MISSISSIPPI
STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph.D.
Director

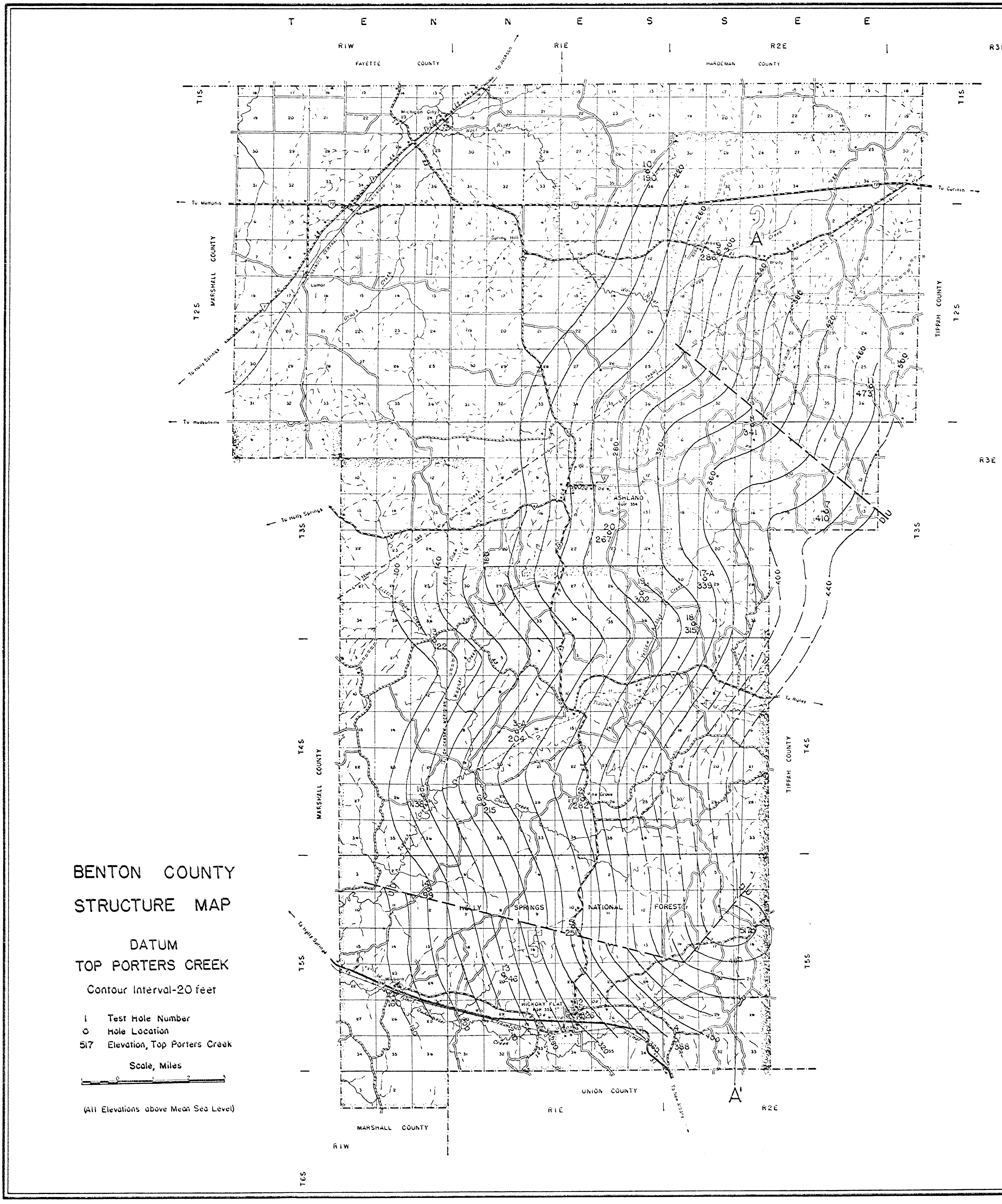
BULLETIN 80

BENTON COUNTY GEOLOGY

By

TRACY WALLACE LUSK, M.S.

UNIVERSITY, MISSISSIPPI
1956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TIPPAH COUNTY
UNION COUNTY
Michigan City
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Lamar
ASHLAND
Pine Grove
HICKORY FLAT
HOLLY SPRINGS NATIONAL FOREST
To Memphis
To Corinth
To Holly Springs
To Hudsonville
To Ripley
A
A'
BENTON COUNTY
STRUCTURE MAP
DATUM
TOP PORTERS CREEK
Contour Interval-20 feet
1 Test Hole Number
o Hole Location
517 Elevation, Top Porters Creek
Scale, Miles
(All Elevations above Mean Sea Level)

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MISSISSIPPI GEOLOGICAL SURVEY

LETTER OF TRANSMITTAL

Office of the Mississippi Geological Survey
University, Miss.
November 24, 1956

To His Excellency,
Governor James Plemon Coleman, Chairman, and
Members of the Geological Commission

Herewith is the manuscript for the Benton County Geology report (Bulletin 80) — a report that has suffered "many small necessary interruptions" and a six-month leave of absence, all officially approved, but interruptions none-the-less, for the field work was begun in March 1954. In fact, it became necessary to issue a "Preprint" from Mississippi State Geological Survey Bulletin 80, Benton County Geology, by Tracy Wallace Lusk, "Oil and Gas Possibilities" in September 1956 to meet the urgent demands for immediate information.

As in all complete survey reports, the General Geology is treated first, followed by Economic Geology, under which Oil and Gas Possibilities, Water, Iron Ore, Bauxite, Clays (Kaolin and miscellaneous) are discussed.

The Oil and Gas discussion is almost entirely the same as in the "Preprint." It describes a prominent structure, the 'Flat Rock Church Structure,' that extends across the county and into bordering counties.

In the section on 'Water' attention is called to the fact that while sand aquifers are numerous, many are silty and, therefore, not large water reservoirs.

Benton County has the distinction of once having had a charcoal blast-furnace even though it had only one blast. In addition to iron ore for iron, the Carbonate Ore, "Siderite," was formerly mined for paint pigment. After chipping the oxidized crust from the large Carbonate nodules, the unoxidized part was shipped for pigment.

A considerable quantity of medium to low-grade bauxite ore is present. It was rather thoroughly investigated by Morse and Morse, William Clifford and Paul Franklin, Father and Son. Incidentally, Paul's report, The Bauxite Deposits of Mississippi, Mississippi State Geological Survey Bulletin 19, 1923, was accepted for the Master's thesis at the University of Chicago before his entry there. When the high grade ores are exhausted elsewhere, then these local deposits should be utilized.

The Kaolin Clays, according to Thomas E. McCutcheon, Mississippi State Geological Survey Ceramic Engineer, can be washed and so beneficiated as to compare with the high grade clays for "compounding into bodies of ceramic white ware which includes electrical, chemical, and table porcelain, hotel china and dinner ware, ceramic floor and wall tile, pottery shapes and art ware."

Clays belonging to the Fearn Springs and Ackerman formations, McCutcheon classifies as pottery clays and brick and tile clays.

The sand is extensively used locally as a road metal.

Very sincerely yours,
William Clifford Morse
Director and State Geologist

CONTENTS

ILLUSTRATIONS

FIGURES

PLATES

BENTON COUNTY GEOLOGY

TRACY WALLACE LUSK, M. S.

INTRODUCTION

Benton County, an area of 408 square miles, is bounded on the north by the State of Tennessee, on the east by Tippah County, on the south by Union and Marshall Counties and on the west by Marshall County (Figure 1). The area lies within the parallels of 34° 35′ and 35° 00′ north latitude, and the meridians of 89° 00′ and 89° 24′ west longitude. It is a relatively small county having a maximum east-west distance of 19 miles across the northern part and a minimum east-west distance of 12 miles

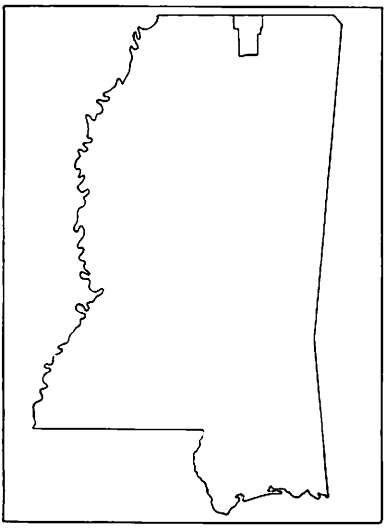

Figure 1.—Location of Benton County.

across the southern part. The maximum north-south distance is about 28 miles.

It was not until 1870, that Benton County[1] was established. Prior to that time it was included as a part of Tippah and Marshall Counties which were established in 1836.

The county is primarily agricultural. A large part of the cultivatible land is in the northern part of the county. Much of the southern part is in the Holly Springs National Forest, which is a pine timber region.

The area is served by three east-west highways and one north-south highway. The Frisco Railroad line cuts across the southwest corner of the county, and a branch of the Illinois Central Railroad cuts across the northwest corner.

Field work for this project began in March 1954. Many small necessary interruptions and a six-month leave of absence have greatly delayed the completion of the report.

PHYSIOGRAPHY

Benton County lies entirely within the North Central Hills physiographic province. As the name suggests, the region is hilly. The south and east part of the county is rather rugged, high hills and steep slopes. The northwestern part of the county is somewhat hilly, but large rolling areas are common over most of this section of the county.

The maximum overall relief is from an elevation of 280 feet on the Tippah River in the southwestern corner to 770 feet in the northeastern corner. The average relief is approximately 100 to 150 feet. The surface has a general slope to the southwest.

The County is drained by three major streams. Wolf River drains most of the northern part, Tippah River drains the central and southern part, and the Coldwater River has a small drainage area in the northwestern part.

CLIMATE

Benton County is near the northern border of the humid sub-tropical region. The county is far enough north for the weather to be influenced by the cold air masses that move down from the Arctic regions, resulting in occasional temperature drops to below freezing. However, the winters are short, about four months, and the summers long.

The precipitation is relatively heavy, the average annual precipitation being 52.49 inches (Table 1). The rainfall is sporadic and seasonally unpredictable. The summer months (June-September) may or may not experience long periods of drought. The summer is, however, known to be a period of light rainfall.

The climatological data for Benton County proper are insufficient for obtaining long term information, therefore, the records accumulated at Holly Springs,[2] Marshall County, Mississippi, were examined for the purpose of presenting the weather conditions of Benton County which are essentially the same (Table 1).

TABLE 1

MONTHLY AND ANNUAL TEMPERATURE AND PRECIPITATION AT HOLLY SPRINGS, MARSHALL COUNTY, MISS., 1955

	Temperature (°F)			Precipitation (Inches)	
Month	Average	Max.	Min.	Total	Departure from normal
Jan.	41.3	51.0	31.6	2.43	—2.43
Feb.	44.7	59.3	35.5	7.46	3.26
Mar.	55.0	65.7	44.2	7.49	1.85
Apr.	64.9	75.1	54.7	10.36	5.10
May	71.9	82.9	60.9	2.88	—1.78
June	72.6	83.5	61.6	4.65	.50
July	80.6	90.3	70.8	7.84	3.95
Aug.	79.3	89.7	68.8	5.60	1.66
Sept.	74.9	87.7	62.0	1.58	—1.47
Oct.	61.8	74.3	49.2	2.01	—1.12
Nov.	49.9	62.2	37.5	4.94	.99
Dec.	42.5	52.8	32.2	2.22	—3.54
Annual	61.6			59.46	6.97

Annual average precipitation — 52.49

GENERAL GEOLOGY

The stratigraphic section exposed at the surface in Benton County can generally be described as a series of sands, silts, clays, and lignites compacted to varied degrees. Sand is the dominant constituent, particularly in the northwestern part. The outcropping formations belong to the Midway, Wilcox, and Claiborne beds.

The Midway is represented only by the thin western edge of the Porters Creek Clay exposed in the southeastern part of the county.

The entire Wilcox section is exposed. It is represented by the Fearn Springs formation and the Ackerman formation which extend north and south through the county.

The Claiborne comprises the remainder of the geologic section and is represented by the Meridian, Tallahatta, and Kosciusko formations. Attention is called to the fact that in the normal sequence the Winona and Zilpha are formations in the

Claiborne, but these formations were not identified in Benton County.

The sequence of formations present in Benton County are:

Claiborne

Kosciusko formation
Tallahatta formation
Meridian formation

Wilcox

Ackerman formation
Fearn Springs formation

Midway

Betheden formation
Porters Creek formation

The wide spread sand deposits greatly complicated the mapping problem. The writer is fully aware of the inaccuracies that surely must exist in separating some of the geologic units. However, it is hoped that this work will lead to a better understanding of the Tertiary of Mississippi.

STRATIGRAPHY

MIDWAY

PORTERS CREEK FORMATION

The Porters Creek is the oldest outcropping formation in Benton County. Its areal extent is confined to a narrow strip along the southeastern border of the county (Plate 1).

Inasmuch as only the upper 70 to 80 feet of the formation are exposed, it is likely that at least a part of this is equivalent to the Naheola formation of Alabama which has been recognized farther south in Mississippi, where it is better developed. However, because of the few outcrops in the county, and the fact that typical dark gray clay shale was found, it was not deemed practical to attempt mapping the Porters Creek and the Naheola as separate units.

The name Porters Creek was first used by Safford.[3] The type locality is along the creek of the same name in Hardeman County, Tennessee. Prior to this, Hilgard[4] applied the name Flatwoods, but this was dropped in favor of the geographic term Porters Creek.

Conant[5] states that the Porters Creek has a probable maximum thickness of 200 to 250 feet in Tippah County. Test Hole No. 3a bears out the reliability of this statement. This test hole penetrated the entire thickness of the formation which was 244 feet. McGlothlin[6] states that the formation generally thickens downdip to approximately 1000 feet. The subsurface thickening is evidenced as nearby as Marshall County as suggested by Vestal[7] as being 400 to 500 feet.

The Porters Creek clay is typically characterized by a massive structure that breaks in a conchoidal fracture. The clay is dark gray when fresh and dries to a light gray. Also, the clay bed is rather thick and uniform throughout in texture. Some silt and mica (muscovite) are present, and lenticular sandstones and sands are locally developed.[8] In some places in Benton County the upper part of the formation exhibits a bedded structure with some fine sand interbedded. Locally concretionary masses of iron carbonate (siderite) are developed near the top of the Porters Creek formation. The outer shell of these iron concretions weathers to an iron oxide type ore.

Probably the best exposure is along the Hickory Flat-Blue Mountain road about 1.6 miles west of Flat Rock Church (Figure 2). The lithologic character of the Porters Creek at this location is indeed, very similar to that of the Naheola formation. The clay shale is evenly bedded with some fine sand. This interval contains a thin bed of iron oxide ore near the base of

Figure 2.—West dipping Porters Creek shale in the east wall of Oaklimeter Creek in a road cut (C., W.½, Sec.17, T.5 S., R.2 E.) 1.6 mile southwest of Flat Rock Church. May 25, 1956.

the section, and two beds of iron ore near the top of the section. The contact with the overlying formation is gradational.

SECTION OF EAST VALLEY WALL OF OAKLIMETER CREEK ALONG HICKORY FLAT-BLUE MOUNTAIN ROAD 1.6 MILES WEST OF FLAT ROCK CHURCH. (C. W.½, SEC.17, T.5 S., R.2 E.)

	Feet	Feet
Midway		
Betheden formation		7.0
Iron ore, oxide at least on the surface, brown, weathers shaly, core remains solid	1.0+	
Bauxitic and kaolinitic clay, white, sandy; bluish-white sand, slightly consolidated; gray clay, lignitic streaks	5.0	

Covered for a distance of 20-30 yards	1.0	
Porters Creek formation		51.0
Clay, sand, and silt, mixed, weathered brown; 2 beds of iron oxide ore near top	5.0	
Clay, weathered, gray, bluish-gray, yellow, white, lignitic	21.0	
Clay shale, dark gray to black, interbedded with fine sand, micaceous; 7-10 degrees west dip; thin iron ore	16.0	
Iron oxide ore, brown	0.5	
Covered to base of hill in Creek valley	8.5	

Mississippi State Geological Survey Test Hole No. 1 was drilled and cored with several objectives in mind — 1) determine the thickness of the kaolin; 2) determine the elevation of the top of the Porters Creek; and 3) determine the number of zones of iron ore and the thickness.

TEST HOLE NO. 1

Location: About 50 feet south of Hickory Flat-Blue Mountain road near Flat Rock Church in front of residence (NE.¼, NW.¼, Sec.16, T.5 S., R.2 E.)

Elevation: 580 feet (approximately)

Thickness	Depth	Description
		Fearn Springs formation
4.0	4.0	Soil and subsoil
6.0	10.0	Clay, gray and pink, plastic for first 3 or 4 feet, grading into silt.
41.0	51.0	Clay, brown, gray, black, slightly silty, several streaks of lignite, two zones of iron carbonate, $FeCO_3$
		Betheden formation
18.0	69.0	Kaolin, white and pale green, semi-plastic
		Porters Creek formation
31.0	100.0	Clay, dark gray, slightly silty, micaceous

All of the test holes drilled by the Mississippi State Geological Survey reached the Porters Creek formation, which because of its definite characteristics was the objective horizon. The only test hole to drill through the Porters Creek was No. 3a. This hole was drilled for the prime reason of determining the thickness of the Porters Creek.

TEST HOLE NO. 3a

Location: On south side of east-west road and on west side of Autry Branch (SE.¼, NE.¼, Sec.17, T.4 S., R.1 E.).

Elevation: 368 feet

Thickness	Depth	Description
		Ackerman formation
5.0	5.0	Soil and subsoil
19.0	24.0	Clay, gray and yellow, some light gray silt and fine sand
46.0	70.0	Sand, light gray, fine-medium, some dark specks, slightly micaceous, interbedded fine argillaceous sand and pink clay
47.0	107.0	Sand, fine-medium, yellow-brown
		Fearn Springs formation
20.0	127.0	Clay, light to dark gray, plastic, streaks of red sand between 110-115 feet, crumbly iron ore about 119 feet
37.0	164.0	Silt and fine sand, dark gray, argillaceous silt, and greenish-gray, micaceous, speckled, sand
		Porters Creek formation
244.0	408.0	Clay, black, micaceous, tough, trace of white-gray clay and possible thin bed of iron carbonate at 220-222.5, same at 249 and 269, possible trace of selenite observed between 310 and 320; at 330 the clay became crumbly and contained small amount of sand
		Clayton formation
2.0	410.0	Sandstone, hard, calcareous, glauconitic
20.0	430.0	Sand, very fine, highly micaceous, probably glauconitic

The contact of the Porters Creek formation with the overlying formation is characterized by both conformable and disconformable relations. Where the Betheden[9] material is present the contact is conformable, and where the Betheden has been eroded away so that the contact is with the Wilcox it is disconformable.

The contact between the Porters Creek formation and the Betheden formation in place is rare in Benton County. At some locations it is difficult to determine whether or not the

Betheden material has been reworked into the overlying Wilcox. This situation is dicussed more fully in the Betheden section.

Other localities where the Porters Creek formation is exposed are:

1. NW.¼, Sec.28, and NE.¼, Sec.29, T.5 S., R.2 E., along a small tributary of Box Creek.
2. SW.¼, NW.¼, Sec.29, T.5 S., R.2 E., in the bed of a creek.
3. NE.¼, SE.¼, Sec.8, T.5 S., R.2 E., in the bed of Oaklimeter Creek.
4. C., Sec.21, T.5 S., R.2 E., in a road cut.
5. SE.¼, SW.¼, Sec.16, T.4 S., R.2 E., in a road cut.
6. NE.¼, Sec.21, T.4 S., R.2 E., in a road cut.

All of the localities listed above represent the upper part of the Porters Creek formation. Contacts with the overlying formation can be seen at each locality.

BETHEDEN FORMATION

The Betheden formation as defined by Mellen[10] ". . . includes all residual material at the top of the Midway and below the Midway-Wilcox unconformity. It includes the deposits of bauxite, kaolin, bauxitic and kaolinitic clays and overlying lignite." The type locality is at Livingston Spring near Betheden in Winston County, Mississippi.

This formation was not mapped as a separate unit, because in many places along the outcrop it has been eroded away leaving only a few isolated areas of Betheden material in place. Where found in place, the formation is mapped with the Porters Creek, from which it was apparently derived.

The area in the vicinity of Flat Rock Church exhibits the best exposures of the Betheden in place in the county. The kaolin deposit just a little west of Flat Rock Church (NW.¼, Sec.16, T.5 S., R.2 E.,) presents substantiating evidence of residual origin (Figure 3). The kaolin there is very pure and massive. Mississippi Geological Survey Test Hole No. 1, which was drilled within a quarter of a mile of the kaolin outcrop, cored 18 feet of white kaolin superjacent to the Porters Creek formation. The log has been included in the description of the Porters Creek formation.

Figure 3.—Kaolin specimen from ditch bed (C., NW.¼, Sec.16, T.5 S., R.2 E.) one quarter of a mile southwest of Flat Rock Church.

The section of the road cut 1.6 miles west of Flat Rock Church, given in the discussion of the Porters Creek formation, has 5.0 feet of bauxitic and kaolinitic clay that is probably in place (Figure 4). The material here is slightly sandy but the structure is massive. The resistant nature of silica to weathering is perhaps the reason for the impure state of the clay. The contact with the Porters Creek formation is gradational.

Mississippi Geological Survey Test Hole No. 4 had 5.0 feet of Betheden type clay, which was cored with the recovery being excellent. The location for the test hole is only about 3.0 miles southwest of Flat Rock Church. This tends to indicate that nearly all of the southeastern corner of Benton County would be classified as favorable for kaolin exploration.

Figure 4.—Bauxitic kaolin in the east wall of Oaklimeter Creek in a road cut (C., W.½, Sec.17, T.5 S., R.2 E.) 1.6 miles southwest of Flat Rock Church. May 25, 1956.

TEST HOLE NO. 4

Location: On east side of gravel road (old Highway 78) about one mile north of Frisco Railroad crossing (NW.¼, Sec.31, T.5 S., R.2 E.).

Elevation: 500 feet (approximately)

Thickness	Depth	Description
		Fearn Springs formation
4.0	4.0	Soil and subsoil, brown, loam
4.0	8.0	Clay, plastic tough, tan and gray
5.0	13.0	Silt, yellow, argillaceous
2.5	15.5	Clay, gray; very thin lignite at top
25.5	41.0	Silt, greenish-gray to buff to dark gray, sandy, micaceous
8.0	49.0	Lignite and lignitic clay
15.0	64.0	Clay, gray, plastic, carbonaceous
4.0	68.0	Sand, no recovery
2.0	70.0	Silt, white, sandy
37.0	107.0	Sand, fine silty near top, grading into clean sand
		Betheden formation
5.0	112.0	Clay, white to pale green, micaceous
		Porters Creek formation
18.0	130.0	Clay, dark gray to black, micaceous

The Betheden formation crops out along the road that parallels the Tippah River on the south side (SE.¼, SW.¼, Sec.16, T.4 S., R.2 E.). Here the Betheden consists of a kaolinitic clay and bauxite. The lower contact is gradational and the upper contact is unconformable. The total thickness of the Betheden here is only about 6 to 7 feet. At one time there was probably a greater thickness of the Betheden present, but no doubt erosion removed the upper part of it. Within a distance of one mile along the same road is another outcrop where the Betheden has been completely removed and where the Fearn Springs sand rests unconformably on the Porters Creek formation (NE.¼, Sec.21, T.4 S., R.2 E.) The sand has a small amount of reworked kaolin in it.

Reworked bauxitic clay can be seen in a road cut in SW.¼, SE.¼, Sec.21, T.4 S., R.2 E. Here the clay is reworked in the reddish-brown sand of the Fearn Springs formation.

Another locality where the Betheden is probably in place is in a road cut in SW.¼, NE.¼, Sec.21, T.5 S., R.2 E. The Betheden here is white and yellow, massive, kaolinitic clay containing a trace of lignite at the top, all which is overlain by a reddish-brown, silty, sandy, weathered surface zone that contains some limonitic iron ore.

WILCOX

FEARN SPRINGS FORMATION

Fearn Springs is the basal formation of the Wilcox in Mississippi. It was first recognized as a separate unit by Mellen,[11] at Fearn Springs in Winston County (SE.¼, NE.¼, Sec.3, T.13 N., R.14 E.), which is considered the type locality.

The formation is limited to the beds lying unconformably on top of the Betheden formation where it is still present or on top of the Porters Creek formation where the Betheden has been eroded, and disconformably below the Ackerman formation.

The Fearn Springs formation is well developed in Benton County. The area of outcrop is a very irregular belt extending practically the full north-south length of the county. The strike is slightly east of north making the dip, which is very low (15 to 20 feet per mile), slightly north of west. The thickness varies from a few feet to a maximum of 100 to 200 feet.

The Fearn Springs in Benton County is composed of sands, silts, clays, and lignites and varying combinations of the same. In places there is a basal sand that may be either fine or coarse and may contain fragments of silicified wood. The silicified wood is more often associated with the coarser sand. Conant[12] recognized a coarse sand as basal Fearn Springs in Union County (NW.¼, NW.¼, Sec.6, T.6 S., R.2 E.). At this location, which is within a few yards of the Benton County line, the sand contains silicified wood fragments and a few quartz boulders. The writer found one quartz boulder about three inches in diameter in place. The basal sand at some localities contains reworked bauxite and bauxitic and kaolinitic clay. It seems logical that this material was scoured from the underlying Betheden formation.

The evidence is indicative of the Fearn Springs formation being a channel type deposit, at least in part. It was suggested by Priddy[13] "that deposition started in the deeper valleys, which were cut during Betheden time, and that it continued intermittently through the contribution of silts, clays, and even bauxite fragments or bauxitic clays weathered from nearby Porters Creek or Betheden hills, until the original drainage lines were choked up and swamps were formed which supported the vegetation now preserved as lignite." Conant[11] advanced the idea ". . . that shortly prior to the deposition of the Wilcox sands the region was slightly rejuvenated, perhaps by a slight uplift of the land, so that the streams had an increased erosive power and removed much of the bauxite-kaolin residuum." The writer is in accord with a combination of both of these ideas, which supports the channel type deposit and explains the presence of Betheden type material in the Fearn Springs.

The greatest exposed thickness of the Fearn Springs is in the southern part of the county near Hickory Flat. At this place the formation was measured to be about 103 feet thick with the lower contact not exposed.

SECTION OF THE SOUTH VALLEY WALL OF OAKLIMETER CREEK ALONG GRAVEL ROAD ABOUT ONE MILE SOUTHWEST OF HICKORY FLAT (W.½, SEC.33, T.5 S., R.1 E.).

	Feet	Feet
Wilcox		
Ackerman formation		5.0
Sand, weathered soil zone, very coarse quartz grains, numerous fragments of silicified wood	5.0	
Fearn Springs formation		103.4

Clay, breccia in lower part, containing many ferruginous rock fragments and one ferruginous rock layer 0.75 foot thick; laminated with fine silty sand in upper part, micaceous	68.0
Clay, bluish-green, grading up into black lignitic clay. The thickness of this zone was difficult to determine because of the large angle of dip to the south	10.5
Clay, shaly, laminated with fine silty, slightly micaceous sand	6.9
Covered	10.0
Clay, shaly, laminated with fine, silty, slightly micaceous sand, boulders of ferruginous rock at base, probably part of interval above	5.5
Sand, fine, silty, slightly micaceous, bluish; cross-bedding shows south dip of 16 degrees	1.5
Sand, fine, silty, slightly micaceous, greenish	1.0

Section began in road ditch at base of hill.

Several of the test holes penetrated more than 100 feet of Fearn Springs material. The log of one such hole (No. 10) is given under the discussion of the Tallahatta formation. Mississippi Geological Survey Test Hole No. 2 also drilled through a probable thickness of 172 feet of Fearn Springs material.

TEST HOLE NO. 2

Location: On west side of State Highway 5 near Pine Grove Church (SE.¼, NE.¼, Sec.27, T.4 S., R.1 E.).

Elevation: 510 feet (approximately)

Thickness	Depth	Description
		Meridian formation
5.0	5.0	Soil and subsoil
22.0	27.0	Sand, medium to coarse, reddish-brown, micaceous, slightly argillaceous
6.0	33.0	Clay, slightly silty, white and pink
3.0	36.0	Sand, quartz, clean, fine to medium, micaceous
		Ackerman formation
5.0	41.0	Silt, gray and yellow, argillaceous, some fine sand
4.0	45.0	Sand, no return (lost circulation)
8.0	53.0	Clay and silt, gray and yellow, argillaceous, some fine sand
3.0	56.0	Lignite and lignitic clay
		Fearn Springs formation (?)
54.0	110.0	Silt, dark gray, slightly argillaceous, speckled with a dark mineral; streak of lignite at 64 feet

118.0	228.0	Sand, very fine in upper part and medium to coarse in lower part, gray, speckled with dark mineral, micaceous; few streaks of clay
		Porters Creek formation
272.0	500.0	Clay, black, shaly, micaceous

Mississippi Geological Survey Test Hole No. 12, which was spudded in near the top of the Fearn Springs formation, drilled through 104 feet of that formation before reaching the Porters Creek formation.

TEST HOLE NO. 12

Location: On the east side of State Highway 5 at crossroad about 0.3 mile north of junction of U. S. Highway 78 and State Highway 5 (SW.¼, NE.¼, Sec.27, T.5 S., R.1 E.).

Elevation: 430 feet (approximately)

Thickness	Depth	Description
		Fearn Springs formation
3.0	3.0	Road bed material, sandy
2.0	5.0	Sand, very coarse, quartz
9.0	14.0	Clay, gray to yellow, semi-plastic
90.0	104.0	Clay, dark gray, carbonaceous, micaceous, silty, streaks of very fine sand increasing below 50 feet
		Porters Creek formation
46.0	150.0	Clay, dark gray to black, micaceous, silty, grading down into a tough clay

Mississippi Geological Survey Test Hole No. 15 reveals another example of an apparently unusual thickness of the Fearn Springs formation. The Fearn Springs at this locality is about 178 feet thick, which represents the complete section of the formation here.

TEST HOLE NO. 15

Location: On south side of U. S. Highway 78 and just north of Frisco Railroad at Winborn (C., S.½, Sec.23, T.5 S., R.1 W.).

Elevation: 370 feet (approximately)

Thickness	Depth	Description
		Ackerman formation
15.0	15.0	Clay, reddish-brown
7.0	22.0	Clay, light gray, sandy
10.0	32.0	Sand, coarse, quartz
		Fearn Springs formation
37.0	69.0	Clay, silty, dark gray, micaceous; streaks of very fine carbonaceous sand

16.0	85.0	Sand, dark gray, very fine, argillaceous
2.0	87.0	Clay, silty, sandy, yellow
56.0	143.0	Sand, pale green, very fine, grading down into a medium, iron-stained, quartz sand; streaks of blue-green clay
4.0	147.0	Sand, gray, fine, argillaceous, micaceous
12.0	159.0	Clay, dark gray, carbonaceous, micaceous
8.0	167.0	Silt, cream and yellow, sandy, micaceous
43.0	210.0	Sand, very fine, micaceous; several streaks of light, silty, clay
		Porters Creek formation
20.0	230.0	Clay, dark gray to black, micaceous, tough

Figure 5.—Fearn Springs-Ackerman contact and basal Ackerman sand exposed in a road cut (NW.¼, SW.¼, Sec.6, T.5 S., R.2 E.) about 2 miles east of Highway 5. May 25, 1956.

The lithologic similarity of the Fearn Springs formation and the overlying Ackerman formation greatly confuses the two. The contact is in few places clear and distinct. At many localities only the contact zone can be determined. Without the aid of a topographic map, separating the Fearn Springs from the Ackerman would be exceedingly difficult. The problem is not solved easily even when topographic maps are available. However, outcrops in areas that have a good development of basal Ackerman sand usually show a prominent contact. Such a locality is the section of a road cut about 2 miles east of Highway No. 5, near the head of the South Fork of Chilli Creek (SW.¼, NE.¼, Sec.6, T.5 S., R.2 E.), given in the discussion of the Ackerman formation (Figure 5).

The criteria used for separating the Fearn Springs and Ackerman formations were threefold: 1) Lithologic change; 2) stratigraphic position; and 3) the presence of silicified wood. Silicified wood seems to be characteristic of the base of the Fearn Springs and also the base of the Ackerman.

Localities that show the Fearn Springs-Ackerman contact zone are:

1. NE.¼, Sec.22, T.5 S., R.1 E., along Highway 5. Here there is a silicified log protruding out of the bank of reddish-brown, medium to coarse sand overlying a yellow-gray silty clay containing a few small gray clay balls.

2. SE.¼, Sec.19, T.5 S., R.1 E., in a road ditch on the west side of a small branch. At this location a mottled clay is in contact with a coarse brick-red sand. Silicified wood fragments were observed along this zone.

3. SW.¼, Sec.30, T.5 S., R.1 E., in a road cut. The contact zone is evidenced by silicified wood fragments.

4. NW.¼, Sec.29, T.5 S., R.1 E., in a road cut near the junction of a north bound road. The Fearn Springs formation is a vari-colored silty, micaceous clay containing a thin ledge of iron ore about 1.0 foot below the contact. The overlying Ackerman formation is a reddish-brown, coarse to pebble bearing massive sand containing fragments of silicified wood in place and gray clay balls.

5. SW.¼, Sec.30, T.5 S., R.2 E., in a road cut. This contact zone is near the top of a present hill. Many pieces of ferruginous rock float and a few pieces of silicified wood mark a zone that apparently represents the Fearn Springs-Ackerman contact. This location is topographically and stratigraphically in the correct place.

6. NW.¼, Sec.34, T.4 S., R.1 E., in a road cut. Silicified wood fragments lie on a lignitic clay which is underlain by a prominent ledge of iron ore.

7. C., Sec.8, T.5 S., R.2 E., in a road cut. The contact zone is marked by a coarse sand and pea gravel containing silicified wood, overlying a silty clay.

8. SE.¼, Sec.32, T.3 S., R.2 E., in a road cut. A white and dark gray clay is in contact with a buff to brown sand. The sand contains a small amount of petrified wood.

Figure 6.—Fearn Springs-Ackerman contact (SW.¼, Sec.17, T.4 S., R.2 E.) exposed in the road cut in the west valley wall of Duncan Branch. Nov. 2, 1956.

9. SE.¼, SW.¼, Sec.21, T.4 S., R.2 E., in a road cut. This location shows no contact, but the sand at the base of the Fearn Springs contains reworked bauxite.

10. NW.¼, Sec.26, T.5 S., R.1 E., in a cut of old Highway 78. Here the Fearn Springs is composed of vari-colored (gray, brown, red), silty, micaceous clay. The overlying Ackerman is composed of a coarse, reddish-brown, cross-bedded sand containing gray clay balls and irregular streaks of pea gravel.

11. SW.¼, Sec.17, T.4 S., R.2 E., in a road cut up the west wall of Duncan Branch (Figure 6). The Fearn Springs is a

multi-colored, argillaceous silt. The overlying Ackerman is a medium to coarse, reddish-brown sand with a thin ferruginous sandstone at the contact.

ACKERMAN FORMATION

The name Ackerman was first suggested by Lowe[15] in 1913. He designated Blantons Gap near the town of Ackerman, Choctaw County, Mississippi, as the type locality. Later, Mellen[16] found it ". . . necessary to restrict the Ackerman formation to those beds lying above the Fearn Springs formation and below the Holly Springs formation." At a still later date Attaya[17] concluded that the name Holly Springs should be dropped from use ". . . inasmuch as the sands included in the formation are actually equivalents of three formations rather than one." Taking this condition into account it remains that in the northern part of the state the Ackerman formation be restricted to the beds lying above the Fearn Springs formation and below the Meridian formation. The contacts at the bottom and top of the Ackerman formation are unconformable.

In Benton County the entire Ackerman formation is present (Plate 1). The thickness varies from a feather edge on the east to about 100 to 150 feet on the west. The direction of dip is slightly north of west and at the rate of about 15 to 20 feet a mile.

The Ackerman formation consists of sands, silts, clays, and lignites. As a rule the clay is silty and the lignite is argillaceous. The coarse basal sand phase is very poorly developed in Benton County. The erosional unconformity at the base of the Ackerman probably accounts at least in part for the local deposits of the coarse basal sand. As might be expected, the coarse sand deposits seem to have accumulated only in old valleys or channels cut in the top of the Fearn Springs formation. Even in such places the sand is much thinner in this area than in the areas to the south along the strike. The stratigraphic section exposed in a road cut near the head of the South Fork of Chilli Creek exemplifies the condition of the basal Ackerman sand in Benton County, which at this location is only 10.4 feet thick (Figure 5).

SECTION OF ROAD CUT ABOUT 2 MILES EAST OF HIGHWAY 5, NEAR THE HEAD OF THE SOUTH FORK OF CHILLI CREEK (NW.¼, SW.¼, SEC.6, T.5 S., R.2 E.).

	Feet	Feet
Wilcox		
Ackerman formation		62.4
Silt and clay, light gray, brown, and yellow, slightly micaceous	52.0	
Sand, medium to coarse, reddish-brown to yellow, cross-bedded, numerous thin streaks of white clay, otherwise clean; capped by thin ferruginous sandstone	10.4	
Unconformity		
Fearn Springs formation		18.6
Silt, gray with yellow streaks, slightly micaceous, grading up into a light-gray clay, capped by a thin layer of ferruginous siltstone. The clay grades laterally into a lignitic clay	18.6	

The section began at base of hill in the valley floor.

Another locality that exposes the basal sand of the Ackerman formation is a cut along an east-west road on the south side of Tippah River (SW.¼, Sec.17, T.4 S., R.2 E.). Here the sand is 16.0 feet thick (Figure 6).

SECTION OF WEST WALL OF DUNCAN BRANCH ALONG EAST-WEST ROAD (SW.¼, SEC.17, T.4 S., R.2 E.).

	Feet	Feet
Claiborne		
Meridian formation		8.0
Sand, reddish-brown, coarse	8.0	
Wilcox		
Ackerman formation		116.0
Clay, gray, silty, sandy, breccia zone, micaceous; much sandstone and siltstone float on surface and in places worked down into sandy zones	100.0	
Sand, medium to coarse, some quartz pebbles, reddish-brown, micaceous; ferruginous sandstone at base and top; sandstone at top shows a very strong bedding dip to the west	16.0	
Unconformity		
Fearn Springs formation		31.0
Silt, argillaceous, gray, yellow, pink, cross-bedded, micaceous	26.0	
Sand, fine to medium, reddish-brown, capped by a 6-inch ferruginous sandstone	5.0	

Section began at the bridge spanning Duncan Branch.

Another stratigraphic section which will serve to illustrate the absence of the coarse sand at the base of the Ackerman formation is located about one mile southeast of Hickory Flat along a gravel road cut.

SECTION OF SOUTH VALLEY WALL OF OAKLIMETER CREEK ALONG GRAVEL ROAD ABOUT 1 MILE SOUTHEAST OF HICKORY FLAT (SE.¼, NE.¼, SEC.34, AND SW.¼, SEC.35, T.5 S., R.1 E.).

	Feet	Feet
Claiborne		
Meridian formation		20.5
Sand, coarse to gritty, brown; can be observed better in sand pit west along road	20.5	
Wilcox		
Ackerman formation		97.0
Silt, slightly sandy, grading up into a clay breccia and finally into a whitish gray silty clay with a small amount of greenish clay, capped by a ferruginous siltstone. Thickness of this interval is approximate since it had to be projected along the road about half a mile	30.0	
Silt, sandy, fine, light gray, yellow, tan, brown, cross-bedded; one prominent bed of siliceous iron ore about 30 feet from base dipping at a high angle to the south. Near the base are fragments of petrified wood	67.0	
Fearn Springs formation		50.0
Clay, light to dark gray, somewhat blocky, weathers and presents a very rough shaly surface; at the top is a thin bed of lignitic clay	31.2	
Sand, fine, silty, slightly micaceous, light gray, yellow, greenish-yellow, and dark brown, containing streaks of light gray silty clay, also thin beds of ferruginous rock	18.8	

Section began at the base of the hill at a tree in a right angle curve.

Another exposure where the basal Ackerman sand is missing is along a gravel road about one mile east of Highway 5 (Sec.25, T.4 S., R.1 E.). The stratigraphic section at this place illustrates the difficulty of determining the exact contact of the Fearn Springs formation and the Ackerman formation where there is no basal sand or other evidence to indicate a contact. The position of the contact was chosen on the basis of the relative elevations of nearby contacts where better evidence is available.

SECTION OF ROAD CUT ABOUT 1 MILE EAST OF HIGHWAY 5 (C., S.½, SEC.25, T.4 S., R.1 E.). SECTION BEGAN AT BASE OF HILL 0.1 MILE WEST OF ROAD FORK AND CONTINUED ON NORTH FORK TO TOP OF HILL.

	Feet	Feet
Claiborne		
Meridian formation		31.0
Sand, reddish-brown, very coarse, micaceous; tiny white clay balls widely scattered in lower part	31.0	
Wilcox		
Ackerman formation		91.4
Silt, light gray to greenish-gray, grading up into a mottled clay; capped by a ferruginous siltstone	26.2	
Covered	5.2	
Silt, brown and gray, speckled, gummy when wet and shaly or platy when dry	26.0	
Silt, greenish-gray, grading up into gray clay. Middle part is a mottled, plastic clay containing small pieces of ferruginous rock	29.0	
Covered	5.0	
Fearn Springs formation		37.0
Clay, dark gray, shaly, one layer of iron ore	18.8	
Sand, brown and yellow, fine to medium, cross-bedded, interbedded with streaks of gray clay	13.0	
Covered	5.2	

The erosional unconformity between the Ackerman and Meridian formations is illustrated in an outcrop along a road leading north, about 2.0 miles from Highway 78 (NW.¼, Sec.12, T.5 S., R.1 W.). Here the Meridian sand has filled in an old channel cut into the Ackerman formation. Along the sides of the old channel there is a mixture of clay balls and ferruginous fragments. The relief on top of the Ackerman formation here is approximately 40 to 50 feet.

There are several exposures of the Ackerman-Meridian contact along the gravel road mentioned in the preceding paragraph. The south valley wall of Chilli Creek at the place where this road crosses, exhibits a very good stratigraphic section of the Ackerman and Meridian formations. The section was continued downward by means of Mississippi Geological Survey Test Hole No. 6, drilled near the base of the valley wall. When put together the test hole section and the surface section give the entire thickness of the Wilcox at this location. This composite section shows the Ackerman formation to have a thickness of 90.2 feet and the Fearn Springs formation a thickness of 113.0 feet. Also inasmuch as the basal Ackerman sand is present in the test hole, the Fearn Springs formation can be separated from the Ackerman formation. The stratigraphic section below is followed by the log of the test hole.

SECTION OF SOUTH VALLEY WALL OF CHILLI CREEK NEAR THE JUNCTION OF CHILLI CREEK VALLEY AND TIPPAH RIVER VALLEY (NE.¼, SE.¼, SEC.30, T.4 S., R.1 E.).

	Feet	Feet
Claiborne		
Meridian formation		30.0
Sand, reddish-brown, coarse to gritty, cross-bedded near base with some reworked clay and silt, light and dark banded upward, micaceous	30.0	
Wilcox		
Ackerman formation		72.2
Clay, silty, light gray, weathers shaly, interbedded with very fine, micaceous, speckled sand; several very thin seams of iron ore and one seam about 6 inches thick at 18 feet, one about 6 to 8 inches at 30 feet, one about 6 inches at 33 feet	67.2	
Sand, very fine, greenish gray, speckled	5.0	

Section began at the Chilli Creek bridge.

TEST HOLE NO. 6

Location: On east side of road near base of Chilli Creek Valley wall (NE.¼, SE.¼, Sec.30, T.4 S., R.1 E.).

Elevation: 360 feet (approximately)

Thickness	Depth	Description
		Ackerman formation
5.0	5.0	Soil and subsoil
6.0	11.0	Clay, silty, yellow-brown
7.0	18.0	Sand, medium to coarse, argillaceous
		Fearn Springs formation
40.0	58.0	Silt, dark gray, micaceous, some very fine sand
14.0	72.0	Sand, very fine, argillaceous, speckled with dark mineral
1.0	73.0	Lignite, black
15.0	88.0	Clay, light brown to gray, silty, grading down into sand
43.0	131.0	Sand, medium to coarse
		Porters Creek formation
39.0	170.0	Clay, gray, tough, slightly micaceous

Probably the most interesting lithologic feature of the Ackerman formation is the quartzitic claystone that is found at or near the top of the formation. This rock has proved to be a very significant and important criterion for determining the age of the beds within the Wilcox. The claystone is not everywhere present, but has been found at many widely scattered locations. It is light gray, contains an abundance of root and plant impres-

Figure 7.—Ackerman-Meridian contact just above hat which is resting on claystone boulder exposed in a road cut at Flat Rock Church (NE.¼, NW.¼, Sec.16, T.5 S., R.2 E.). Photograph by F. E. Vestal.

sions, and ranges in thickness from a few inches to a little more than a foot. At some places it is slightly more consolidated than at others. The writer considers this claystone the most reliable marker bed in the Ackerman formation. Its widespread distribution makes it especially valuable. It has long been known at Flat Rock Church (Figure 7), where it has an elevation of approximately 600 feet and is overlain by a ferruginous siltstone that contains excellent leaf impressions. Presence of this claystone along the western edge of the Ackerman outcrop belt, 9 or 10 miles west of Flat Rock Church, provided the chief basis for determining the age of the beds at Flat Rock Church, which has long been controversial. Listed below are several locations other than Flat Rock Church where the claystone can be observed.

1. SW.¼, Sec.11, T.5 S., R.1 W., in a road cut (Figure 8). Here the claystone is some 40 feet below the Ackerman-Meridian contact, at an elevation of approximately 380 feet.

Figure 8.—Claystone in Ackerman clay exposed in a road cut (SW.¼, Sec.11, T.5 S., R.1 W.) about 2 miles north of Winborn. June 4, 1956.

2. C., W.½, Sec.19, T.4 S., R.1 E., in a road cut. The claystone at this location is light gray with root and plant impressions and is about 6 to 8 inches thick. It is very near the Ackerman-Meridian contact, and has an elevation of approximately 400 feet.

3. NE.¼, Sec.19, T.4 S., R.1 E., in a road cut. Here the claystone is slightly ferruginous, otherwise the same as elsewhere, and it is near the contact with the overlying Meridian. The elevation is approximately 420 feet.

4. NW.¼, Sec.4, T.5 S., R.1 E., in a road cut. The quartzitic claystone here is just under the contact with the Meridian formation.

5. E.½, NW.¼, Sec.20, T.5 S., R.2 E., in a road cut. At this location the claystone is slightly broken up, as if it may have dropped from its original position. The elevation is approximately 580 feet.

Figure 9.—Ackerman-Meridian contact about 4 feet above the claystone layer exposed in a road cut (NE.¼, NW.¼, Sec. 27, T.2 S., R.2 E.) in the southwest valley wall of Sourwood Creek. Aug. 9, 1956.

6. NE.¼, NW.¼, Sec.27, T.2 S., R.2 E., in a road cut (Figure 9). This outcrop is very similar to the outcrop at Flat Rock Church. The light-gray claystone containing plant impressions is about 3 feet below the Ackerman-Meridian contact. At the contact is a limonitic siltstone containing leaf imprints, above which is the reddish-brown, coarse Meridian sand. The elevation is approximately 530 feet.

7. NW.¼, NE.¼, Sec.36, T.2 S., R.2 E., in a road cut ditch (Figure 10). The claystone here is light gray and very hard. The Meridian sand lies above.

This same quartzitic claystone has been found in adjoining Marshall County and in Webster County by Vestal[18] at the same stratigraphic position.

At or near the top of the Ackerman formation at many localities is a ferruginous siltstone, which at some places contains imprints of fossil leaves. One such place, long known as an area for collecting fossil leaf impressions is Flat Rock Church. Berry[19] did a considerable amount of work on plant fossils from this location. As is usual in the case of a well known collecting place, the Flat Rock Church area is now practically barren of good specimens. Indeed, one does well to find a specimen with

Figure 10.—Ackerman claystone at the Meridian contact near the top of a hill in a road cut (NW.¼, NE.¼, Sec.36, T.2 S., R.2 E.) in the south valley wall of Turkey Creek. Aug. 9, 1956.

characters sufficiently clear to make identification possible. As stated by Berry, the siltstone ledge is thin and obscure, and anything short of a careful examination of the area might easily miss it.

An exposure of the Ackerman formation in the road cut of Highway 5 at Pine Grove Church shows plainly the ferruginous siltstone ledge that does contain a few fossil leaves. At this location it is below the Ackerman-Meridian contact which shows about 32 feet farther up the hill. A stratigraphic section of the outcrop follows:

Figure 11.—Ackerman-Meridian contact and small sand pit along a road (NE.¼, NW.¼, Sec.4, T.3 S., R.2 E.) about 0.4 mile west of New Hope Church and Cemetery. Aug. 9, 1956.

SECTION OF HIGHWAY 5 CUT AT PINE GROVE CHURCH (NW.¼, SW.¼, SEC. 26, T.4 S., R.1 E.).

	Feet	Feet
Claiborne		
Meridian formation		29.0
Sand, reddish-brown, coarse, gritty in places, banded with dark and light streaks, slightly cross-bedded; a few small white clay balls	29.0	
Wilcox		
Ackerman formation		49.3
Sand, silt and clay, fine, micaceous, white, yellow, pink and purple sand in lower part, grading up into a laminated silty clay and sand having same colors and characteristics as lower part; about 1.0 foot above lower contact is thin layer of ferruginous sandstone	32.5	
Clay, white, grading up into gray and a thin streak of lignite; slightly silty near bottom but tough, plastic clay upward, with root impressions; capped by a ferruginous siltstone containing a few fossil leaves	16.8	

Section began at base of hill south from the church.

Two other locations where fossil leaves were found in the limonitic siltstone are: 1) NE.¼, NW.¼, Sec.4, T.3 S., R.2 E., in a road cut (Figure 11). The siltstone here is at the contact of the Ackerman and Meridian formations. The Ackerman is a light-gray plastic clay and the Meridian is a reddish-brown very coarse sand. 2) NE.¼, NW.¼, Sec.27, T.2 S., R.2 E., in a road cut. The siltstone is at the Ackerman-Meridian contact. The Ackerman is a light-gray plastic clay. The overlying Meridian is a reddish-brown coarse sand.

The several logs of test holes that follow will aid in establishing the lithology of the Ackerman formation as well as its relationship with underlying and overlying formations. For the most part these logs will likewise aid in the same manner for the underlying Fearn Springs formation.

TEST HOLE NO. 3

Location: On east side of gravel road near the base of Big Snow Creek valley wall in small abandoned sand pit (SE.¼, Sec.36, T.3 S., R.1 W.).
Elevation: 390 feet (approximately)

Thickness	Depth	Description
		Meridian formation
5.0	5.0	Sand, badly weathered
13.0	18.0	Sand, fine to medium, clean, quartz, micaceous, few thin streaks of clay
2.0	20.0	Clay, sandy, yellowish-brown
7.0	27.0	Sand, medium to coarse, brown
		Ackerman formation
10.0	37.0	Silt, sandy, yellow to white, speckled
4.0	41.0	Silt, sandy, gray, speckled, streak of lignite at top
4.0	45.0	Silt, sandy, greenish-gray, speckled
30.0	75.0	Silt, very argillaceous, gray, micaceous
75.0	150.0	Sand, gray, fine to medium, speckled, silty, micaceous; gray clay from 108-113 feet.
		Fearn Springs formation
32.0	182.0	Silt, sandy, argillaceous, micaceous
4.0	186.0	Clay, green
32.0	218.0	Clay, dark gray, slightly silty, micaceous
41.0	259.0	Sand, fine to medium, gray, micaceous, argillaceous, streaks of gray to black, carbonaceous clay and silt; streak of lignite at 256 feet.
9.0	268.0	Clay, gray, micaceous, slightly silty
		Porters Creek formation
32.0	300.0	Clay, dark gray to black, micaceous

TEST HOLE NO. 5

Location: On west side of State Highway 5 about 2.0 miles north of Hickory Flat (SW.¼, Sec.15, T.5 S., R.1 E.).

Elevation: 530 feet (approximately)

Thickness	Depth	Description
		Ackerman formation
2.5	2.5	Clay, light gray (fill)
3.5	6.0	Soil and subsoil
3.0	9.0	Silt, gray to white, argillaceous, micaceous
72.0	81.0	Silt, dark gray, sandy, argillaceous, micaceous; streak of brown silty sand about 25 feet, speckled with dark mineral; streak of lignite at 78 feet
		Fearn Springs formation (?)
0.5	81.5	Rock, light gray, probably siltstone
8.5	90.0	Clay, dark gray, micaceous
6.0	96.0	Lignite and lignitic clay
56.0	152.0	Clay, dark to light gray, plastic, micaceous, few streaks of green clay
26.0	178.0	Sand, interbedded clay
18.0	196.0	Clay, gray and black, micaceous
39.0	235.0	Silt, argillaceous, some very fine sand, speckled with a dark mineral
20.0	255.0	Silt, white, sandy, argillaceous
5.0	260.0	Sand, fine to coarse, quartz
14.0	274.0	Silt, white, sandy, argillaceous
		Porters Creek formation
26.0	300.0	Clay, black, micaceous

TEST HOLE NO. 8

Location: On south side of gravel road 50 or 60 yards east of small bridge (NW.¼, NE.¼, Sec.4, T.3 S., R.2 E.).

Elevation: 526 feet

Thickness	Depth	Description
		Ackerman formation
2.5	2.5	Sand, medium to coarse, light brown, probably colluvial
8.0	10.5	Sand, coarse, light brown, argillaceous
2.0	12.5	Clay, white
7.0	19.5	Sand, coarse, clean, quartz
1.0	20.5	Clay, yellow
6.0	26.5	Sand, coarse, thin gray clay stringers

20.0	46.5	Sand, greenish-gray, silty, fine, argillaceous, speckled with a dark mineral; sand capped by thin gray siltstone
5.0	51.5	Sand, medium to coarse, gray, argillaceous, laminated with woody material
		Fearn Springs formation
94.0	145.5	Silt, sandy, gray, some interbedded clay, micaceous; hard rock layers at 65.0, 111.5, and 145.5 feet
8.0	153.5	Silt, gray, and coarse quartz sand
24.0	177.5	Silt, white to yellow, slightly argillaceous
8.0	185.5	Clay, gray, silty
		Porters Creek formation
14.5	200.0	Clay, gray, carbonaceous

Test Hole No. 9

Location: On north side of gravel road about 1.0 mile east of Canaan on the west side of Grogg Creek (SE.¼, NW.¼, Sec.8, T.2 S., R.2 E.).

Elevation: 480 feet

Thickness	Depth	Description
		Ackerman formation
6.5	6.5	Sand, coarse, brown
14.0	20.5	Clay, brown to buff, streaks of coarse sand
2.0	22.5	Silt, sandy, argillaceous, light gray
13.0	35.5	Clay, gray to lavender, speckled
1.0	36.5	Lignite and lignitic clay
36.0	72.5	Clay, silty, sandy, gray; some specks of green clay
3.0	75.5	Sand, medium, gray, clean
		Fearn Springs formation
37.0	112.5	Clay, silty, sandy, gray
8.0	120.5	Clay, gray, sandy, speckled
22.0	142.5	Sand, medium, gray, speckled with dark mineral
52.5	195.0	Clay, silt, and sand, interbedded; thin lignite at 161.5 feet
		Porters Creek formation
15.0	210.0	Clay, dark gray

Test Hole No. 13

Location: On east side of gravel road about 1.0 mile north of junction with old Highway 78 (SW.¼, NE.¼, Sec.20, T.5 S., R.1 E.).

Elevation: 410 feet (approximately)

Thickness	Depth	Description
		Ackerman formation
11.0	11.0	Clay, brown, gray, white, slightly carbonaceous; many bits of iron rock

4.0	15.0	Clay, blue-green, plastic, slightly micaceous
11.0	26.0	Clay, dark gray, carbonaceous, finely micaceous
2.5	28.5	Lignite, black
39.5	68.0	Clay, gray, plastic, grading down into a darker gray, carbonaceous clay; thin streaks of whitish-gray iron carbonate at 36 and 38 feet
		Fearn Springs formation (?)
19.0	87.0	Lignite and lignitic clay, dark brown
4.0	91.0	Clay, light gray, plastic, micaceous
7.0	98.0	Clay, white, very siliceous
3.0	101.0	Clay, light gray
24.0	125.0	Silt, light gray, micaceous, some fine sand
43.0	168.0	Sand, very fine to coarse, quartz, micaceous
		Betheden formation (?)
4.0	172.0	Clay, greenish-yellow, plastic
		Porters Creek formation
18.0	190.0	Clay, black, micaceous, tough

Test Hole No. 14

Location: On east side of gravel road in the valley of a small tributary of Tippah River (SE.¼, SW.¼, Sec.1, T.5 S., R.1 W.).

Elevation: 360 feet (approximately)

Thickness	Depth	Description
		Ackerman formation
4.0	4.0	Sand, brown; colluvium
4.0	8.0	Clay, brown and gray
6.0	14.0	Silt, argillaceous, gray, micaceous
14.0	28.0	Sand, very coarse, some pea size, quartz; 2 ferruginous sandstone layers
26.0	54.0	Silt, cream, sandy
6.0	60.0	Clay, dark gray, carbonaceous, slightly silty, micaceous
19.0	79.0	Silt, cream, sandy
62.0	141.0	Sand, fine to coarse, some interbedded clay
		Fearn Springs formation
15.0	156.0	Clay, silty, sandy, cream and orange
9.0	165.0	Clay, dark gray, silty, carbonaceous, micaceous
5.0	170.0	Lignite and lignitic clay
21.0	191.0	Sand, fine to medium, quartz, clean
8.0	199.0	Clay, silt, and sand
23.0	222.0	Sand; streaks of white, silty clay
17.0	239.0	Clay, white, silty; streaks of sand
22.0	261.0	Sand, quartz
		Porters Creek formation
29.0	290.0	Clay, dark gray, tough, micaceous

TEST HOLE NO. 16

Location: On west side of gravel road and on south side of small tributary of Tippah River (SE.¼, NW.¼, Sec.25, T.4 S., R.1 W.).

Elevation: 350 feet (approximately)

Thickness	Depth	Description
		Ackerman formation
11.0	11.0	Clay, gray, yellow, pink, slightly micaceous, carbonaceous
10.0	21.0	Sand, blue, very fine, micaceous, argillaceous, dark specks, streaks of light gray
7.0	28.0	Clay, green, grading into gray, plastic, micaceous
2.0	30.0	Lignite and lignitic clay
2.0	32.0	Clay, gray, slightly micaceous
5.0	37.0	Clay, green, plastic, hard and soft streaks
9.0	46.0	Silt, gray, sandy, argillaceous, micaceous; streaks of gray clay
0.5	46.5	Rock, light gray, siliceous, probably iron carbonate
47.5	94.0	Clay, gray, micaceous, silty, slightly sandy; thin iron carbonate at 54 feet, streak at 62, 75 and 88 feet
4.0	98.0	Clay, white to pale green, slightly siliceous and micaceous
4.0	102.0	Clay, gray, carbonaceous, micaceous, silty, slightly sandy
		Fearn Springs formation
110.0	212.0	Sand, fine to medium
		Porters Creek formation
68.0	280.0	Clay, dark gray to black, micaceous

TEST HOLE NO. 17-A

Location: On an old abandoned road about 0.1 mile off east side of gravel road which is now a dead end (SW.¼, NW.¼, Sec.29, T.3 S., R.2 E.).

Elevation: 500 feet (approximately)

Thickness	Depth	Description
		Meridian formation
3.0	3.0	Soil and subsoil, brown, sandy
2.0	5.0	Sand, coarse, quartz
		Ackerman formation
9.0	14.0	Sand, very fine, pink, yellow, lavender, white, silty, argillaceous, micaceous
1.0	15.0	Clay, buff, micaceous, slightly silty

17.0	32.0	Sand, fine, gray, micaceous, argillaceous, carbonaceous
31.0	63.0	Clay, gray, plastic, slightly micaceous; streak of lignite at 38 feet
36.5	99.5	Sand, very fine, gray, argillaceous, micaceous; streaks of gray clay; siliceous iron carbonate 84-85 feet
		Fearn Springs formation
35.5	135.0	Sand, fine, yellow, capped by ferruginous sandstone, grades into a light gray sand; several zones of sandstone
1.0	136.0	Lignite, black
9.0	145.0	Clay, light and dark gray
2.0	147.0	Sand, medium, clean, quartz
14.0	161.0	Clay, white, sandy, plastic near bottom (possibly some kaolin); streaks of gray and green clay
		Porters Creek formation
29.0	190.0	Clay, dark gray to black, micaceous, tough

The Ackerman-Meridian contact is probably the most outstanding geologic feature cropping out in the county. It can be traced with relative certainty through the county, a condition often desired but seldom had. The upper contact of the Ackerman formation is exposed in many places, some of which are:

1. NE.¼, NW.¼, Sec.22, T.5 S., R.1 W., along a dirt road about 0.2 mile north of U. S. Highway 78. The Ackerman formation is a pinkish-gray clay and the overlying Meridian formation is a very coarse red, yellow, and white sand, which is locally highly cross-bedded.

2. SE.¼, SW.¼, Sec.11, T.5 S., R.1 W., in a road cut. At this location some of the Ackerman-type clay has been worked into the base of the Meridian sand superjacent to the Ackerman formation which is a slightly micaceous gray clay (Figure 12).

3. SW.¼, SE.¼, Sec.1, T.5 S., R.1 W., along the same road as above location. The Ackerman here just below the contact is a fine silty sand — white, yellow, and speckled with a dark mineral. The Meridian is a very coarse reddish-brown sand with a streak of pebble bearing yellow sand at the contact.

4. SE.¼, SW.¼, Sec.24, T.4 S., R.1 W., in a road cut. The Ackerman is a gray-white plastic clay overlain by the reddish-brown sand of the Meridian.

5. SE.¼, Sec.34, T.4 S., R.1 W., in a gully west of a gravel road. At the contact is a light-gray clay overlain by a reddish-brown, coarse to pebble bearing sand. Several quartz boulders were observed here.

Figure 12.—Ackerman-Meridian contact in road cut (SE.¼, SW.¼, Sec.11, T.5 S., R.1 W.) about 1.7 miles north of Winborn. June 4, 1956.

6. NW.¼, SW.¼, Sec.26, T.4 S., R.1 E., in a Highway 5 cut at Pine Grove Church. The Ackerman at the contact is a very fine sand and silt overlain by a very coarse reddish-brown sand.

7. NW.¼, NW.¼, Sec.4, T.3 S., R.2 E., along a dirt road leading west from a gravel road. A very sharp disconformable contact between a light-gray clay below and a coarse reddish-brown sand with some pea gravel above.

8. NE.¼, NW.¼, Sec.4, T.3 S., R.2 E., along a gravel road. The Ackerman formation is a light-gray very plastic clay overlain by a coarse reddish-brown sand. At the contact is a limonitic siltstone containing fossil leaf imprints.

9. NW.¼, NW.¼, Sec.34, T.2 S., R.2 E., in a road cut. A sharp erosional unconformity exists between a yellow-gray fine silty sand and the overlying reddish-brown coarse sand.

10. SE.¼, NW.¼, Sec.29, T.2 S., R.2 E., in a road cut. Here about 30 to 40 feet of typical Ackerman silty clay is overlain by a reddish-brown coarse sand.

11. S.½, SE.¼, Sec.21, T.2 S., R.2 E., in a road cut. At this place Ackerman gray silty clay underlies reddish-brown sand. Not much clay is exposed in the cut but the elevation correlates with nearby contacts.

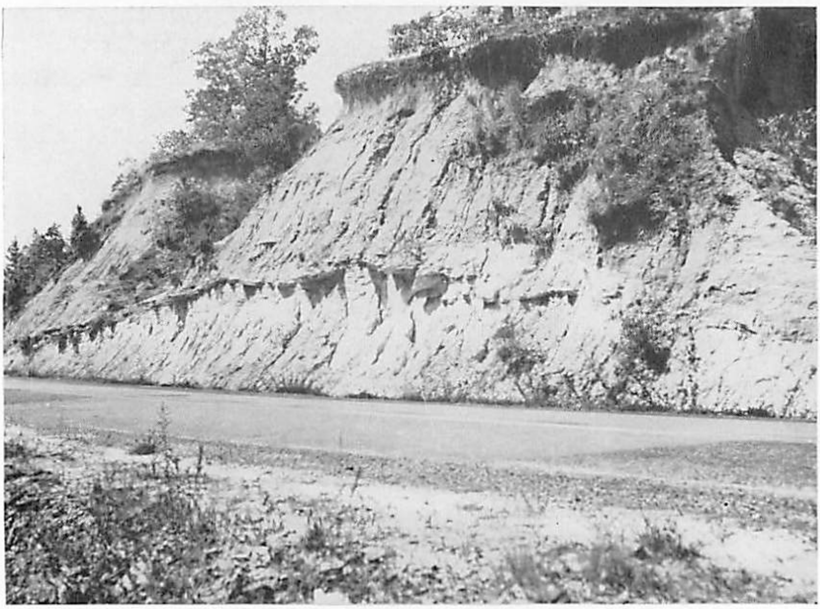

Figure 13.—Ackerman-Meridian contact in Highway 5 cut (C., E.½, Sec.10, T.5 S., R.1 E.) about 3.4 miles north of junction with Highway 78 at Hickory Flat. Sept. 14, 1954.

12. C., E.½, Sec.10, T.5 S., R.1 E., in a Highway 5 cut about 3.5 miles north of Hickory Flat (Figure 13). The Ackerman and Meridian are separated by a thin bed of ferruginous siltstone. The Ackerman is a compact gray argillaceous silt, and the overlying Meridian is a coarse reddish-brown micaceous sand containing a few tiny white clay balls and just above the contact are several thin discontinuous layers of ferruginous sandstone.

13. SW.¼, Sec.1, T.4 S., R.1 E., in a road cut. Here the Ackerman formation consists of yellow and white silty clay. The overlying Meridian is a reddish-brown coarse sand.

14. C., N.½, Sec.9, T.4 S., R.1 E., off the southwest side of the road in a ditch below a big gully. There is a ferruginous siltstone at the contact of a light-gray silty clay and a reddish-brown sand.

15. N.½, SW.¼, Sec.12, T.3 S., R.2 E., in a road cut. A ferruginous siltstone separates a light-gray silty clay below from a reddish-brown sand above.

The Ackerman is one of the most important formations in the county, because of the iron ore it contains. The iron ore is usually a carbonate ore ($FeCO_3$) where it is fresh but weathers to a limonite ($2\ Fe_2O_3 \cdot 3\ H_2O$). The ore is not in continuous beds but rather in concretionary masses from 1 inch to a foot or more thick. Locations of some of the more concentrated areas are treated later in the report.

CLAIBORNE

MERIDIAN FORMATION

Lowe[20] first applied the name "Meridian sand" to a member unit at the base of the Claiborne. The type locality is exposures in the vicinity of Meridian, Lauderdale County, Mississippi. Later Foster[21] applied the name Meridian to the same rock unit, but suggested its elevation to formational rank. In 1942, Thomas[22] placed the Meridian at the top of the Wilcox rather than the base of the Claiborne. The writer prefers to place the Meridian in the Claiborne as the basal formation.

The Meridian formation in Benton County is part of Hilgard's Orange Sand, as evidenced by his section[23] at Hurley's School house, in Tippah County, which is now known as Flat Rock Church and is in southeastern Benton County.

The Meridian formation in Benton County can best be generally described as a very coarse to medium sand. The color on outcrop is usually reddish-brown, but where the sand is fresh and a few feet above its lower contact it is characteristically banded light and dark brown. At many localities the basal part contains stringers of reworked clay, and at some places clay balls are present through the entire thickness of the sand. The sand is micaceous (muscovite) to a greater or lesser degree. Locally large boulders of sandstone are developed near the top of the formation. These sandstones are usually very hard and at some localities are quartzitic. At a few places some boulders are as large as an automobile (Figure 14).

The disconformity at the base of the Meridian formation is plainly exhibited in Benton County, but the upper contact is not nearly so clear. This is due to the fact that at many

Figure 14.—Meridian sandstone exposed in the west valley wall of Shelby Creek (SW.¼, NE.¼, Sec.14, T.3 S., R.2 E.) near Test Hole 7. Aug. 9, 1956.

localities the upper contact is between two sands. The disconformity reported by Foster[24] of the upper contact is not so evident as it is in the vicinity of Meridian, Mississippi, where the Meridian sand contacts with the overlying Tallahatta shale. As a result of the lateral change of the Tallahatta formation from shale to sand, the exact Meridian-Tallahatta contact can be determined at only a few locations.

The overlap of the Meridian formation has added to the confusion of age determination of the Meridian as well as the underlying Wilcox strata. Also, the overlap has created numerous outliers of the Meridian sand that cap hills much farther east than would normally be expected. For instance, the writer believes the coarse reddish-brown sand that caps the hill at Flat Rock Church to be an outlier of the Meridian formation.

The thickness of the Meridian formation is about 100 to 150 feet. At first thought one might be inclined to question that a formation of such relatively slight thickness could have an outcrop belt of 12 or more miles wide. The dip is low, about 15 to 20 feet to the mile, but that would normally account for a thickness of at least 180 to 240 feet. The answer lies in the topography or configuration of the surface. The general slope of the surface is west and southwest at the rate of about 10 to 15 feet to the mile. Under such conditions it can easily be seen why the outcrop of the Meridian formation can be so wide and yet the formation itself be relatively thin.

As has already been stated, the lower contact of the Meridian formation is a well-defined disconformable contact. Numerous outcrops that show the base of the Meridian have been listed in the discussion of the Ackerman formation. The break between the Ackerman and the Meridian is always sharp, but the extreme lower portion of the Meridian in many places contains reworked clay and fragments of ferruginous sandstone, indicating the action of swift water. The large grain size of the sand deposit also substantiates the other evidence of this type of deposition. Locally the sand is cross-bedded, indicating also a turbulent action of the water.

Mississippi Geological Survey Test Hole No. 7, drilled to a total depth of 240 feet, began in the Meridian formation. The site was selected in order to better establish the age of the huge masses of sandstone located within 100 yards of the hole (Figure 14). The Meridian here is considerably farther east than might be expected and the elevation of the contact with the Ackerman is abnormally low, but the explanation apparently lies in the erosional unconformity that exists between the two formations. As indicated by the log, both the Fearn Springs formation and the Ackerman formation are thinner than normal.

TEST HOLE No. 7

Location: On west side of dirt road behind abandoned farm house (SW.¼, NE.¼, Sec.14, T.3 S., R.2 E.).

Elevation: 601 feet

Thickness	Depth	Description
		Meridian formation
5.5	5.5	Soil and subsoil, light brown, silty, argillaceous
19.0	24.5	Sand, coarse, quartz, brown and yellow
33.0	57.5	Sand, coarse, quartz, brown, ferruginous; interbedded white plastic clay; zones of friable ferruginous sandstone, slightly micaceous, at 37.5, 42.0 and 47.5 feet; ferruginous, coarse sandstone at 50.5-52.5 feet
		Ackerman formation
15.5	73.0	Clay, white, plastic
47.5	120.5	Sand, fine to medium, quartz, clean
		Fearn Springs formation
5.0	125.5	Lignite and coarse sand; lignite in thin seams
65.0	190.5	Clay, blue-gray, silty, micaceous, some fine sand; thin, soft, lignite partings; streaks of coarse quartz sand
		Porters Creek formation
49.5	240.0	Clay, dark gray to black, carbonaceous, finely micaceous

Mississippi Geological Survey Test Hole No. 11 illustrates the lithologic character of the Meridian formation and indicates the total thickness of the underlying Wilcox beds at this location. The hole is three miles north and one mile east of Test Hole No. 7. The elevation of the Ackerman-Meridian contact in No. 7 is 543.5 feet and in No. 11 is 567.0 feet, a difference of only 23.5 feet. Also, the Fearn Springs and Ackerman formations are thin in No. 11 as well as in No. 7.

TEST HOLE No. 11

Location: On north side of gravel road (NE.¼, NE.¼, Sec.36, T.2 S., R.2 E.).

Elevation: 642 feet

Thickness	Depth	Description
		Meridian formation
4.5	4.5	Soil and subsoil, brown, sandy
2.5	7.0	Sand, brown, very coarse
12.5	19.5	Sand, medium to coarse, deep red, argillaceous

38.5	58.0	Sand, coarse, quartz, some interbedded clay near top; micaceous; quartz pea gravel
17.0	75.0	Sand, brown, medium to coarse; thin streaks of white clay, large muscovite flakes
		Ackerman formation
1.5	76.5	Rock, light gray, probably quartzitic siltstone, as shows in nearby outcrop
51.5	128.0	Clay, white, grading down into dark gray silty clay; thin iron rock at 98 feet and thin streak of lignite between 90 and 100 feet
7.0	135.0	Sand, very coarse, quartz
		Fearn Springs formation
4.0	139.0	Lignite and lignitic clay
12.0	151.0	Clay, gray, silty, finely micaceous
3.0	154.0	Sand, very fine, argillaceous, speckled with dark mineral; streak of dark gray plastic clay
2.0	156.0	Lignite, black
1.0	157.0	Clay, dark gray, underclay
7.0	164.0	Sand, very fine, light gray
5.0	169.0	Clay, dark and light gray, some green
		Porters Creek formation
61.0	230.0	Clay, dark gray to black, micaceous

Mississippi Geological Survey Test Hole Nos. 18, 19, and 20 were drilled in the east-central part of the county. Each of the holes started in the Meridian sand, so the entire thickness of the formation is not shown by the logs.

TEST HOLE NO. 18

Location: On west side of gravel road 1.5 miles north of Highway 4 (NE.¼, SE.¼, Sec.31, T.3 S., R.2 E.).

Elevation: 530 feet (approximately)

Thickness	Depth	Description
		Meridian formation
78.0	78.0	Sand, reddish-brown to white, clean, quartz, about 50 per cent frosted grains; fine to coarse, micaceous, a few streaks of white clay; hard rock at 76-78 feet (probably quartzitic)
		Ackerman formation
16.0	94.0	Clay, gray, plastic, finely micaceous
4.0	98.0	Sand, fine to medium, clean, quartz
8.0	106.0	Clay, gray, sandy, micaceous; thin rock at 106 feet

3.0	109.0	Sand, reddish-brown, micaceous; very hard sandstone at 108 feet
		Fearn Springs formation
41.0	150.0	Silt, sandy, argillaceous, greenish-gray, micaceous, speckled, streaks of gray clay
60.0	210.0	Sand, silty, argillaceous, micaceous, greenish-gray; streaks of gray and white clay between 180 and 190 feet; grades into a clean, fine to medium sand
		Betheden formation
5.0	215.0	Clay, yellow and light gray
		Porters Creek formation
15.0	230.0	Clay, dark gray to black, micaceous

TEST HOLE NO. 19

Location: On log road about 0.3 mile off south side of gravel road (NE. ¼, SW.¼, Sec.25, T.3 S., R.1 E.).

Elevation: 500 feet (approximately)

Thickness	Depth	Description
		Meridian formation
75.0	75.0	Sand, reddish-brown to white, medium to coarse, micaceous; streaks of white clay; thin ferruginous sandstone at the base
		Wilcox (Undifferentiated)
26.0	101.0	Clay, silty, sandy, yellow and light gray, micaceous
75.0	176.0	Sand, very fine, dark gray, argillaceous, micaceous; streaks of gray clay
22.0	198.0	Sand, fine, cleaner than above; some clay streaks, white and gray
		Porters Creek formation
12.0	210.0	Clay, dark gray to black, micaceous; a few inches of white clay on top

TEST HOLE NO. 20

Location: In small valley on west side of gravel road about 2.0 road miles south of Ashland (C., N.½, Sec.23, T.3 S., R.1 E.).

Elevation: 520 feet (approximately)

Thickness	Depth	Description
		Meridian formation
78.0	78.0	Sand, brown to white, medium to very coarse, about 50 per cent frosted grains; few streaks of white clay

		Ackerman formation
21.0	99.0	Clay, white, pink, slightly silty, finely micaceous
58.0	157.0	Sand, fine, argillaceous, micaceous; many streaks of white, pink, yellow, and lavender, silty clay; cleaner sand below 120 feet
		Fearn Springs formation
37.0	194.0	Clay, yellow, dark gray, some white, micaceous, silty, carbonaceous; streak of lignite 187-188 feet
59.0	253.0	Sand, fine, speckled, micaceous; streaks of blue-gray clay
		Porters Creek formation
17.0	270.0	Clay, dark gray to black, micaceous, tough

Figure 15.—Meridian sand pit (C., Sec.13, T.5 S., R.1 W.) about 1.5 miles northeast of Winborn. Aug. 9, 1956.

Sand pits are numerous in Benton County, and most of them are in the Meridian sand. This sand is used as a road surface for nearly all of the rural roads in the outcrop area of the Meridian formation. As a result, the road is an all weather road and as nearly free of dust as could be expected from any surfacing short of asphalt or concrete.

A large sand pit (C., Sec.13, T.5 S., R.1 W.) located in the first group of hill lands on the southeast side of Tippah River, has exposed 20 to 30 feet of sand (Figure 15). The sand is very coarse throughout, and is mostly reddish-brown with some streaks of yellow and white. It contains scattered white clay balls. The approximate elevation of the outcrop is 500 feet. The contact with the underlying formation does not show in the pit and the sand extends to the top of the hill.

Figure 16.—Meridian sand pit (NW.¼, Sec.5, T.4 S., R.2 E.) on the east side of a sand road, 0.75 mile north of Highway 4. June 4, 1956.

Another large sand pit (NW.¼, Sec.5, T.4 S., R.2 E.) about 12 miles northeast of the above mentioned pit has exposed about 40 feet of very coarse sand containing small white clay balls throughout (Figure 16). The elevation of this pit is approximately 480 to 500 feet. Test Hole No. 18, located about 0.5 mile north of the pit, drilled through 78 feet of the same sand which caps the ridge in the area.

The status of this sand formation in Benton County as well as in some other areas of north Mississippi, that the writer is calling Meridian, has long been one of controversy. Some workers have considered at least a part of this sand somewhat older and placed it at the base of the Ackerman formation in the Wilcox. Others have considered it a superficial deposit of probable Pleistocene age. Test Hole No. 10, of which the log is given in the discussion of the Tallahatta formation, drilled through 117 feet of Meridian sand with only one significant clay break, all of which was below the Tallahatta. Also the elevations of the contact of the Ackerman and Meridian indicate a low but definite dip in a westerly direction. As further evidence that the age of the Meridian sand is as presented, Vestal[25] in his report on Marshall County presents the following information. "Prospect Hole 14, located above a Tallahatta outcrop along Highway 4 about six miles northeast of Holly Springs, passed through the entire Meridian formation, 152 feet, possibly 173 feet.

"LOG OF PROSPECT HOLE 14

Location: At the top of the ridge above an outcrop of Tallahatta white clay shale on the north side of Highway 4, approximately 6 miles northeast of Holly Springs. (Northern part, Sec.24, T.3 S., R.2 W.)

Property: D. A. Higdon — Elevation: 500 feet app.

Int.	Thick.	Depth	Description
			Tallahatta formation
1	48.0	48.0	Sand, brown clayey and silty toward top; considerable ferruginous sandstone at slight depth; sand fine to medium; grades downwards into white
2	34.0	82.0	Clay, white, sandy and silty, plastic; contains lentils of fine white sand
3	12.0	94.0	Sand, white, medium fineness, angular grains
4	9.0	103.0	Clay, as interval 2
			Meridian formation
5	35.5	138.5	Sand as interval 3; contains clay streaks
6	116.5	255.0	Sand, light colored, silty
			Ackerman formation
7	5.0	260.0	Clay, light gray mottled with brown; silty, grades downward into
8	31.0	291.0	Clay, dark blue to almost black and gray; sandy and silty."

The value of a correct concept of the Meridian sand cannot be overemphasized. The importance of this formation as a fresh water aquifer should not be overlooked. The outcrop area of the Meridian formation in Benton County might well be compared to a sponge. The large grain size of the sand provides a permeable reservoir for catching much of the 50-inch annual rainfall that would normally run off as surface water and allowing the water to percolate beneath the surface as ground water, thus providing productive, potable water for the present generation and future generations.

A few of the places that better show the Meridian-Tallahatta contact zone are:

1. In a gully on the east side of a gravel road about 30 feet below the road (NE.¼, Sec.15, T.3 S., R.2 E.) (Figure 17). At

Figure 17.—Meridian-Tallahatta contact (NE.¼, Sec.15, T.3 S., R.2 E.) on the south side of a gravel road in a gully about 30 feet below the road. Nov. 2, 1956.

the contact is a slightly resistant, dark brown sand and above it is a very coarse sand and pea gravel containing typical Tallahatta white ball clay, reworked in balls and stringers. The elevation of the contact is about 610 feet.

2. The east valley wall of Wolf River on the north side of U. S. Highway 72 at an elevation of about 500 feet (NE.¼, NW.¼, Sec.3, T.2 S., R.1 E.). There is no distinct contact, inasmuch as sand is both above and below. The sand below the contact zone is cross-bedded, banded brown and tan, micaceous, and contains a few white clay balls. The sand above has a slight purple tint,

is micaceous, and has a greater number of white clay balls and stringers.

3. On the west side of a gravel road about 0.5 mile south of U. S. Highway 72 (SE.¼, NE.¼, Sec.2, T.2 S., R.1 E.). The contact is marked by a yellow-brown ferruginous sandstone and a zone of black sand. Below the contact is a medium grained

Figure 18.—Meridian-Tallahatta contact (C., E.½, Sec.9, T.2 S., R.2 E.) in a road cut about 2.2 miles east of Canaan. Aug. 9, 1956.

banded dark and light sand and above is a coarse yellow, white, brown and lavender cross-bedded sand containing white clay balls.

4. In a cut on the south side of a gravel road (C., E.½, Sec.9, T.2 S., R.2 E.) (Figure 18). The contact is marked by a ferruginous sandstone ledge underlain by a coarse brown banded sand and overlain by a weathered white sandy silt. The elevation is about 620 feet.

5. In a gully (C., W.½, NW.¼, Sec.25, T.2 S., R.1 E.) on the east side of a gravel road about 0.75 mile north of Good Hope Church. The Meridian is a brown coarse sand overlain by a

brown fine to medium slightly micaceous sand containing white clay balls. The contact zone is at an elevation of about 575 feet.

6. West valley wall of Big Snow Creek in a cut on the south side of Highway 4 (SW.¼, SW.¼, Sec.18, T.3 S., R.1 E.). The Meridian is a fine to medium slightly micaceous brown sand and the overlying Tallahatta is a coarse gritty brown micaceous sand containing a lens of white plastic clay. Tallahatta cross-bedded micaceous sand and white clay balls continue to the top of the hill. The elevation of the contact zone is about 450 feet.

7. In a wash about 100 yards north of a gravel road (NE.¼, Sec.11, T.2 S., R.1 E.). Near the top of the exposure is a probable Meridian-Tallahatta contact zone. It is indicated by a bed of very coarse sand and milky quartz pebbles, which is highly micaceous (large muscovite flakes). The entire sand section contains white clay balls. The elevation is approximately 520 feet.

8. In a wash (SW.¼, NW.¼, Sec.30, T.1 S., R.2 E.) on the northwest side of a gravel road about 0.75 mile from the Tippah County line. The Meridian below the contact zone is a coarse reddish-brown sand and the Tallahatta above is a coarse sand and quartz pea gravel and a thin bed of ferruginous sandstone and sandstone concretions containing a fine white sand. The approximate elevation of the contact zone is 650 feet.

TALLAHATTA FORMATION

W. H. Dall[26] first used the term "Tallahatta" in print at the suggestion of E. A. Smith of Alabama. "Tallahatta" replaced the descriptive term of "Buhrstone" which had been in use. The type locality of the Tallahatta formation is in the Tallahatta hills in Choctaw County, Alabama — hills bordering Tallahatta Creek. As used and defined this formation includes all the beds overlying the Meridian formation and underlying the Winona formation.

The outcropping Tallahatta formation of the north Mississippi area has had a considerable facies change from the Tallahatta formation of Choctaw County, Alabama and Lauderdale County, Mississippi. Foster[27] describes the formation in Lauderdale County as being ". . . composed of a soft siliceous siltstone of low specific gravity. It is rather evenly bedded in layers from an inch or less to 2 feet or more thick, the more thickly bedded material being more uniformly fine grained and more abundant in the upper half of the formation. It is commonly exposed in bluffs and very steep hill slopes along the belt of outcrop, and where so exposed the individual beds are jointed and block-like, the subconchoidal fracture being one of the striking features. In fresh cuts, however, the material is more earthy or chalk-like and the subconchoidal fracture is not so well developed." The Tallahatta formation in Benton County is, indeed, different from the above description. In Benton County it is composed largely of a fine to very coarse pebble bearing, micaceous quartz sand containing white clay balls in a greater or lesser number. In some places the white clay is in rather large pockets or lenses. A striking example of a very large lens of the white clay is at the Holly Springs Brick and Tile Company plant at Holly Springs in Marshall County, which joins Benton on the west. The Tallahatta clay is used in making brick and tile.

Much of the Tallahatta outcrop area in the northwestern part of Benton County is rather high and of surprisingly gentle relief. Numerous local areas reaching an elevation of 560 to 600 feet above mean sea level are practically flat. Such a condition might lead one to suspect that much of the near surface deposit was clay rather than sand, which normally exhibits a rugged topography. Because of the slight relief, outcrops are few.

In the northeastern corner at an elevation of 640 to 680 feet the Tallahatta has been traced to within about 0.5 mile of the Tippah County line. This is much farther east than the formation would normally be expected to reach. However, the relatively great elevation is the probable reason for such a condition.

Wolf River, which has its beginning in northeastern Benton County, runs generally northwest into Tennessee. The broad river valley cuts across the Tallahatta outcrop area, thereby reducing the number of exposures, which are greatly needed to solve the mapping problem. Exposures particularly desired are those that show the contact with the underlying Meridian formation — a contact naturally obscured due to the fact that both formations are dominantly sand.

Some of the locations that show the probable Meridian-Tallahatta contact zone have been listed in the description of the Meridian formation. In practically every one the contact is between two sands. In some places there is a ferruginous sandstone separating them, and in most outcrops the white clay content is somewhat greater in the Tallahatta. In some of the localities there is a quartz pea gravel at the contact. The quartz pebbles are smooth and well rounded.

Tallahatta sand containing white clay inclusions is exposed in several places along Highway 4 west of Ashland. The road cut up the east valley wall of Little Snow Creek has exposed about 80 feet of Tallahatta material which is fine to medium micaceous white to brown sand containing some white clay. Farther east along Highway 4, in the west and east valley walls of Big Snow Creek, Tallahatta material is exposed and has practically the same description as at the location above. At the top of the east valley wall of Big Snow Creek in a gully on the north side of the highway is a rather large lens of white clay (SE.¼, Sec.18, T.3 S., R.1 E.).

About 1.5 to 2.0 miles south of Highway 4 on a dead-end country road are two more good outcrops of Tallahatta sand and clay. One of these is in a gully on the west side of the road (SE.¼, Sec.26, T.3 S., R.1 W.). There is no conclusive evidence of a contact with the underlying Meridian, even though the elevation is suggestive. Near the base of the outcrop there is a zone of very coarse sand and a few loose pieces of ferruginous sandstone about 4 inches thick and 2 to 3 feet in diameter. It was not possible to determine exactly where the sandstone came from, but it was found in the gully floor just under the coarse sand. For the most part, the section is fine to medium micaceous light and dark banded sand containing a few small white clay balls. The other outcrop is located along this same road about 0.3 mile farther south (NW.¼, Sec.36, T.3 S., R.1 W.). Here the Tallahatta is a light-colored highly micaceous clay overlain by a very coarse grit-bearing micaceous reddish-brown sand.

In a deep ravine on the west side of Highway 5 about 2.0 miles south of Ashland is a section of sand approximately 100 feet thick between the elevations of 500 and 600 feet. At this location a Meridian-Tallahatta contact might be expected, but there is no evidence of it. The section is composed of a banded light and dark brown cross-bedded micaceous medium to very coarse sand containing white plastic clay balls and streaks.

A large and deep ravine exposing about 80 feet of Tallahatta sand is located about 150 feet south of the main gravel road leading east out of Ashland and about 1.0 mile from the town (SE.¼, SW.¼, Sec.12, T.3 S., R.1 E.) (Figure 19). At this place the section is practically all sand, but south along the walls of

Figure 19.—Large ravine (SE.¼, SW.¼, Sec.12, T.3 S., R.1 E.) in probable Tallahatta sand about 1 mile east of Ashland. Aug. 9, 1956.

the ravine are several pockets of white clay in the sand. The clay outcrops were spotted from the Mississippi Geological Survey helicopter.

In the northern part of the county, along U. S. Highway 72, Tallahatta material crops out in numerous places. About 2.6 miles east of the junction of Highways 72 and 7, is a sand pit (NE.¼, NE.¼, Sec.1, T.2 S., R.1 W.) (Figure 20). At first it was thought that a Meridian-Tallahatta contact between two sands was visible here. However, because of the elevation it was decided that the whole sand section belongs to the Tallahatta formation. Exposed is a reddish-brown and buff cross-bedded fine to coarse sand containing some light colored sandy silt in

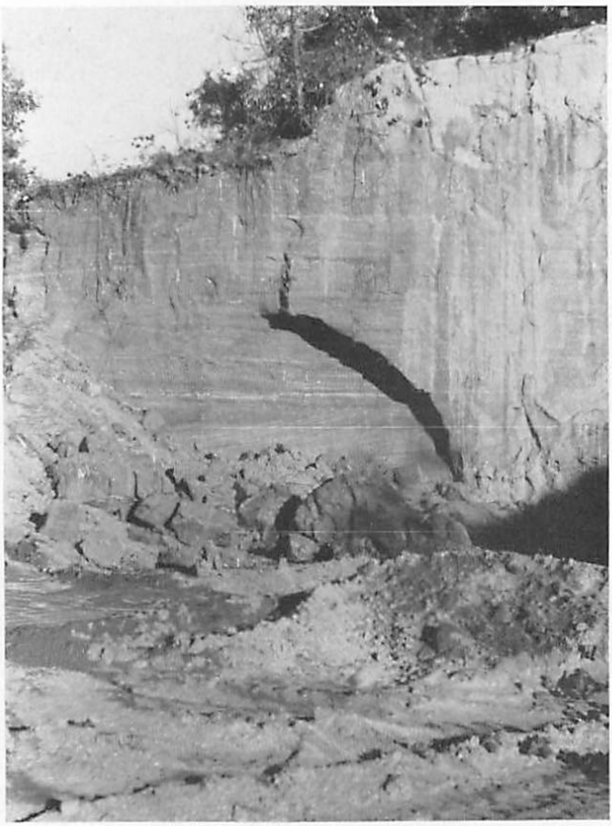

Figure 20.—Wall of Tallahatta sand pit (NE.1/4, NE.1/4, Sec.1, T.2 S., R.1 W.) on the south side of Highway 72, about 2.6 miles east of the junction of 72 and 7. Nov. 1, 1956.

the lower part. Farther east on U. S. Highway 72, the east wall of Wolf River Valley exposes a probable Meridian-Tallahatta contact zone in the lower part and Tallahatta sand with stringers of white clay to the top of the hill (C., N. line, Sec.3, T.2 S., R.1 E.) (Figure 21). The probable contact zone is in a vertical wall that faces north about 100 feet north of the highway. At the base of the wall are numerous springs.

Figure 21.—Tallahatta sand with stringer of white clay (C., N. line, Sec.3, T.2 S., R.1 E.) exposed in Highway 72 cut in the east valley wall of Wolf River. Photograph by F. E. Vestal.

Figure 22.—Tallahatta sand pit with lens of white clay (NE.¼, Sec.11, T.2 S., R.2 E.) on the east side of a gravel road about 2 miles south of Highway 72. Aug. 9, 1956.

The sand exposed by the pit (NE.¼, Sec.11, T.2 S., R.2 E.), on the east side of a north-south gravel road about two miles south of U. S. Highway 72, is probably a part of the Tallahatta formation. The wall of the pit plainly exhibits a lens of white ball clay in the sand (Figure 22), which is so typical of the Tallahatta. The elevation of this pit is from about 660 to 680 feet.

Mississippi Geological Survey Test Hole No. 10 was started in the Tallahatta formation. The contact with the underlying Meridian formation was at a depth of 40 feet.

TEST HOLE NO. 10

Location: On south side of road at Hardaway Church (SW.¼, SE.¼, Sec.25, T.1 S., R.1 E.).

Elevation: 582 feet

Thickness	Depth	Description
		Tallahatta formation
6.0	6.0	Soil and subsoil, brown, sandy
2.0	8.0	Clay, weathered, gray and brown, silty and sandy
1.0	9.0	Sand, medium to coarse, brown
8.0	17.0	Silt and clay, white and pink, micaceous, and some fine sand
6.0	23.0	Sand, white, fine, micaceous; capped by thin ferruginous sandstone
10.0	33.0	Clay, white, micaceous (large muscovite flakes); streaks of fine reddish-brown sand
7.0	40.0	Sand, fine to medium, brown, micaceous; streaks of black and ferruginous sandstone
		Meridian formation
28.0	68.0	Sand, medium coarse, reddish-brown, clean, micaceous; thin streaks of pink and white silty clay; streak of deep red sand at 68.0 feet
14.0	82.0	Sand, medium to very coarse, quartz, clean, some grains stained red
18.0	100.0	Clay, silty and sandy, white and pink, micaceous; fine red sand; several layers of deep red sand
57.0	157.0	Sand, medium to very coarse, reddish-brown coated quartz; streaks of white and pink clay
		Ackerman formation
58.0	215.0	Clay, white, silty, grading into speckled silt and sand; streak of lignite between 170.0 and 180.0 feet; some gray clay
32.0	247.0	Sand, fine to medium, clean; streaks of white and gray clay and lignite

		Fearn Springs formation
29.0	276.0	Clay, gray, silty
20.0	296.0	Silt, gray, speckled, slightly sandy
45.0	341.0	Sand, gray, very fine, silty; streak of lignite at 320 feet
9.0	350.0	Clay, gray, white, yellow; several beds of lignite
46.0	396.0	Sand, fine, gray, micaceous; interbedded white plastic clay
		Porters Creek formation
14.0	410.0	Clay, black, shaly

The overlap of the Kosciusko formation in north Mississippi has covered and perhaps removed much of the Winona and Zilpha formations which normally lie on top of the Tallahatta formation. This condition has placed the Kosciusko disconformably on top of the Tallahatta in Benton County. The locations and description of this contact are discussed under the Kosciusko formation.

WINONA AND ZILPHA FORMATIONS

In the normal sequence of Claiborne beds the Winona formation is superjacent to the Tallahatta formation and the Zilpha formation superjacent to the Winona and subjacent to the Kosciusko formation. Neither of these formations was recognized in Benton County.

The writer doubts if either the Winona or the Zilpha area of deposition reached as far east as Benton County. Possibly the Winona sea reached the northwestern edge of the county. If so, erosion has removed all identifiable sediments. At the present, there remains only a suggestion of the Winona deep red sand.

The overlap of the Kosciusko formation has, no doubt, covered much of the Winona and Zilpha formations. Exposures in other counties show clearly that in places the Zilpha and Winona have been cut completely through and Kosciusko material deposited on Tallahatta shale.[28]

KOSCIUSKO FORMATION

Cooke[29] suggested the term "Kosciusko" which replaced Lowe's term "Decatur." Cooke's definition is: "The name Kosciusko sandstone member is here proposed as a designation for the ledges of saccharoidal to quartzitic sandstone exposed in the vicinity of Kosciusko, the county seat of Attala County Mississippi, and for the unconsolidated sands of the same age in Mississippi." Later Thomas[30] redefined the Kosciusko ". . . to include all beds above the Zilpha shale and below the Wautubbee formation." Thomas also elevated it from a member of the Lisbon formation to the rank of formation.

Figure 23.—Tallahatta-Kosciusko contact (SW.¼, SW.¼, Sec.8, T.2 S., R.1 W.) in a road cut about 1 mile west of the railroad crossing at Lamar. Nov. 1, 1956.

The state of confusion of the geologic sequence of beds in north-central Mississippi can largely be attributed to the overlap of the Kosciusko formation. It was traced first into Lafayette County by Attaya[31] and later into Marshall County by Vestal.[32] Without the aid of this earlier work, it is doubtful if this formation would have been recognized as such in Benton County.

The areal extent of the formation is confined to the high hills and ridges in the northwestern part of the county which are capped with material belonging to the Kosciusko (Plate 1). These hills reach an elevation of 600 feet or more.

The Kosciusko in Benton County is composed of reddish-brown coarse to very coarse sand containing some ferruginous sandstone. No doubt some of the sand in northeastern Marshall County previously mapped as Kosciusko which extends into northwestern Benton County has been called Tallahatta in this report. This is the sand that contains the reworked white clay.

The most prominent Tallahatta-Kosciusko contact found is about a mile west of the railroad crossing at Lamar. The contact is very near the top of a high hill (SW.¼, SW.¼, Sec.8, T.2 S., R.1 W.) (Figure 23). Its elevation is approximately 600 feet. Separating the formations is a thin ferruginous sandstone and siltstone cemented as one rock. The lower half is a siltstone and the upper half is a sandstone. The formational contact is very irregular. On the south side of the road is a rather large wash, part of which was once an old road. The exposure is littered with small pieces of ferruginous sandstone and siltstone from the hard contact layer that was undercut by erosion and dropped from its original position. The sandstone is very coarse to gravelly and contains some imprints of wood structure. The Tallahatta material appears to be the typical white clay, but it proved to be very silty and sandy. The Kosciusko is a reddish-brown medium to coarse sand that is badly weathered forming the soil zone.

In a gully less than a quarter of a mile west of the above location is another contact of the Tallahatta and Kosciusko formations (SE.¼, SE.¼, Sec.7, T.2 S., R.1 W.) (Figure 24). The exposure is about 100 to 150 yards south of the road. Below the contact the Tallahatta is a white argillaceous sandy silt and above the contact the Kosciusko is a badly weathered reddish-brown sand that grades up into the soil zone. About 10 feet below the contact at the base of the white silt bed is a very thin ferruginous siltstone overlying a very fine vari-colored micaceous sand. Small pieces of ferruginous rock from this bed are strewn over the gully outcrop, which appears to be very similar to the exposure of Section 8, but here the siltstone is lying for the most part in place. The condition is very suggestive that some of the ferruginous sandstone and siltstone at the other locality may be from the same horizon even though it is not evident.

In a wash on the southeast side of Highway 7, about 1.5 miles southwest of Lamar, the outcrop of white clay and reddish-brown, very coarse sand and pea gravel at an elevation of 560 to 600 feet is highly suggestive of a Tallahatta-Kosciusko contact zone. An exact contact is not clear inasmuch as there are several beds of very coarse sand at different horizons above and below small lenses of Tallahatta white clay. At least a part of the clay may be reworked in the Kosciusko.

Figure 24.—Tallahatta-Kosciusko contact (SE.¼, SE.¼, Sec.7, T.2 S., R.1 W.) exposed 100 to 150 yards south of the road in a gully about 1.2 miles west of the railroad crossing at Lamar. Nov. 1, 1956.

On the west flank of Hamer Hill (NE.¼, NW.¼, Sec.6, T.3 S., R.1 E.) at an elevation of approximately 620 feet, is a Tallahatta-Kosciusko contact between a white clay below and red sand above separated by a thin ferruginous sandstone layer. Near the top of Hamer Hill are large masses of ferruginous sandstone belonging to the Kosciusko formation. This hill, which reaches a maximum elevation of 712 feet, no doubt is closely associated with the so-called "mountains" of adjoining Marshall County and nearby Lafayette County. They probably owe their existence to the capping of hard sandstone that is common to each of the "mountains". The sandstone development may have been local, which would explain the presence of the few remaining isolated hills. Shaw[33] referred to these high hills as "monadnocks", and regarding the sandstone caps he states ". . . it must apparently be inferred that the formation of the hard masses began on a peneplain now marked by the tops of most of these hills and that instead of disintegrating with exposure to the weather the masses that now cap the hills have become more and more consolidated." Whereas Shaw considered the material to be of Pliocene age, it is now believed to be much older and of Claiborne age.

PLEISTOCENE AND RECENT

Deposits that now cover the valley floors of most of the main streams and tributaries of Benton County presumably were laid down during Pleistocene times or the period following, which is termed Recent. This material may be considered as being alluvium and colluvium.

Alluvium may be defined as material brought in and deposited by streams, in their channels and on their valley floors. Such conditions are brought about by the sediments being poured in by the main stream and its tributaries in greater quantities than the transporting power of the stream can manage. The bottom lands of today, formed in this manner, are for the most part the most fertile and best suited farm areas.

The best examples of alluvial valleys in Benton County are Tippah River Valley and Wolf River Valley. Some of the main tributaries of Tippah and Wolf Rivers also have rather prominent valleys. These are Oaklimeter Creek, Chilli Creek, and Big Snow Creek, which run into Tippah River, and Turkey Creek, Indian Creek, and Grogg Creek, which run into Wolf River.

Many streams in north-central Mississippi have been in the recent past and to some extent are now, unduly subjected to filling through man's ignorance and shortsightedness in removing the forest cover and cultivating the hill slopes, thereby greatly accelerating the rate of erosion. As a result, the hills are scarred by deep gullies and some of the smaller stream channels have been completely filled with sand (Figure 25). Also, some of the bottoms are partially covered by sand. The problem of controlling erosion has been carried far towards a solution through the efforts of the Soil Conservation Service, which has been instrumental in getting the hills reforested with pine trees.

Figure 25.—Sand filled stream channel (SE.¼, SE.¼, Sec.13, T.3 S., R.1 W.) along north side of Highway 4. Nov. 2, 1956.

Colluvium is surface material that has gradually moved down from its original position and mantled the underlying deposits. Probably the chief method of such movement is by landslips, which normally are rather common in areas covered by loose unconsolidated material such as sand, silt, and clay. Clay is especially prone to sliding and to provide conditions favorable to slides. However, in Benton County landslips were not found to be widespread. This might be attributed to two factors: 1) In most localities the clays contain some silt and sand which increase the coefficient of friction, and 2) inasmuch as a large part of the hill area of the county is within the Holly Springs National Forest, its protective forest cover has been preserved by regulated conservation methods. The only area worthy of note for colluvial material is the range of very steep hills bordering Tippah River on the south between Highway 5 and Highway 4. Here the sand that caps the hills has washed down the slopes giving the appearance that the hills are sand from bottom to top.

ECONOMIC GEOLOGY

OIL AND GAS POSSIBILITIES

The possibility of oil and gas production in Benton County should not be considered remote. As a matter of fact, some evidence of structural conditions favorable for the accumulation of oil and gas was found by the present survey. The evidence is believed to be significant enough to warrant the immediate release of the findings to the public in order to expedite the exploration of the natural resources of Mississippi.

"Mississippi State Geological Survey
William Clifford Morse, Director
University, Mississippi

For release on
June 26, 1956

Flat Rock Church Structure

Recent field investigations of Benton County, soon to be published as Mississippi State Geological Survey Bulletin 80, Benton County Geology, by Tracy W. Lusk, Assistant State Geologist, have revealed unusual west dips in the southeastern corner of the County. The dip was first noticed in the outcropping Midway beds (Porters Creek formation). This condition was confirmed later by drilling.

A structure map drawn on the top of the Porters Creek formation suggests a faulted dome with the apex near Flat Rock Church (NE.¼, NW.¼, Sec.16, T.5 S., R.2 E.). The fault plane that cuts the dome trends NE-SW. A little over a mile southwest of the dome the fault plane changes direction and extends N.75°

W. at least as far as the Tippah River, distant seven miles. The upthrown side of this NE-SW fault is on the southeast with a vertical displacement of approximately 100 feet. The mapped closure on the top of the Porters Creek formation is about 35 feet located in Secs.9, 16, and 17, T.5 S., R.2 E.

The writer and the State Geologist believe the area to be worthy of a test well for Paleozoic production or at least further exploration."

Without a doubt the weakest element involved in the determination of the Flat Rock Church Structure was the mapping horizon. The datum horizon used, the top of the Porters Creek formation, is an erosional surface broken by numerous irregularities. On the other hand the very nature of the Porters Creek formation lends itself to a topography of low relief such as is now exhibited by the outcrop belt of the Porters Creek, which has long been characteristically termed "Flatwoods." Also the structural evidence was critically examined from several points of view in order to make the best and most logical interpretation of the existing conditions.

The dip of the outcropping Porters Creek beds (Figure 2), mentioned in the Press Release, fits into the structure as mapped from data obtained by drilling (Plate 2). The west dip on these beds was measured to be between 7 and 10 degrees, which is considerably greater than the normal 25 to 30 feet to the mile.

As possible supporting evidence of uplift and faulting is the unusually thick* deposit of kaolin at Flat Rock Church, discussed under the heading Kaolin. Assuming the kaolin to be residual, a contemporaneous uplift or fault would have broken and cracked the beds so as to hasten as well as increase the depth of weathering. Also an uplift might have aided in the preservation of the kaolin by placing it on a "mound" above at least a part of the scouring sands of the Wilcox which did erode much of the old surface of the Midway.

Of course, the most conclusive evidence was obtained by means of the 10 holes drilled along the sides of the fault as far

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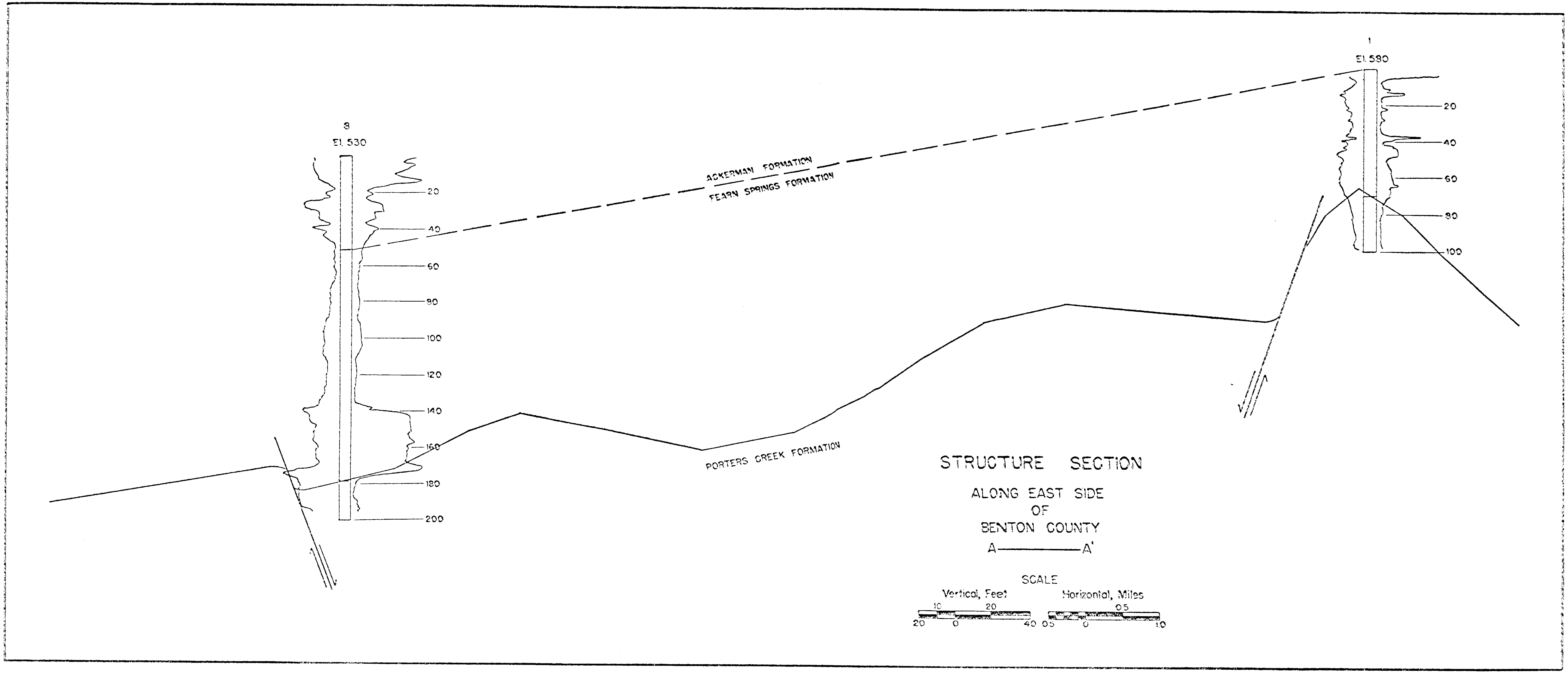
* Unusually thick deposit of kaolin is used as a relative comparison of other areas in Mississippi along this same geologic horizon.



STRUCTURE SECTION

ALONG EAST SIDE
OF
BENTON COUNTY
A——A'

west as the Tippah River. It should be made clear that to the knowledge of the writer none of the holes cut the fault, so the exact location of the fault is not known. However, the fault is confined within limits narrow enough to make it useful.

The direction of flow of Oaklimeter Creek is also indicative of the fault. The creek heads a little north of Flat Rock Church and flows southwest for a distance of 6.5 miles and abruptly turns a little north of west for 7.0 miles to the Tippah River. For the first 3.0 miles of its course, the creek and the SW-NE fault trace coincide; the 7.0 miles of the creek, that flows slightly north of west, parallels the fault trace that trends N. 75° W. In this direction the creek and the fault are about 3.0 miles apart.

The structure section (Plate 3) clearly shows the domal type structure of the Flat Rock Church area. The structure section follows a north-south line along the eastern part of Benton County across both faults and the apex of the dome. The electric logs of holes 1 and 8 were made by a Widco Logger. Hole 1 was started in the Fearn Springs formation, therefore, the actual top of the Fearn Springs is not represented. The Ackerman formation crops out in a road cut (Figure 7) a few feet above the top of hole 1 indicating that a negligible thickness of Fearn Springs is missing. Also the lower 15 to 20 feet of the Fearn Springs section in hole 1 rightfully belongs to the underlying Midway (Betheden formation). The two electric logs (Plate 3) are typical examples, demonstrating that electrical correlation of the Wilcox sediments in this area is certainly not practical.

Any oil or gas production in Benton County would almost certainly have to come from the Paleozoic rocks, which are not at the surface any place in the county. Such a condition makes surface prospecting hazardous and deceptive. Because of the great lapse of time between the deposition of the much older Paleozoic formations and the deposition of the overlying younger formations, any structural disturbance occurring in the Paleozoic prior to subsequent deposition would probably not be reflected in the overlying beds at all — a condition now known to exist in other areas of the State. On the other hand a structure that does show at the surface could logically be expected to have originated from a deep seated source, thereby being reflected in the underlying Paleozoic formations. In other words, the absence of a surface structure by no means condemns the area as being void of favorable structures for the accumulation of oil and gas. Such buried structures will have to be located by methods other than surface geology. A few examples are Gravity Meter, Magnetometer, Seismograph, core drilling, or the so called direct methods which are soil analyses for radioactivity and Scintillometer surveys.

Predicting the depth to the top of the Paleozoic by means of projection and dip rate is very uncertain. Knowledge of existing wells have shown this to be true. However, since well data comprise all the information available it becomes necessary to make the best of them. There have been no deep holes drilled in Benton County. Probably the most reliable well to base an estimate on would be the No. 1 Martindale in northern Tippah County (SE.¼, Sec.27, T.1 S., R.3 E.), which topped the Paleozoic at 1,435 feet. The elevation of the well was 615 feet D.F.[34] A well located at what is believed to be the highest structural point of the Flat Rock Church structure and also far enough southeast of the fault so as not to cross the fault (C.NW.¼, NW.¼, Sec.16, T.5 S., R.2 E.) would be practically along the strike from the No. 1 Martindale well. The elevation of the proposed location at Flat Rock Church is approximately 540 feet G.L. Therefore, the top of the Paleozoic should be at a depth of about 1,200 to 1,400 feet.

The northeastern part of the county has promise of being an area of structural disturbance (Plate 2). The possible existence of a small fault with the fault trace trending NW-SE is indicated by the broad flat area on the downthrow side. The dip on the downthrow side is only about 22 feet to the mile as compared to the apparently normal dip on the upthrow side of about 31 feet to the mile (Plate 2). The fault, as mapped, begins in the vicinity of the SW.¼, Sec. 19, T.2 S., R.2 E. and extends southeast out of Benton County in the vicinity of the NE.¼, Sec.13, T.3 S., R.2 E., a distance of 7.3 miles. The vertical displacement of this fault is small, probably not over 50 to 60 feet. The structure, as interpreted, has no closure on the mapping horizon — the top of the Porters Creek formation. However, if this interpretation is correct, the area is worthy of subsurface exploration in search of information on the underlying Paleozoic formations.

WATER

As stated previously, the sand formations are very important to the present and future prosperity of a large part of the state. Down dip to the west and southwest these sands that crop out in Benton County serve as excellent aquifers. The porosity provides ample reservoir space for catching the would be surface run-off, and the permeability allows the percolation of the water to the down dip areas.

Most of the domestic supplies in the east half of the county are obtained from the Fearn Springs and Ackerman formations. Wells in this area range in depth from about 30 to 170 feet. It is doubtful if either of these formations would supply really large quantities of water. For the most part, the sands are fine to medium and silty and are only locally developed. However, large quantities could probably be obtained considerably deeper from the Ripley formation which is subjacent to the Midway.

The domestic supplies in the west half of the county are mostly obtained from shallow wells in the Meridian and Tallahatta formations. These wells range in depth from 30 to 100 feet. It would be reasonable to expect the Meridian formation to provide rather large supplies in the vicinity of the western border of the county. Here it is overlain by the Tallahatta formation and at high elevations the Kosciusko formation. The depth to the Meridian varies widely, depending on many factors such as elevation and location. Inasmuch as the normal dip is generally to the west, the formation would be expected to be deeper in a westward direction. However, differences in elevation might add to or subtract from the depth to the formation obtained by projection and dip rate. For example, suppose the Meridian is exposed at the surface at an elevation of 500 feet. Five miles west, a well is to be drilled and the elevation of the well site is 550 feet. Figuring the dip of the formation at the rate of 20 feet to the mile, it then follows that in a distance of five miles the formation would be 100 feet lower or at an elevation of 400 feet. By subtracting this elevation from the elevation of the ground at the well site, the approximate depth of the well of 150 feet is obtained.

Many of the wells drilled in the Tippah River Valley flow freely. Practically all of these wells are completed in the Ripley formation.

The water supply at Ashland is obtained from two 6-inch wells, each about 160 to 170 feet deep. No exact information was available. The water level reportedly stands at 140 feet.[35] Numerous privately owned wells in and around Ashland are about the same depth as the town wells.

Hickory Flat gets its water supply from three wells owned and operated by Frank Hall.[36] Two are 4-inch wells. One of

Figure 26.—Iron concretions (NE.¼, Sec.17, T.5 S., R.2 E.) in a ditch near the old mine pits about 1 mile west of Flat Rock Church. Photograph by F. E. Vestal, April 8, 1953.

these is 615 feet deep with the water level 62 feet below the surface and the other is 598 feet deep with the water level 30 feet below the surface. The third well is a 5-inch well at a depth of 612 feet with the water level at 10 feet. Only two of the wells are used at one time and the other well is kept as a standby. Very likely they are completed in the Ripley formation. According to Mr. Hall any one of these wells could supply the present needs of Hickory Flat. The town is in the valley of Oaklimeter Creek, which explains the very high water level in the wells.

Springs are used to some extent as a source of domestic supply. This applies more to the southern and western parts of the county.

IRON ORE

The iron ore of Benton County is in the upper part of the Porters Creek formation and in the Ackerman formation. The surface ore in the Porters Creek is necessarily limited to a small area, due to the fact that the formation crops out only along the southeastern border of the county. The ore in the Ackerman is scattered over a belt 4 to 5 miles wide which extends from the extreme southwestern corner of the county in a northeasterly direction to Wolf River.

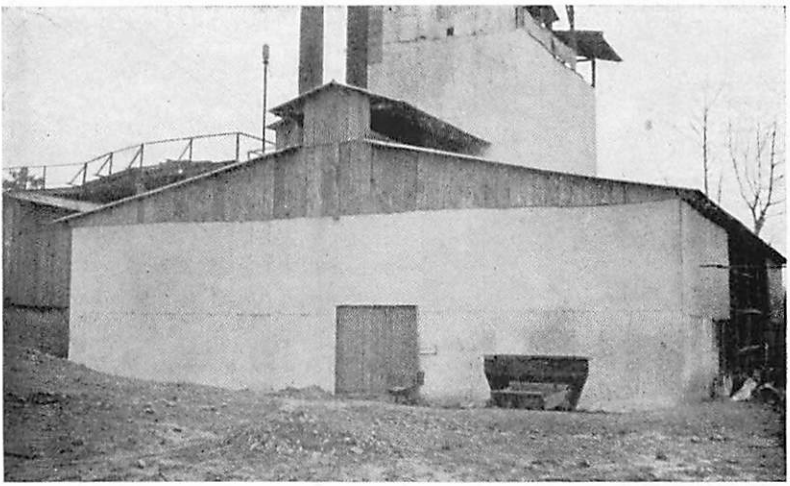


Figure 27.—Hot Blast Charcoal Furnace of the Memphis Mining and Manufacturing Company, formerly located at Winborn. Photograph from Mississippi State Geol. Survey Bull. 12.

For the most part the ore is in the form of concretionary masses rather than in continuous beds. Where the ore is fresh, it is a light-gray iron carbonate (siderite, $FeCO_3$), and where it has been exposed to the elements, the ore is oxidized to a yellow and brown limonite ($2Fe_2O_3 \cdot 3H_2O$) or to a lesser extent to a red hematite (Fe_2O_3). Normally the centers of the larger concretions that are on outcrop, remain unoxidized, in their original state as siderite. The concretions vary in size from a few inches in diameter to a foot or two thick and several feet across (Figure 26).

Iron ore in Benton County is no new discovery. As early as 1913, Lowe[37] reported on the ore of this area as well as other areas. Shortly following Lowe's report in 1913, the Memphis

Mining and Manufacturing Company erected a hot blast charcoal furnace at Winborn for the purpose of processing the iron ore (Figure 27).[38] Unfortunately this enterprise lasted only a short time. A total of 125 tons of pig iron was made (Figure 28).[39]

Figure 28.—Pig iron (125 tons) smelted by the furnace at Winborn. Photograph from Mississippi State Geol. Survey Bull. 12.

The only other utilization of the ore was by the Mepham Paint Company of East St. Louis, Illinois. They opened a pit about 0.5 mile southwest of Flat Rock Church (NE.¼, Sec.17, T.5 S., R.2 E.). This company wanted only the siderite, inasmuch as they were using it as a paint pigment. They did not need continuous shipments, therefore, the mining operation was sporadic. No ore has been mined for this or any other purpose for the past 20 to 25 years. Probably most, if not all of the ore mined near Flat Rock Church was in the Porters Creek formation.

Lowe[40] refers to a deposit of carbonate ore on the J. Q. Hunter property in the Flat Rock Church area as being in the floor of an east ditch and a west ditch with flat low lands between, located in Sec.16, T.5 S., R.2 E. This deposit is described sufficiently to enable the location to be further narrowed as being in the NW.¼, NW.¼, Sec.16, T.5 S., R.2 E. The analysis[41] of the ore from this bed is:

CARBONATE ORE FROM J. Q. HUNTER PROPERTY

	Before Calcination	After Calcination
Fe	41.14	59.93
Mn	4.68	6.47
P	0.11	0.15
S	0.07	0.07
SiO_2	5.15	7.12
Al	0.79	1.09
Insoluble	0.75	1.03
CO_2	33.90	

The ore found in the hills of the south valley wall of Oaklimeter Creek southwest and west of Hickory Flat is in the clays of the Ackerman formation. Probably the most favorable area in this vicinity is the S.½, S.½, Sec.30, and the N.½, Sec.31, T.5 S., R.1 E. In years past, it was prospected rather thoroughly as stated by Lowe,[42] ". . . in recent prospecting by the Memphis Mining & Manufacturing Company, the bed has been laid bare. While ore occurs in large kidney concretions or blocks weighing 1,000 to 2,000 pounds, the laying bare of the ledge shows that they have a remarkable tendency to coalesce so as to form almost continuous beds. This outcrop is in S.30, T.5, R.1 E. The ore is twelve to fourteen inches thick and of good quality. The bed passes from the point of the hill where exposed back under the ridge, underlying about thirty acres to a depth of ten to fifteen feet." This area is also within about one mile of the railroad and there is a good gravel road to the railroad. The analysis[43] of the carbonate ore and the oxide ore is:

CARBONATE ORE FROM MOREHEAD PROPERTY

Fe	50.49	(Calcined 66.6)
Al	3.29	
Mn	10.21	
S	0.52	
P	0.30	
CO_2	25.12	
SiO_2	5.28	
O and H_2O	4.11	
Insoluble	5.06	

OXIDE ORE FROM MOREHEAD PROPERTY

Fe	56.61
Al	13.02
Mn	10.89
S	1.06
P	0.072
CO_2	1.18
SiO_2	10.29
O and H_2O	1.21
Insoluble	5.57

Figure 29.—Iron ore concretion in road ditch (NW.¼, NW.¼, Sec.12, T.5 S., R.1 W.) about 2.5 miles north of Winborn. June 4, 1956.

About 2.5 miles due north of Winborn (NW.¼, Sec.11, T.5 S., R.1 W.) in a road cut outcrop, there appear to be two zones of ore that show on the southeast side of the ridge. On the northwest side, two zones crop out, one of which is about 12 inches thick (Figure 29). Should the ore prove to underlie the ridge, the area would be favorable for strip mining. The overburden would be about 20 to 40 feet over 150 to 200 acres. All the ore is well above drainage and the overburden is unconsolidated sand and clay. The nearest railroad is at Winborn which is about 3 miles by gravel road. Potts Camp is only about 3.5 miles southwest by a gravel road that is presently being improved for possible hard surfacing in the near future.

The stratigraphic section (NE.¼, SE.¼, Sec.30, T.4 S., R.1 E.) of the south valley wall of Chilli Creek given in the discussion of the Ackerman formation includes three zones of ore, each about 6 inches thick on outcrop. On the other side of this ridge, (SW.¼, SE.¼, Sec.30, T.4 S., R.1 E.) the exposure along the

Figure 30.—Iron ore bed about 8 to 10 inches thick (SW.¼, NW.¼, Sec.10, T.4 S., R.1 E.) in Highway 5 cut about 1 mile north of Tippah River. Nov. 2, 1956.

road also shows one or two iron ore zones. Even though the outcrop thickness of the ore is not impressive, this location is mentioned because it is considered to be favorable for further exploration. The writer believes that drilling is the proper method to use to adequately evaluate this as well as the other areas described. The details of how such a drilling program should be conducted are treated later in the bulletin.

On the northwest side of Tippah River in the valley wall near the confluence of Wagner Creek and Tippah River (NE.¼, SW.¼, Sec.19, T.4 S., R.1 E.) in a road cut, are two or three well developed zones of ore. The beds are about 6 to 12 inches thick.

This area is also considered favorable for further exploration.

A continuous bed of iron ore (Figure 30) about 8 to 10 inches thick is exposed for a distance of 100 to 150 feet along the east side of Highway 5 (NW.¼, Sec.10, T.4 S., R.1 E.) about 1 mile north of Tippah River. This was the only ore zone observed at this location, but the hills extending up from the outcrop to the east are considered favorable for the formation of additional zones.

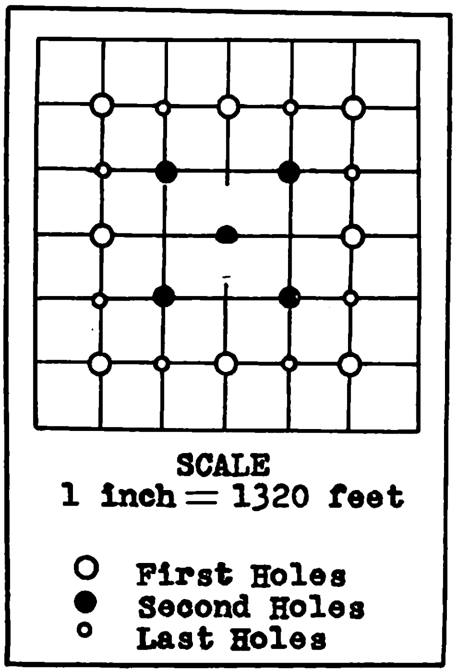


Figure 31.—Diagram of systematic drilling procedure for evaluating iron ore properties.

Probably the most promising area is in the south valley wall of Wolf River (SW.¼, Sec.21, T.2 S., R.2 E.). The outcrop is along an abandoned road that once crossed Wolf River. Between the elevations of 480 to 510 feet, possibly six layers of ore crop out. The layers range in thickness from 6 to 12 inches. The overburden would be light (20 to 30 feet) over an area of about 80 acres.

Prospecting and evaluating the concretionary type iron ore is not an easy task. With the ore being in masses of widely varying sizes, estimating tonnage is very difficult. However, the writer believes that the best and most economical method of estimating the tonnage is by drilling. Several steps are necessary for such a project. As an example a 160-acre block with known outcrops of ore will be used. First the block should be gridded by north-south and east-west lines evenly spaced. The recommended grid spacing is 440 feet (Figure 31). Next, the limits of the ore field should be determined. This can be done by drilling holes 880 feet apart around the block as illustrated in Figure 31. Assuming the whole block is found productive, it would then be necessary to drill the second group of holes. One is located at the center and the others are at the intersections of the grid lines around the center. The holes around the center are also 880 feet apart. If the zones of ore prove to be rather uniform and persistent, the last group of holes may not be essential. However, such a condition would not be expected, and the last group of holes would likely be needed. These would place nearly all the holes on 440-foot centers, which is not at all too close. It is understood that topographic conditions might cause the need for alterations in any systematic drilling program. The foregoing outline should enable any competent geologist to determine the number of ore beds present and a good approximation of the persistency of each. Also available from the logs of the holes would be sufficient data to arrive at an excellent overburden estimate. Inasmuch as the siderite ore cores very easily, a few spot cores could be taken for analyses.

BAUXITE

Bauxite in Mississippi was first brought to the attention of the public in 1923.[44] This investigation was very throughly done, at least so far as Benton County is concerned, because no new deposits of any importance have been found since.

Inasmuch as one of the main deposits, McGill and Tapp properties[45] (SE.¼, Sec.1, and NE.¼, Sec.12, T.3 S., R.2 E.), that was previously investigated, is in Benton County, the results will be repeated for convenience. The investigation consisted of digging two trenches and one test pit on the McGill property in Sections 1 and 12 and one test pit on the Tapp property in Section 12, and of studying numerous outcrops. As stated by Morse[46] ". . . the top of the bauxite ranges from about 422 to 432 feet and the composition of the ore from 31 to 42 per cent." According to up-to-date elevations,[47] the elevations quoted above are approximately 70 feet low. Several outcrops are still visible, but the old test pits are nearly filled and the trenches are now only slight scars that are grown over with vegetation. The following sections, analyses, and estimates were reported by Morse.[48]

"SECTION OF H. A. McGILL TRENCH No. 1

	Feet
Wilcox	
6. Sandstone, nodular iron	1.5
5. Bauxite, soft, mottled, iron-stained. Sample No. 5	4.0
4. Bauxite; two layers of hard red pisolitic ore. Sample No. 6	4.0
3. Bauxite, soft white, containing small red lenses of ore. Sample No. 7	4.2
2. Bauxite, soft white clayey. Sample No. 8	2.7
Water level	
1. Soft clay shale filled with mica and plant remains	0.3

"ANALYSES OF SAMPLES FROM H. A. McGILL TRENCH No. 1

	S-5	S-6	S-7	S-8
Aluminum oxide (Al_2O_3)	34.57	34.18	38.00	41.61
Ferric oxide (Fe_2O_3)	7.33	16.62	10.60	1.49
Silicon dioxide (SiO_2)	41.80	31.28	28.88	38.56
Titanium dioxide (TiO_2)	1.60	1.60	1.60	1.60
Loss on ignition	12.32	14.70	15.22	15.55
Non-volatile with HF	3.08	1.40	0.28	1.70
Moisture	0.65	1.65	6.77	0.52
	101.35	101.43	101.35	101.03

"SECTION OF H. A. McGILL TEST PIT No. 1

	Feet
9. Soil and subsoil	1.7
Wilcox	
8. Sandstone, nodular ferruginous	0.8
7. Bauxitic clay. Sample No. 12	2.0
6. Sandstone, nodular ferruginous	1.5
5. Bauxitic clay grading into bauxite at the base. Sample No. 13	3.0
4. Bauxite, hard, containing considerable iron. Some of it is green in color. Sample No. 14	3.0
3. Clay, yellow; black markings	1.2
2. Sandstone, white, ferrous	0.8
1. Clay, yellow; black markings	2.5

"ANALYSES OF SAMPLES FROM H. A. MCGILL TEST PIT NO. 1

	S-12	S-13	S-14
Aluminum oxide (Al_2O_3)	29.64	32.45	29.60
Ferric oxide (Fe_2O_3)	9.06	10.05	32.00
Silicon dioxide (SiO_2)	39.30	33.88	14.80
Titanium dioxide (TiO_2)	0.60	0.70	0.80
Loss on ignition	11.00	12.66	15.90
Non-volatile with HF	8.54	3.92	1.60
Moisture	2.54	6.84	5.33
	100.68	100.50	100.03

"TONNAGE OF MCGILL AND TAPP PROPERTIES

H. A. MCGILL		
Ore, Al_2O_3	31 per cent	405,333 tons
Ore, Al_2O_3	34-42 per cent	140,000 tons
Total		545,333 tons
J. W. TAPP		
Ore, Al_2O_3	34-42 per cent	190,000 tons"

The McGill property is now owned by Billy Hyman and the Tapp property is now owned by the Rooker Brothers.

The only other areas that deserve note are in the southeastern corner of the county — 1) Flat Rock Church area, and 2) L. V. Fowler estate. At each place, bauxite is now known only in relatively small amounts. Chemical analyses of samples from each area were made at the Mississippi State Chemical Laboratory by the late State Chemist, W. F. Hand.

FLAT ROCK CHURCH AREA

(AT OR NEAR NE.¼, SEC.17, T.5 S., R.2 E.)

Aluminum oxide	29.43
Silica	57.57
Iron oxide	1.19
Titanium oxide	1.64
Phosphoric acid	0.018
Organic and volatile matter	10.17
	100.018

L. V. FOWLER ESTATE

(AT OR NEAR SW.¼, SEC.29, T.5 S., R.2 E.)

Aluminum oxide	34.07
Silica	37.44
Iron oxide	13.34
Titanium oxide	1.77
Phosphoric acid	0.018
Organic and volatile matter	13.92
	100.558

Both the Flat Rock Church area and Fowler area are more prominently noted for deposits of kaolin than the bauxite, which is plainly low grade.

CLAYS

KAOLIN

The kaolin of Benton County has properties sufficiently high to attract much more attention than it has in the past. To the knowledge of the writer, neither has it been used commercially nor have any attempts been made to use it commercially. The kaolin is not in the same category as the bauxite which is known and accepted as a low grade ore. As a matter of fact, much of the kaolin is exceedingly pure as stated by McCutcheon.[40] "The typical clays are of such purity in their natural state that it is well worth while that they be washed, as such beneficiation would place them in a rank equal to the better grades of domestic and foreign kaolins." He states further that ". . . when washed free of the small amounts of impurities they would be especially suitable for compounding into bodies of ceramic white ware which includes electrical, chemical, and table porcelain, hotel china and dinner ware, ceramic floor and wall tile, dust pressed wall tile, pottery shapes and art ware. They are well suited for use in compounding glazes and enamels. For non-ceramic purposes, they are suited for use as a filler in paper, rubber, oil cloth and linoleum, and as a pigment for paint." It is hoped that the foregoing statements by a qualified Ceramic Engineer will serve to show the potentialities of these clays.

The kaolin is along the same stratigraphic horizon as the bauxite, which is at the top of the Midway in the Betheden formation. It is most likely a residual deposit, originating by weathering of the long exposed surface of the Porters Creek formation. In view of the massive structure of some of the kaolin, it seems unlikely that it is a primary sedimentary deposit, which normally would show some evidence of bedding. It is true that some bauxite and kaolin has been found bedded in sand, but this is apparently material that has been reworked into the base of the Wilcox.

There are two areas of seemingly economic importance — 1) Flat Rock Church area and, 2) L. V. Fowler area. Both of these are in the southeastern corner of the county. Considerable work has been done on these areas in the past by the Mississippi State Geological Survey and the U. S. Bureau of Mines. The investigations of the Mississippi State Geological Survey have been published, but to the knowledge of the writer the investigations[50] of the U. S. Bureau of Mines, which are on file with the Mississippi Survey, have not been published. Inasmuch as this is either included in bulletins covering other counties or not available at all to the public, selected data have been compiled herewith for the convenience of interested parties.

The Flat Rock Church area, which has already been mentioned in connection with oil and gas possibilities, iron ore, and bauxite, also has a sizable deposit of kaolin. Probably the best exposure is in the bed of a small stream ditch (NW.¼, Sec.16, T.5 S., R.2 E.) that shows 6 to 8 feet of very white clay (Figure 3). The following chemical analysis by the Mississippi State Chemical Laboratory indicates that at least part of the clay section is exceedingly free from impurities.

KAOLIN FROM STREAM DITCH NEAR FLAT ROCK CHURCH
(NE.¼, SEC.16, T.5 S., R.2 E.)

Aluminum oxide (Al_2O_3)	39.70
Silica (SiO_2)	45.31
Iron oxide (Fe_2O_3)	0.70
Ignition loss	13.32
Moisture	1.00
Total	100.03

Logs of several of the auger holes drilled in the area during the survey of Tippah County,[51] and records of some of the laboratory tests follow.

"SALVATION ARMY PROPERTY
TEST HOLE A 8

Location: T.5 S., R.2 E., Sec.16, NW.¼ (Benton County), in a stream ditch where white clay is exposed, about 350 yds. west of the road from a point in front of the S. W. Jackson house, and 550 yds. west southwest of Flat Rock Church. Drilled: July 28-29, 1938
Elevation: About 110 ft. below Flat Rock Church
Water level: 10 ft. (seep)

No.	Depth	Thick.	Description of strata and designations of samples
			Midway
1	4.6	4.6	Clay, white plastic; free from grit; between 3.0 and 4.6 grades into next lower clay; P 1
2	9.0	4.4	Clay, yellow; white streaks and lignitic streaks; P 2

3	10.0	1.0	Clay, yellow; light-blue streaks; P 3
4	17.0	7.0	Clay, light-blue; a few yellow streaks down to 12.6; at 11.0 thin layer of sand rock about 1 inch thick; at 13.0 layer of yellow sand rock probably 2 or 3 inches thick; below 13.0 increasingly silty and somewhat micaceous; P 4
5	19.0	2.0	Clay, dark-blue; believed at time of drilling to be Porters Creek clay, but, on basis of ceramic properties, probably a pottery clay; P 5

Remarks: Top of this hole in bottom of ditch at top of clay layer, and at base of overlying 3.6-foot layer of flood plain alluvium."

"J. M. Gunter Property

Test Hole A 168

Location: T.5 S., R.2 E., Sec.9, near E. edge of SW.¼ of NW.¼ (Benton County), in middle of pasture about 137 yds. northeast of hole A 200

Drilled: Aug. 10, 1938

Elevation: 14 ft. above A 200

Water level: 23.6 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	2.5	2.5	Soil and subsoil, red
2	4.0	1.5	Clay, bluish-white; red streaks
3	6.5	2.5	Clay, white plastic slightly silty; C 1
4	8.0	1.5	Clay, red sandy
5	10.2	2.2	Sand, white coarse rocky
6	14.0	3.8	Sand, rocky
7	17.0	3.0	Sand, gray
			Midway
8	22.0	5.0	Clay, white; some silt; slight change at 19.0 to streaks of brown; C 2
9	28.6	6.6	Clay, yellow plastic slightly arenaceous; gradual change to next lower sand; C 3
10	30.6	2.0	Sand, gray; yellow streaks"

"J. M. Gunter Property

Test Hole A 200

Location: T.5 S., R.2 E., Sec.9, SW.¼ of NW.¼ (Benton County), about 200 yds. northwest of the Gunter House Drilled: Aug. 10-11, 1938

Elevation: 14 ft. below house and about 25 ft. below A 8

Water level: 20.5 ft.

No.	Depth	Thick.	Description of strata and designations of samples
			Recent colluvium
1	3.0	3.0	Soil and subsoil, yellow
2	5.9	2.9	Sand, yellow argillaceous

			Midway
3	15.9	10.0	Clay, white; very little silt; P 1
4	17.0	1.1	Clay, yellow and blue, silty; P 2
5	19.6	2.6	Clay, white; streaks of lignite; P 3
6	21.8	2.2	Clay, yellow rocky; P 4
7	25.6	3.8	Clay, blue silty plastic; smaller sample because of rock which would not be penetrated by 9-inch auger but was pentrated by 4-inch auger; C 1
8	26.2	0.6	Clay, dark-blue highly silty micaceous; C 2

Remarks: 0 to 8.0 ft. was a 9-inch auger hole on hill above creek bank where clay is exposed. 8.0-14.0 ft. taken from trench on creek bank; 14.0-15.9 ft. from 9-inch hole at foot of trench; 15.9-21.8 ft. from 9-inch hole on creek bank; 21.8-26.2 ft. from 4-inch hole in bottom of 9-inch hole."

"JIM HILL PROPERTY

TEST HOLE A 201

Location: T.5 S., R.2 E., Sec.9, SE.¼ of NW.¼ (Benton County), about 200 yds. N.30° E. of the Gunter house, 72 ft. north of outcrop of white clay in stream ditch. Drilled: Aug. 25, 1938

Elevation: 8 ft. above outcrop of white clay

Water level: no water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	4.0	4.0	Soil and subsoil, clay and sand, red and gray
2	5.9	1.9	Clay, gray and yellow very silty semi-plastic
3	8.8	2.9	Clay, gray and yellow arenaceous plastic; a few lignitic streaks
			Midway
4	12.5	3.7	Clay, white plastic; very little silt; no mica; C 1
5	14.0	1.5	Clay, white; very little silt; yellow streaks; no mica; a few lignitic streaks; C 2
6	14.9	0.9	Clay, mottled gray and yellow; a few small rocks, probably iron carbonate rocks; C 3
7	15.3	0.4	Rock, ferruginous; probably iron carbonate
8	16.2	0.9	Clay, yellowish-gray plastic very silty; a few small ferruginous rocks; hole closed on a rock"

"SCREEN ANALYSES

HOLE A 8 SAMPLE 0.0 - 3.0 FT.

Retained on screen	Percent	Character of residue
30	6.08	Abundance of hard kaolin; trace of limonite
60	17.91	Abundance of hard kaolin; trace of limonite

100	14.19	Abundance of hard kaolin; trace of limonite
150	3.68	Abundance of hard kaolin; trace of limonite
200	4.00	Abundance of hard kaolin; traces of limonite and muscovite
250	4.60	Abundance of hard kaolin; trace of limonite
Cloth	49.54	Clay substance including residue from above.

HOLE A 200 SAMPLE 5.9 - 15.9 FT.

Retained on screen	Percent	Character of residue
30	14.45	Abundance of hard kaolin; trace of limonite
60	14.04	Abundance of hard kaolin; trace of limonite
100	10.20	Abundance of hard kaolin; traces of quartz and limonite
150	4.66	Abundance of hard kaolin; traces of quartz and limonitic clay
200	3.95	Abundance of hard kaolin; small amount of quartz; trace of limonite
250	3.19	Abundance of hard kaolin; small amount of quartz; trace of limonite
Cloth	49.51	Clay substance including residue from above"

"CHEMICAL ANALYSES*

HOLE A 8 SAMPLE 0.0 - 3.0 FT.

Soluble salts	0.15	Titania, TiO_2	0.95
Ignition loss	13.60	Lime, CaO	0.25
Silica, SiO_2	42.62	Sulphur, SO_3	0.03
Alumina, Al_2O_3	41.87	Magnesia, MgO	0.22
Moisture, air dried	1.31	Potash, K_2O	0.02
Iron oxide, Fe_2O_3	0.48	Soda, Na_2O	0.11

HOLE A 200 SAMPLE 5.9 - 15.9 FT.

Soluble salts	0.20	Titania, TiO_2	1.63
Ignition loss	15.88	Lime, CaO	0.49
Silica, SiO_2	42.52	Sulphur, SO_3	Trace
Alumina, Al_2O_3	36.84	Magnesia, MgO	0.19
Moisture, air dried	1.42	Potash, K_2O	None
Iron oxide, Fe_2O_3	1.85	Soda, Na_2O	0.06

*Analyses of residue washed through 250 mesh screen
M. R. Livingston, Analyst"

During the course of the present survey Mississippi Geological Survey Test Hole No. 1, given in the discussion of the Porters Creek formation, penetrated 18.0 feet of white and pale green kaolin or high alumina clay. A core of this material is on file at the Mississippi Geological Survey. It is possible that the kaolin thickness in the test hole is slightly exaggerated due to the structural conditions. In other words, the bit may have drilled through a tilted bed rather than a horizontal bed. Normally the dip would be insignificant. The overburden at the hole location is 51.0 feet of clay that contains two zones of iron carbonate.

It seems reasonable and conservative to estimate that 20 to 40 acres near the center of the northwest quarter of Section 16 with an overburden of 3 to 40 feet are underlain by a 6-foot bed of practically pure kaolin, representing an aggregate of 420,000 to 840,000 short tons. The deposit in the southeast quarter of the northwest quarter of Section 9 is not nearly as extensive as in Section 16. Conant[52] states that ". . . this clay does not extend far, though it probably underlies 2 or 3 acres on the low ridge where the overburden is not over 10 or 15 feet, and may even be much more extensive." This would represent an estimate of 35,000 to 50,000 short tons.

The L. V. Fowler area (SE.¼, Sec.30, T.5 S., R.2 E.) has good possibilities for commercial kaolin. From the available records, it seems that these clays are not as well suited for the finer ceramic purposes as are the high alumina clays of the Flat Rock Church area. In comparing the clays of the two areas McCutcheon[53] says that ". . . these clays have the same stratigraphic position but in the strictest sense are not necessarily true kaolins inasmuch as a number of samples were found to contain considerable amounts of gibbsite and are consequently higher in alumina than typical kaolins." Also, it seems that much of the kaolin is highly contaminated with silt. He[54] states further that the clays ". . . are suited for the manufacture of commercial aluminum sulphate, commercial aluminum chloride and alum."

The logs of two test holes drilled during the survey of Union County[55] and some of the laboratory tests of samples from these holes follow.

"L. V. FOWLER PROPERTY

TEST HOLE D 33

Location: T.5 S., R.2 E. Sec.30, NE.¼ of SW.¼ of SE.¼ (Benton County), 157 ft. south of hole D 1 Drilled: Nov. 22-Dec. 1, 1938
Elevation: 7.5 ft. below D 1 and 13.5 ft. above bottom of stream ditch
Water level: no water

No.	Depth	Thick.	Description of strata and designations of samples
1	4.9	4.9	Soil and subsoil, grayish-yellow sand
			Midway

2	9.8	4.9	Clay, white slightly silty plastic; yellow-brown streaks; gradually becomes pisolitic commencing at 7.6; C 1
3	15.1	5.3	Clay, white somewhat pisolitic slightly silty; brown streaks; whiter and less pisolitic below 12.2; C 2
4	20.5	5.4	Clay, brown silty semi-plastic; yellowish-gray streaks; rock layers 15.1 - 15.8; sandy and more micaceous 15.8 - 18.7; few pebbles 18.7 - 20.5; C 3
5	22.9	2.4	Clay, dark-gray highly micaceous and silty; C 4

Remarks: This hole is about 5.5 ft. above top of 8-ft. outcrop about 25 ft. away; 8-inch auger used to rock layer at 15.1 and 4-inch auger below this."

Elevation: 450.8 approximately

"L. V. FOWLER PROPERTY

TEST HOLE D 257

Location: T.5 S., R.2 E., Sec.30, NW.¼ of SE.¼ (Benton County), 4 ft. west of test hole D 34 Drilled: June 3-19, 1939
Elevation: 1.8 ft. above D 34
Water level: 4 ft.

No.	Depth	Thick.	Description of strata and designation of samples
1	4.0	4.0	Soil and subsoil, red clay and sand
			Fearn Springs
2	4.8	0.8	Clay, dark-gray silty plastic; thin yellow streaks; C 1
3	7.9	3.1	Clay, light-gray silty plastic; C 2
4	11.2	3.3	Clay, light-gray; yellow sandy streaks; C 3
5	13.7	2.5	Silt, dark-gray; thin streaks of white clay; C 4
6	15.8	2.1	Silt, light-gray micaceous; streaks of white and yellow clay; darker at 15.0, still darker at 15.4; C 5
			Midway
7	16.2	0.4	Clay, gray silty plastic; small yellow streaks; C 6
8	32.5	16.3	Clay, light-gray plastic; slightly contaminated by silt from above; becomes increasingly silty and micaceous with depth, notably about 28.4; C 7
9	36.5	4.0	Clay, light-gray silty micaceous; C 8
10	37.5	1.0	Clay, dark-gray; probably Porters Creek clay; C 9

Remarks: A boxed and drained pit was dug to the top of the clay at 4 ft.; samples were taken below that with an 8-inch auger."

"SCREEN ANALYSIS

HOLE D 257 SAMPLE 16.2 - 32.5

Retained on screen	Percent	Character of residue
30	1.61	Abundance of kaolin nodules; trace of clay "ironstones."
60	6.95	Abundance of kaolin nodules; small amount of clay "ironstones"; trace of limonite
100	5.99	Abundance of kaolin nodules; considerable quantity of clay "ironstones"; small amount of muscovite.
150	2.34	Abundance of kaolin nodules; considerable quantity of muscovite; small amount of siderite.
200	3.35	Abundance of kaolin nodules; considerable quantity of muscovite; small amount of siderite.
250	1.11	Abundance of kaolin nodules; small amount of muscovite; trace of siderite.
Cloth	78.65	Clay substance including residue from above.

Alta Ray Gault, technician."

CHEMICAL ANALYSIS

HOLE D 257 SAMPLE 16.2 - 32.5

Ignition loss	15.78	Titania, TiO_2	2.18
Silica, SiO_2	36.57	Lime, CaO	0.79
Alumina, Al_2O_3	43.10	Magnesia, MgO	0.53
Sulphur, SO_3	0.16	Potash, K_2O	Trace
Iron oxide, Fe_2O_3	0.87	Soda, Na_2O	0.49

Analysis of residue washed through 250 mesh screen.
M. R. Livingston, Analyst."

There is a very good possibility of a large quantity of clay in this area. The prospecting by Conant[56] led to these statements. "A small north-flowing tributary of Oaklimeter Creek affords the best exposures, and several auger holes along its valley show a fairly persistent bed of high-alumina clay having a thickness up to 16 feet (D 33, D 34, D 257). Most of the prospecting was east of the outcrops, where some 40 acres seem to be underlain by this clay, though in some places the overburden is 50 feet thick. West of these exposures the same clay probably underlies many more acres." Assuming an average thickness of 8 feet, the estimate for the 40 acres would be approximately 1,000,000 short tons.

MISCELLANEOUS CLAYS

The clays in this group belong to the Fearn Springs and Ackerman formations. For the most part, they are classified as pottery clays and brick and tile clays.

The only clays of this type in Benton County that have been tested are in the southeastern part in the Flat Rock Church area (Parts, Secs.9, 16, T.5 S., R.2 E.). Stratigraphically these overlie the deposits of kaolin which are also common to the area; however, it is very probable that the pottery clays and brick and tile clays, are much more extensive.

Some of the test hole records and laboratory tests of previous work[57] are given in an attempt to present as nearly a complete report of the clays as practical.

"S. W. Jackson Property

Test Hole A 10

Location: T.5 S., R.2 E., near the S. edge of Sec.9 (Benton County), 200 ft. south of Flat Rock Church, in a ditch on north side of road, just below red sand beds. Drilled: June 28-30, 1938
Elevation: 20 ft. below the church
Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	9.1	9.1	Clay, white slightly silty plastic; yellow streaks; P 1
2	12.1	3.0	Clay, blue micaceous slightly silty plastic; C 1
3	25.0	12.9	Clay, light-gray micaceous slightly silty; lignitic streaks; P 2
4	26.7	1.7	Clay, yellow micaceous slightly silty plastic; gray streaks
5	30.4	3.7	Clay, gray micaceous highly silty plastic; yellow streaks
6	32.0	1.6	Clay, gray arenaceous; lignitic streaks; rock in bottom of hole"

Remarks: Elevation 600 to 610 feet

"J. M. Gunter Property

Test Hole A 178

Location: T.5 S., R.2 E., Sec.9, SE.¼ of NW.¼ (Benton County), about 50 yds. west of hole A 169. Drilled: Aug. 23-24, 1938
Elevation: 15 ft. above A 169
Water level: No water

No.	Depth	Thick.	Description of strata and designations of samples
			Wilcox
1	3.5	3.5	Soil and subsoil, red clay, and silt
2	9.0	5.5	Clay, red silty non-plastic

3	10.0	1.0	Clay, gray silty; yellow streaks
4	12.0	2.0	Clay, dark lignitic plastic; no silt; C 1
5	14.0	2.0	Clay, gray plastic slightly silty; C 2
6	17.5	3.5	Clay, gray and yellow highly silty
7	18.0	0.5	Clay, gray highly silty; hole closed on rock"

Remarks: Elevation 500 feet approximately

"SCREEN ANALYSES

HOLE A 10 SAMPLE P 1

Retained on Screen	Percent	Character of residue
30	0.65	Abundance of arenaceous nodules; small amounts of limonite, quartz, and ferruginous rock
60	1.06	Abundance of arenaceous nodules; small amounts of limonite and quartz; trace of hematite
100	0.93	Abundance of arenaceous nodules; small amount of limonite; traces of quartz, clay and hematite
150	0.54	Abundance of arenaceous nodules; small amount of limonite; traces of muscovite, kaolin, and lignite
200	1.11	Abundance of quartz and white clay; small amounts of limonite, muscovite, and gray clay
250	2.49	Abundance of quartz; small amount of muscovite; traces of limonite and white clay
Cloth	93.22	Clay substance including residue from above

HOLE A 10 SAMPLE P 2

Retained on Screen	Percent	Character of residue
30	12.03	Abundance of micaceous lignitic arenaceous clay nodules; trace of free lignite
60	10.77	Abundance of micaceous lignitic arenaceous clay nodules
100	4.98	Abundance of micaceous lignitic arenaceous clay nodules; trace of free lignite
150	2.15	Abundance of clay nodules; small amounts of free lignite and quartz; trace of muscovite
200	3.89	Abundance of gray clay nodules; small amounts of quartz, lignite, and muscovite
250	6.47	Abundance of quartz and gray clay; small amounts of muscovite and lignite
Cloth	59.61	Clay substance including residue from above"

"CHEMICAL ANALYSES*

Hole A 10		Sample P 1	
Soluble salts	0.25	Titania, TiO_2	0.55
Ignition loss	5.81	Lime, CaO	0.41
Silica, SiO_2	71.86	Sulphur, SO_3	0.08
Alumina, $A1_2O_3$	21.03	Magnesia, MgO	0.27
Moisture, air dried	1.54	Potash, K_20	0.08
Iron oxide, Fe_2O_3	0.16	Soda, Na_2O	0.31

Hole A 10		Sample P 1	
Soluble salts	0.05	Titania, TiO_2	1.25
Ignition loss	6.68	Lime, CaO	1.30
Silica, SiO_2	65.39	Sulphur, SO_3	0.03
Alumina, $A1_2O_3$	23.09	Magnesia, MgO	0.51
Moisture, air dried	1.57	Potash, K_2O	0.08
Iron oxide, Fe_2O_3	1.29	Soda, Na_2O	0.19

*Analyses of residue washed through 250 mesh screen
M. R. Livingston, analyst"

These have a very wide variety of uses. McCutcheon[58] states that the pottery clays like that sampled in A 178 ". . . crack and rupture during burning and should not be used alone in heavy ware but are the best in the group for use as flux and bond clays." In general they are suited for making stoneware, conduit, hollow facing tile, terra cotta, faience, garden pottery, and cream and buff to gray face brick.

Mississippi Geological Survey Test Hole No. 1 the log of which is in the discussion of the Porters Creek formation, may be considered a continuation of Test Hole A 10. The mouth of Test Hole No. 1 is probably not more than 10 feet below the mouth of A 10. Probably the rock that stopped A 10 was the topmost zone of iron carbonate found in No. 1. The clay that crops out in the ditch bank at the location of A 10 forms an indurated claystone zone (Figure 7), which in the past has been referred to as "Flint Clay." The outer shell of these dense boulders is normally considerably harder than the clay two or three inches inside. The Smithville Pottery, at Smithville, Monroe County, Mississippi, tested this clay several years ago and were much pleased with the results. The chemical analyses by the Mississippi State Chemical Laboratory of the clay and the claystone are:

CLAYSTONE

Loss on ignition	1.48
Silicon Dioxide, SiO_2	92.79
Aluminum Oxide, Al_2O_3	3.81
Iron Oxide, Fe_2O_3	2.01
Total	100.09

CLAY

Loss on ignition	5.34
Silicon Dioxide, SiO_2	77.17
Aluminum Oxide, Al_2O_3	15.52
Iron Oxide, Fe_2O_3	1.57
Total	99.60

From field examination, the clay appears to be the parent rock of the claystone. If this is true, the analyses indicate that the claystone is a product of weathering, resulting in the dissipation of alumina thereby concentrating the silica.

Probably the other areas that have this same claystone also have similar deposits of clay. These locations are listed in the discussion of the Ackerman formation.

SAND

The sand in Benton County is used extensively as a road metal for rural roads. As a result, they are reasonably good all weather roads. The sand, which belongs mostly to the Meridian and Tallahatta formations, contains a relatively small amount of clay, therefore, the hazard and discomfort of dust is kept at a minimum. Sand blankets nearly all of the county. This places the supply near the demand and makes road maintenance economical.

Much of the sand is suited for structural purposes. It varies in grain size from very coarse to fine. To the knowledge of the writer, none is now used commercially as a structural sand.

No sand was found that even approached a glass sand. It is stained with iron oxide to a greater or lesser extent. Also, none was found pure enough (95 per cent silica) to be classified as a glass sand.

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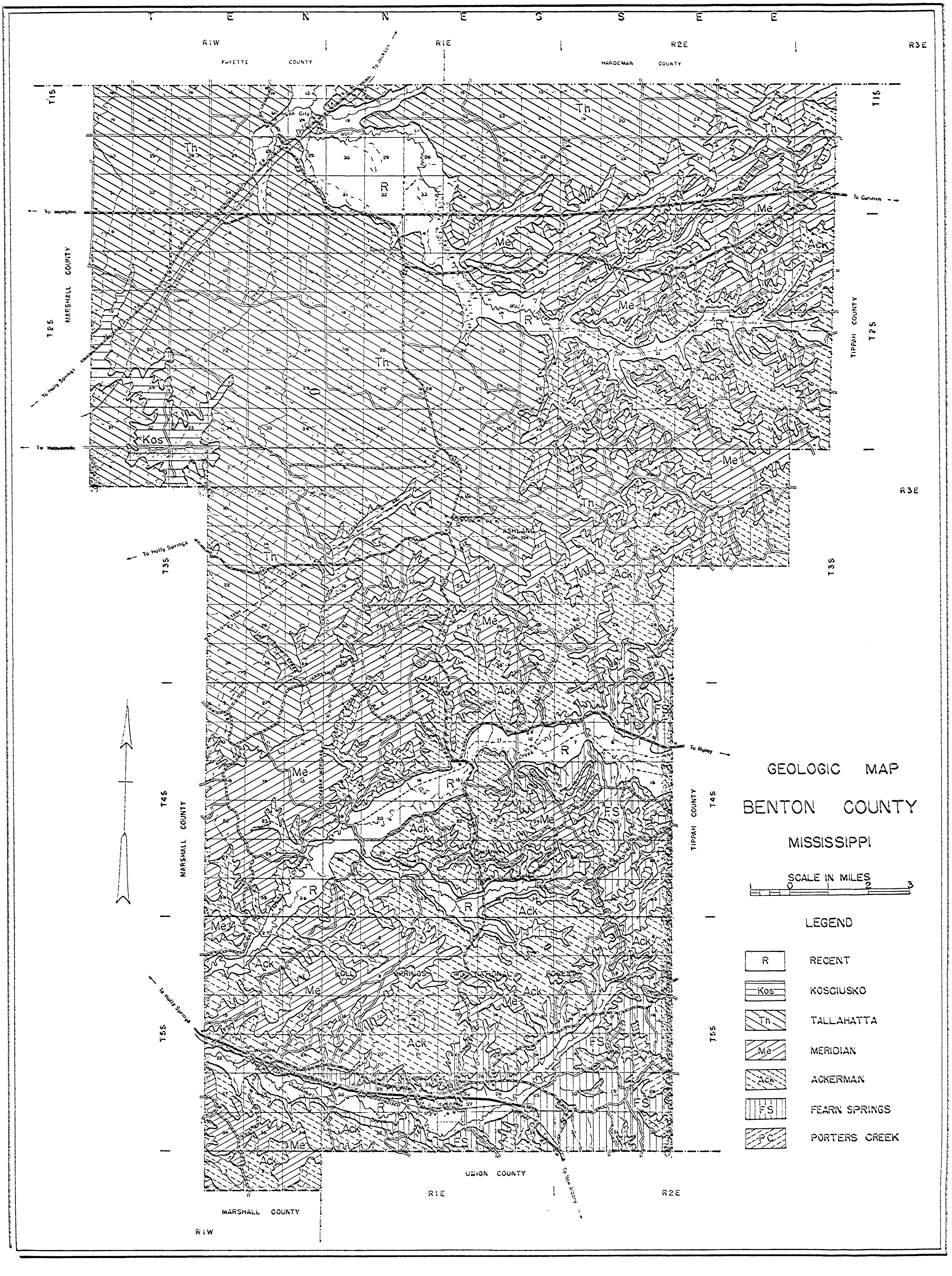
INDEX

Page

Page


T E N N E S S E E
FAYETTE COUNTY
HARDEMAN COUNTY
MARSHALL COUNTY
TIPPAH COUNTY
UNION COUNTY
R1W
R1E
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T1S
T2S
T3S
T4S
T5S
To Jackson
To Memphis
To Corinth
To Holly Springs
To Ripley
To New Albany
Michigan City
Lamar
Ashland
HOLLY SPRINGS NATIONAL FOREST
GEOLOGIC MAP
BENTON COUNTY
MISSISSIPPI
SCALE IN MILES
1 0 1 2 3
LEGEND
R RECENT
Kos KOSCIUSKO
Th TALLAHATTA
Me MERIDIAN
Ack ACKERMAN
FS FEARN SPRINGS
PC PORTERS CREEK