mississippi Bureau of Geology, Report of Investigations 1, 31 p.

Rogers, R. E., 1991, Development of coalbed methane in Mississippi Warrior Basin: Mississippi Mineral Resources Institute, Report 91-7F, 74 p.

Smith, J., 1992, personal communication, Geomet.

Streets, E., 1992, personal communication, Schlumberger sales/petrophysical log analyst.

Stroud, Robert, 1992, personal communication, Plantation Petroleum Corporation.

Tarbutton, R. J., 1980, Resource evaluation of Lower Pennsylvanian (Pottsville) depositional systems of the western Warrior Coal Field, Mississippi: Mississippi Bureau of Geology, Open File Report 3, 28 p.

MISSISSIPPI GEOLOGY
Department of Environmental Quality
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Jackson, Mississippi 39289-1307

Mississippi Geology is published quarterly in March, June, September and December by the Mississippi Department of Environmental Quality, Office of Geology. Contents include research articles pertaining to Mississippi geology, news items, reviews, and listings of recent geologic literature. Readers are urged to submit letters to the editor and research articles to be considered for publication; format specifications will be forwarded on request. For a free subscription or to submit an article, write to:

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