An Investigation of Mississippi Iron Ores

Marshall K. Kern

BULLETIN 101

MISSISSIPPI GEOLOGICAL, ECONOMIC AND TOPOGRAPHICAL SURVEY

FREDERIC FRANCIS MELLEN
DIRECTOR AND STATE GEOLOGIST

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LETTER OF TRANSMITTAL

Office of the Mississippi Geological, Economic and
Topographical Survey
Jackson, Mississippi
October 22, 1963

Mr. Henry N. Toler, Chairman, and
Members of the Board
Mississippi Geological Survey

Gentlemen:

I hand you herewith the manuscript of Bulletin 101, "An Investigation of Mississippi Iron Ores," the preparation and publication of which has been authorized by the Board.

The report was developed over a period of nearly three years. Geologist Kern made trips to the ore fields of East Texas and of Alabama for the purpose of observing techniques of sampling and estimating.

The principal value of the report is in its contributions to the geology of some of the most ferriferous deposits of Mississippi, coupled with analyses of the ores and some estimates of tonnage yields per acre in test areas. The appreciable amount of original work is a much needed supplement to the present titles on these ores. Bulletin 101 summarizes the history of small scale efforts in the production of ore and pig iron in the State. From the experience of these episodes and with a better knowledge of the geology of the ore beds, it can be expected that any future developments of iron or ore can be much more profitable than those of the past.

Mississippi's ores are present in many, many millions of tons. They are characteristically desirable in that the phosphorous and sulfur contents are usually low and the manganese content usually high. Despite these advantages, there are, as yet, unresolved economic problems, such as ore dressing, transportation, price, and competition with larger and richer ores elsewhere. Further study of these and related factors should speed the day when Mississippi will become a producer of primary metals, thus aiding in the further development and expansion of our many young and diversified metal fabricating plants.

Incidentally, the metallic manganese production by American Potash and Chemical Company at Hamilton in Monroe County, from Asiatic and African ores — commenced in 1962 — was the inspiration for our reconnaissance study of manganiferous materials in Mississippi, made a part of this title.

Respectfully submitted,

Frederic F. Mellen
Director and State Geologist

FFM:mw

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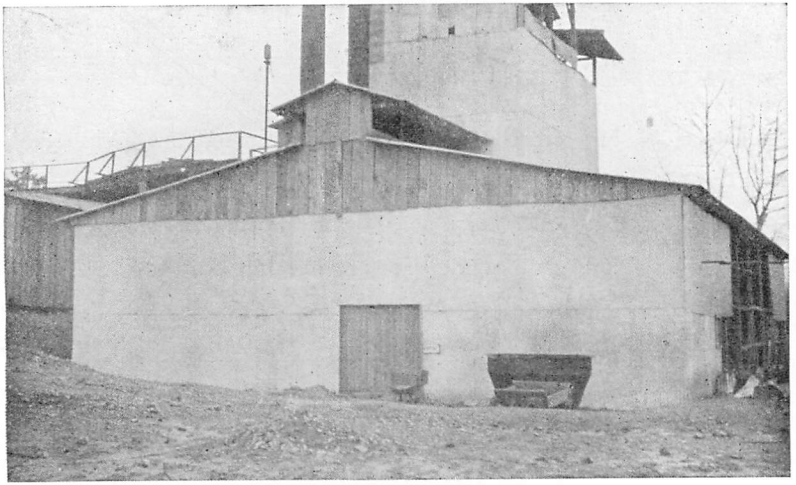

FRONTISPIECE

A. Ten-ton hot blast charcoal furnace of the Memphis Mining and Manufacturing Company, located at Winborn, Benton County. This furnace was erected to reduce the carbonate and brown oxide iron ores of the Potts Camp and Winborn areas. MGS Bull. 12, Fig. 12, 1915.

B. One hundred and twenty tons of pig iron, made by the above furnace from Benton County ore. MGS Bull. 12, Fig. 13, 1915.

In MGS Bulletin 10, A PRELIMINARY REPORT ON IRON ORES OF MISSISSIPPI, by E. N. Lowe, the work for which was done largely in 1912, but transmitted for printing February 24, 1913, references are made to Memphis Mining and Manufacturing Company's camp, prospecting and construction activities, and these are figured in Plates I and II. In MGS Bulletin 12, MISSISSIPPI, ITS GEOLOGY, GEOGRAPHY, SOILS AND MINERAL RESOURCES, by E. N. Lowe, transmitted October 23, 1915, Lowe states: "A few years ago a company prospected the territory around Potts Camp, Winborn and Hickory Flat, and found ore of sufficient quantity and grade to justify development. Accordingly, a small charcoal furnace was erected at Winborn, large quantities of ore were mined and placed at the furnace, and 125 tons of pig iron were made. For some reason the furnace then shut down, and has not been in operation since." These two reports tend to name the year of Mississippi's only smelting operation as 1913.

AN INVESTIGATION OF MISSISSIPPI IRON ORES

MARSHALL K. KERN

ABSTRACT

Iron ore of potential commercial quantity and quality is present at three geologic horizons in the area that embraces north and north-central Mississippi. In its original state the ore is found as iron carbonate ($FeCO_3$) along each of the horizons. Where exposed to oxidizing conditions in the weathering zone, the carbonate is altered to limonite ($2Fe_20_3 \cdot 3H_20$) or other hydrated iron oxides. At most places combinations of these iron minerals are found.

Several thousands of acres along these outcrop belts are favorably situated for strip mining operations. Streams and their tributaries have so dissected the surface that ore deposits may be limited to only a few tens of acres in a ridge.

Determination of ore reserves and delimitation of deposits may be satisfactorily ascertained by core drilling. However, in order to determine suitable spacing of drill holes for optimum results, additional experimental work is necessary.

Upon completion of the investigation, a two weeks' field reconnaissance study of the manganiferous "buck-shot" material in Mississippi was made as a supplement to the original objectives.

INTRODUCTION

Iron in the form of hydrated oxides is the principal coloring matter of the clays, sands, and gravels throughout the State. The colors, which range from light-yellow to orange to cherry-red and red-brown, are readily discernable in the numerous surface exposures of the geologic formations and in the freshly cultivated soils.

Further evidence of the abundance of iron is the many chalybeate springs and "mineral" wells. The waters from these springs and wells carry iron in solution and as suspended particles.

Many sand and gravel deposits have been permeated with iron-rich waters resulting in the cementation of the individual grains, thereby forming indurated ferruginous sandstones and "gravelstones" or conglomerates. Deposits of this type are exemplified by numerous exposures of ferruginous sandstones, "pipe organ" sands, and conglomerates, ranging from Cretaceous to Pleistocene in age. Although much of this material is rich in iron, it is limited in quantity to local concentrations and

contains a large percentage of impurities rendering it non-commercial under present day standards of the industry.

Concentrations of iron-rich materials are found in association with old erosional surfaces where the more soluble materials have been carried away in solution and suspension, leaving behind the less soluble and heavier hydrated oxides of iron.

Limestones and marls subjected to percolating acidic and chalybeate waters are dissolved and broken down by chemical reaction and leave iron-rich materials as residues, as precipitates and/or as replacements of other minerals. These materials are present as residua of the weathered Paleozoic, Clayton and Vicksburg limestones. Such concentrations afford ores of sufficient quantity and quality for commercial mining of the Paleozoic residuum in the Russellville District of northern Alabama and of the Clayton and the Vicksburg residua of southern Alabama. Although commercial deposits of this type have not been discovered at these geologic horizons in Mississippi, it is possible that some may exist.

The aforementioned concentrations of iron-rich materials are considered to be of a secondary origin; that is, the enrichments took place after deposition of the containing sediments.

The known deposits most worthy of immediate consideration, from a standpoint of commercial potential, are those iron-rich materials which appear to be primary in origin, primary, in that iron salts and minerals were deposited contemporaneously with the sediments prior to consolidation of the enclosing strata. The soluble iron was brought into the area of deposition in an environment of reducing conditions and deposited as siderite ($FeC0_3$). In certain instances the iron may have been precipitated as a carbonate and immediately oxidized to the hydrated oxides of iron. Environments conductive to the precipitation of siderite are such as existed during Wilcox deposition on a low, swampy plain covered with heavy vegetation; or as existed during the deposition of the Winona-Zilpha formations and the Matthews Landing marl member of the Porters Creek formation in the neritic zone just below the low tide level of the sea. In these environments the vegetable life of

the swamp and the animal and vegetable life of the sea provided an excess of carbon dioxide (CO_2) which combined with the iron in solution and formed a precipitate of siderite ($FeC0_3$).

The siderite is found near the present day surface in these formations below the zone of aeration; but, where long exposed to the oxidizing and weathering agents it has been converted to the hydrous oxides of iron such as limonite ($2Fe_20_3 \cdot 3H_20$). These primary deposits appear to be more abundant than those of secondary origin.

Table I gives the principal iron-bearing minerals found in Mississippi and their common names, chemical formulas, and percents metallic iron.

Table 1.

Composition of Principal Iron Minerals of Mississippi

Iron Mineral	Common Name	Chemical Formula	Metallic Iron (Fe) %
Hematite	Red ore	Fe_20_3	69.94
Geothite	Needle ore	$Fe_20_3 \cdot H_20$	62.80
Limonite	Brown ore	$2Fe_20_3 \cdot 3H_20$	52.09
Siderite	Spathic	$FeC0_3$	48.20
Pyrite	Fool's gold	FeS_2	46.54

PURPOSE AND SCOPE OF INVESTIGATION

It is the purpose of this study to review the previous investigations of Mississippi iron ores, to add to the existing information on ores of the Wilcox group, and to examine the more important concentrations of iron-rich materials found in the Porters Creek and Naheola formations of the Midway group and in the Winona and Zilpha formations of the Claiborne group (Figure 1).

Reconnaissance was made of the ore-bearing formations in order to determine areas for sampling. Core samples were taken in the selected areas, and chemical analyses were made of the samples to determine the iron (Fe) content.

The discontinuity of the masses of carbonate and oxide ore found in the Wilcox group adds to the difficulity of making

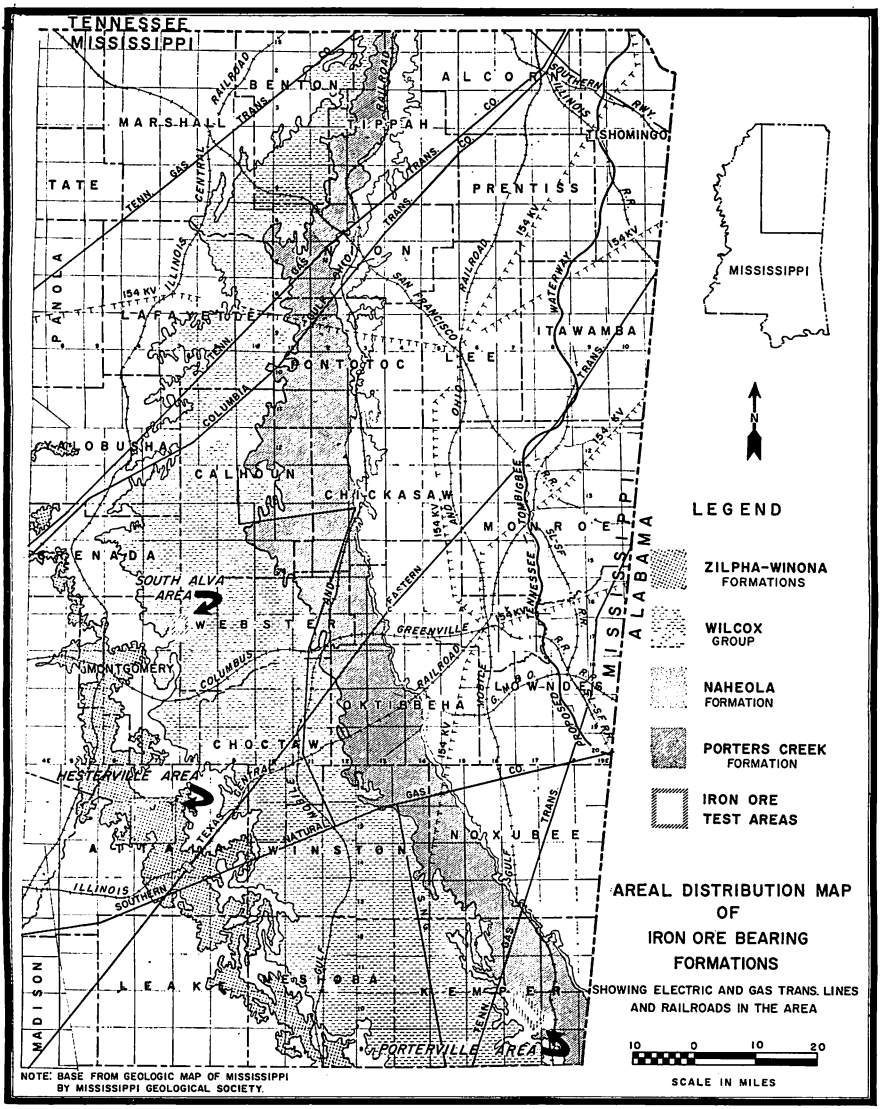

Figure 1.—Map of northeastern Mississippi showing outcrop belts, test areas, gas and electric power transmission lines, railroads and proposed Tennessee-Tombigbee Waterway.

reasonable estimates of the ore in place. In one area drilling of core holes on spacing of one-hundred feet in a grid pattern was undertaken. This is discussed under the "South Alva Area" in the section on "Wilcox ore."

It is not intended that this study should delimit specific areas that contain ore in commercial quantities.

PREVIOUS INVESTIGATIONS

Although the presence of iron-rich material was noted as early as 1854 by Wailes,[1] no investigation was made until 1912 by Lowe.[2] Lowe describes numerous outcrops of the Wilcox and Porters Creek ores in Benton, Marshall and Lafayette Counties. Chemical analyses of the ore were included in his report, indicating good quality of both oxide and carbonate of iron. Manganese is present in relatively high percentages in most samples. As to the quantity of ore present, Lowe[3] stated: "The ore beds, above drainage, outcrop so frequently on hill slopes, and have been exposed at so many places, ... that while we would not attempt an estimate of the quantity, we are safe in saying that it runs in the millions of tons."

In 1951 Vestal[4] reported on the iron ore of Webster County and the adjacent areas in eastern Montgomery and northern Choctaw Counties. He described the natural outcrops, prospect pits, and strip mines in the area. Estimates based on his observations total 16,379,826 long tons over an aggregate of only 25 square miles.

Attaya[5] in 1952 made a similar investigation of the iron ore in eastern Lafayette County. Reserves for this district were estimated to total 6,401,872 long tons.

Other workers also describe iron-rich materials observed while making mineral resources surveys of other counties in north-central Mississippi.

METHOD OF FIELD INVESTIGATION

Field work for the present investigation consisted of two phases. First, an area was visited for the purpose of observing ore outcrops, checking topographic conditions and selecting locations for core holes. Next, the drilling equipment was brought into the area and core drilling was undertaken.

A total of 92 test holes was drilled or cored. Aggregate depths came to 5,634 feet. Of the 92 test holes 74 penetrated deposits either of limonite ($2Fe_2O_3 \cdot 3H_2O$) or of siderite ($FeCO_3$) or both. Two holes were lost because of water-saturated sand.

The core barrel used for sampling was of similar design as one used by Lone Star Steel Company in East Texas (Figure 2). Three of these barrels were built in a local machine shop under the supervision of the writer.

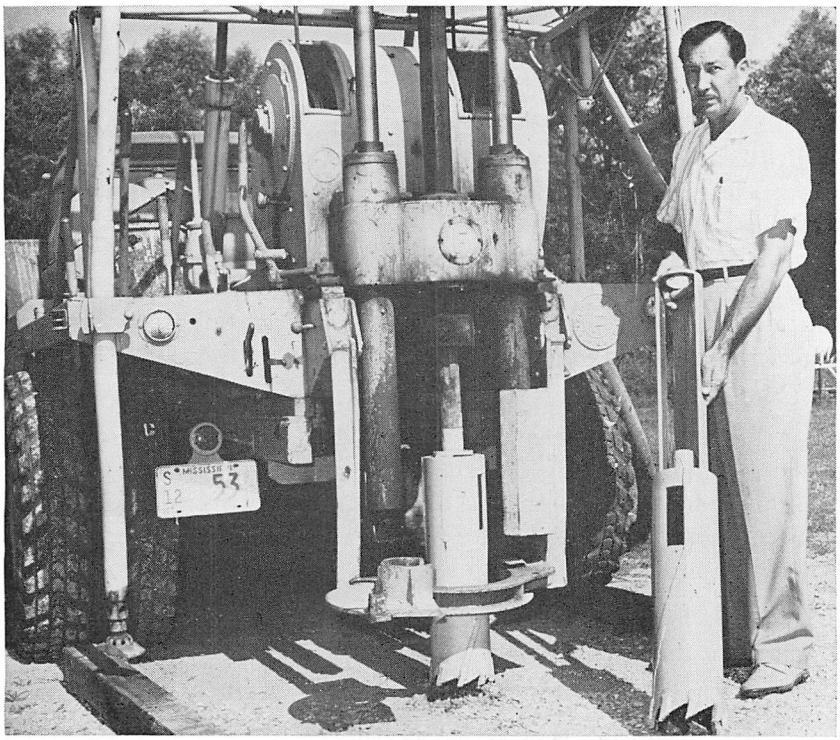

Figure 2.—Core barrels and drilling rig used in sampling iron ore. The barrel attached to the kelly is in operating position. Writer holds other barrel with extruding mechanism in raised position as when barrel is full. Photo by Perry Nations, August 1, 1963.

Seamless steel tubing six inches in diameter (O. D.), 1/4 inch thick and 24 inches long was used as the barrel. The cutting edge of the barrel consists of eight teeth cut out of the barrel at an angle of 15° on the cutting surface and 80° on the drag side. Inserts of 3/8 inch keystock steel were welded

on the cutting surface being flush, with the inside of the barrel and protruding 1/8 inch on the outside. A hard facing of tungsten carbide was floated on the keystock to render it durable.

The upper end of the barrel was closed with 1/2 inch plate steel welded inside the barrel. An external tool joint from discarded 2-3/8 inch drill pipe was welded to the top plate to connect to the rotary kelly.

An extruding plate of 1/4 inch steel slightly smaller than the inside diameter of the barrel was attached to two 1/4-inch by two-inch steel straps. These straps pass through slots on opposing sides of the top plate and attached to a ring plate above the barrel. The ring plate slides up the kelly as the extruder plate is pushed up when the barrel is filling. When the core barrel is raised from the bore hole the ring plate strikes the base of the rotary housing causing the core to be extruded from the lower end of the barrel.

On opposing sides of the barrel are windows two inches wide and six inches in vertical length. The purpose of these openings is to allow water and mud in the hole to escape above the core as it rises in the barrel. A sample about twelve to fourteen inches in length is recovered on each trip. Recovery is very good except in loose water sand.

The Survey's George E. Failing "750" truck mounted drill was used to operate the core barrel.

ORE ANALYSES

Chemical analyses were made of 73 samples from 19 core holes (Table 2). Samples were selected in the field after visual examination. Material which appeared suitable for ore was bagged and transported to the chemist. The chemist then broke the samples down to suitable size for sampling. Approximately 100 gram samples were pulverized by mortar and pestle. Analyses were made from approximately one gram of this material. Extractable iron (Fe) was obtained from filtrate after digestion in hot HC1 acid concentrate.

No attempt was made to beneficiate the ore before analyzing. Average waste to ore ratio was about six to one by visual estimates.

TABLE II

Chemical Analyses of Iron Ore

Test Hole No.	Test Hole Loc.	Elev. of Test Hole (feet)	Depth of Sample (feet)	Loss on Ignition %	Insolubles %	Silica (SiO_2) %	Total Iron (Fe) %	Remarks
		Attala County			Winona-Zilpha			
A-1	Cen.NW.1/4 NE.1/4 Sec.15, T.16 N., R.6 E.	350±	9-12	-	-	-	13.00	
A-2	NW.1/4 SW.1/4 NW.1/4 Sec.35, T.16 N., R.6 E.	360±	3-5	5.2	80.2	13.33	14.55	
			5-8	5.8	75.2	15.16	19.40	
			18-29	23.6	42.6	12.55	5.28	
A-3	SE.1/4 SE.1/4 NW.1/4 Sec.36, T.16 N., R.6 E.	400±	26-28	8.7	62.73	19.6	22.73	
			28-32	36.6	21.00	7.3	5.71	
			34-36	30.1	23.3	6.6	9.14	
A-4	NE.1/4 SW.1/4 Sec.13, T.15 N., R.6 E.	428	10-11	21.5	17.3	9.34	42.03	
			33-35	25.7	22.6	12.48	30.00	
			35-36	14.09	65.3	39.7	9.39	
			38-39	18.13	45.33	16.9	20.65	
			39-40	16.98	51.67	21.32	19.46	
			40-41	13.80	62.38	17.12	16.36	
			41-42	15.40	58.65	22.38	17.19	
			42-43	4.90	72.20	23.80	13.07	
			43-44	9.19	71.70	-	6.73	
			46-47	14.20	68.10	25.09	5.51	
			47-48	14.80	49.7	23.40	10.16	
A-5	NW.1/4 NE.1/4 SW.1/4 Sec.29, T.15 N., R.7 E.	421						No ore.
A-6								Drld.-not sampled.
A-7	SW.1/4 SW.1/4 Sec.17, T.15 N., R.7 E.	431	34-35	27.00	14.80	9.14	28.76	
			35-38	6.20	57.60	-	18.41	Claystone.
			35-38	7.50	61.47	-	18.71	
			38-44	8.04	-	42.7	26.00	Siderite matrix.
			48.5-51	7.64	43.87	21.29	31.31	

Test Hole No.	Test Hole Loc.	Elev.of Test Hole (feet)	Depth of Sample (feet)	Loss on Ignition %	Insolubles %	Silica (SiO_2) %	Total Iron (Fe) %	Remarks
		Attala County con't.			Winona-Zilpha			
A-8	Cen.E.1/2 SW.1/4 NE.1/4 Sec.17, T.15 N., R.7 E.	457	12-17	8.04	60.12	39.4	22.81	
			17-22	6.90	68.50	14.6	21.54	
			23-24	4.1	65.58	11.55	20.71	
A-9	SE.1/4 NW.1/4 Sec.16, T.15 N., R.7 E.	474	20-23	13.8	48.35	-	32.60	
			23-24	10.72	48.50	27.7	38.00	Siderite concretion.
			29-34.5	7.09	79.50	-	16.50	
A-10	NE.1/4 NE.1/4 SW.1/4 Sec.19, T.15 N., R.7 E.	422	31-32	11.1	34.3	20.20	40.80	
			35-39	8.02	37.18	-	24.65	Siderite matrix.
A-11	SW.1/4 NE.1/4 Sec.30, T.15 N., R.7 E.	428	25-25.5	23.9	14.32	7.30	45.90	Partially oxidized siderite.
			30-31	27.5	8.20	-	31.10	
			47-49.5	25.4	-	-	26.9	
			51-53	21.4	42.5	-	24.12	
			53-56	23.28	43.7	30.95	23.34	Siderite matrix
			56-58	18.33	48.1	22.15	21.68	
A-12	NE.1/4 SW.1/4 NE.1/4 Sec.31, T.15 N., R.7 E.	417	27-28	13.04	35.8	20.3	34.56	
			30.5-32	18.80	27.6	-	44.56	
			35-38	8.01	67.4	19.19	21.27	
A-13	NE.1/4 NW.1/4 SE.1/4 Sec.34, T.15 N., R.7 E.	496	-	-	-	-	-	Drld.,not sampled.
A-14	NE.1/4 NW.1/4 Sec.2, T.14 N., R.7 E.	492	27.5-32	21.5	41.5	16.8	26.9	
			45-49	19.5	44.74	-	17.8	
			52-53	27.27	19.16	11.76	38.49	
			53.5-57	8.04	85.2	-	8.4	Dark gray clay.
			53.5-57	25.1	27.1	-	35.38	Siderite concretion.
			57-59	17.8	49.2	-	21.76	

Test Hole No.	Test Hole Loc.	Elev.of Test Hole (feet)	Depth of Sample (feet)	Loss on Ignition %	Insolubles %	Silica (SiO_2) %	Total Iron (Fe) %	Remarks
		Attala County con't.			Winona-Zilpha			
A-15	SE.1/4 SE.1/4 Sec.2, T.14 N., R.7 E.	492	34-37	16.3	60.4	-	12.09	
			37-39	26.6	20.3	-	37.5	
			39-41.5	25.6	21.1	-	27.8	
A-16	NE.1/4 SE.1/4 NW.1/4 Sec.26, T.14 N., R.8 E.	-	-	-	-	-	-	Lost hole (water at 12 ft.).
A-17	SW.1/4 NW.1/4 Sec.36, T.14 N., R.8 E.	523	-	-	-	-	-	No ore.
A-18	NW.1/4 NE.1/4 Sec.13, T.13 N., R.8 E.	554	33-33.5	20.81	34.0	19.07	34.3	Siderite concretions.
A-19	W.1/2 SE.1/4 NE.1/4 Sec.26, T.13 N., R.8 E.	493	33-35	8.92	-	-	43.2	
			35-36	18.04	54.4	32.0	22.37	
			36-40	13.8	63.2	34.7	21.4	
			40-41	10.9	88.0	48.4	14.0	
			43.5-47	34.4	35.8	15.5	19.9	
A-20	NW.1/4 SW.1/4 Sec.25, T.13 N., R.8 E.	474	-	-	-	-	-	Drld., not sampled.
A-21	SW.1/4 NW.1/4 Sec.19, T.13 N., R.9 E.	551	-	-	-	-	-	Drld.,not sampled.
A-22	NW.1/4 SW.1/4 Sec.12, T.13 N., R.8 E.	529	-	-	-	-	-	Drld., not sampled.
A-23	SE.1/4 NE.1/4 Sec.3, T.13 N., R.8 E.	517	-	-	-	-	-	Drld., not sampled.
		Montgomery and Carroll Counties			Winona-Zilpha			
M-5	NE.1/4 SE.1/4 SE.1/4 Sec.7, T.18 N., R.6 E.		10.5-11	8.62	-	-	25.3	
			11-12	9.10	69.76	-	24.36	
			12-13	9.01	-	-	29.1	
			12-13	8.57	-	-	29.2	Duplicate.
			14.5-15.5	16.03	83.9	-	4.5	Glauconitic clay.
			20-21	2.77	-	38.65	7.3	Glauconitic clay.

Test Hole No.	Test Hole Loc.	Elev.of Test Hole (feet)	Depth of Sample (feet)	Loss on Ignition %	Insolubles %	Silica (SiO_2) %	Total Iron (Fe) %	Remarks
	Montgomery and Carroll Counties con't.				Winona-Zilpha			
M-6	NW.1/4 SE.1/4 SE.1/4 Sec.19, T.18 N., R.6 E.		7-8	6.7	46.3	36.03	33.65	Siderite matrix.
			7-8	7.14	63.04	41.3	22.71	Red clay matrix.
M-9	SW.1/4 SW.1/4 SW.1/4 Sec.28, T.19 N., R.6 E.		7-8	5.73	64.32	16.5	19.85	
			8-9	7.08	51.55	16.4	29.48	
M-10	SE.1/4 NE.1/4 NE.1/4 Sec.31, T.19 N., R.6 E.		8-12	7.67	50.16	13.4	30.35	
C-4	SW.cor.NE.1/4 NW.1/4 Sec.13, T.19 N., R.4 E.		14-14.5	5.14	-	-	11.5	
			19-20	19.60	41.42	-	27.6	
			20-21	22.45	10.7	-	43.7	
			22-23	6.53	60.08	33.2	27.65	
C-6	SE.1/4 NW.1/4 NW.1/4 Sec.17, T.19 N., R.5 E.		10-11	8.3	56.17	19.96	31.24	
			11-12	6.55	71.72	26.23	19.63	
			12-13	7.3	61.6	25.7	27.20	

Note: ± Elevations obtained from topographic map.
All others determined by altimeter.

Samples from Kemper and Newton Counties were weighed, broken down in the blunging action of a portable cement mixer and washed over a screen, retaining materials to approximately 1/16 inch. Retained material was weighed to determine the waste to ore ratio. No chemical analyses of these samples were made.

A summary of this information is contained in Table 3.

LOCATION AND ACCESSIBILITY

The outcrop belts of the formations which contain the iron-rich materials under study are located in the area that embraces the north and north-central portions of the State (Figure 1).

The ore of the Porters Creek and Naheola formations is best developed in central and southeastern Kemper County along the western edge of the Flatwoods physiographic belt.

Ore in the Wilcox group is best developed in Benton, Marshall, Lafayette, Webster, Montgomery and Choctaw Counties. Nevertheless, other deposits of ore exist in other counties along this belt.

The Zilpha-Winona outcrop extends from Yalobusha County through Grenada, Carroll, Montgomery, Attala, Leake, Neshoba, Newton, Lauderdale and Clarke Counties. Prominent deposits of iron-rich materials in these strata were observed in Attala County, extending from the central part southeasterly into Leake County.

Hard surfaced State and Federal highways criss-cross these Counties, and there are numerous interconnecting all-weather roads.

The Columbus and Greenville railroad and branches of the Gulf, Mobile and Ohio, the Illinois Central and the St. Louis and San Francisco lines serve these portions of the State. Perhaps 12 to 15 miles would be the greatest distance from mine to shipping point in any specific area.

Several natural gas pipelines and electric power transmission lines, which traverse the State, offer readily available sources of fuel and power.

Table III

Test Hole No.	Elev. Land Surface (feet)	Test Hole Depth (feet)	Overburden (feet)	Ore Zones Thicknesses (feet)	Analyses of Ore* Ext. Fe (Percent)	SiO_2	Remarks
	Determined by Altimeter		Attala County				Winona-Zilpha Ore
A-1	350±	32	-	-	-	-	No ore.
A-2	360±	32	-	-	-	-	No ore.
A-3	400±	36	26	2	22.73	19.6	Nodular siderite altered to limonite.
A-4	428	51	10	3	34	11.43	1 ft.zone and 2 ft.zone w/22 ft. waste between zones.
A-5	421	31	23.5	1.5	-	-	Concretions of limonite, sample not analyzed.
A-6	430	60	32.5	2	-	-	Hole drilled w/water, not sampled. Cuttings of firm siderite.
A-7	431	51	34	9.5	27.6	33.5	3 ft.waste zone not included in thickness.
A-8	457	37	9	14	21.04	25.59	Top 3 ft.ore not analyzed.
A-9	474	45	20	9	33.9	N.D.	Bottom 5 ft.ore not analyzed.
A-10	422	46	31	8	28.0	N.D.	
A-11	428	58	25	11	26.58	N.D.	22 ft.waste interspersed w/ore zones.
A-12	417	47	27	5.5	30.03	N.D.	5.5 ft.waste interspersed w/ore zones.
A-13	496	80	40	17.5	N.D.	N.D.	2 zones siderite, thickness determined by drill cuttings. Not spld.
A-14	492	62	27.5	11.5	30.15	N.D.	16 ft.waste interspersed w/ore zones.
A-15	492	45	15	11.5	32.1	N.D.	Sample of top 4 ft.ore not analyzed. 15 ft.waste between zones.
A-16	-	12	-	-	-	-	Lost hole in water sand.
A-17	523	31	13.5	1.5	-	-	Not sampled.
A-18	554	51	29	6.5	34.30	19.07	5 ft.ore not analyzed. Hole did not reach bottom of lower ore zone.

Test Hole No.	Elev. Land Surface (feet)	Test Hole Depth (feet)	Over-burden (feet)	Ore Zones Thicknesses (feet)	Analyses of Ore* Ext. Fe (Percent)	SiO_2	Remarks
	Determined by Altimeter						
A-19	493	52	33	7	27.77	N.D.	
A-20	474	90	15	14.5	N.D.	N.D.	Thickness of ore determined from drill cuttings.
A-21	551	70	32	9.5	N.D.	N.D.	Thickness of ore determined from drill cuttings.
A-22	529	62	15	5	N.D.	N.D.	
A-23	517	41	5	5	N.D.	N.D.	
			Carroll County				
C-1	N.D.	16	-	-	-	-	No ore.
C-2	N.D.	18	-	-	-	-	No ore.
C-3	N.D.	60	-	-	-	-	No ore.
C-4	N.D.	29	19	4	32.98	N.D.	1 ft.waste in zone (siderite).
C-5	N.D.	27	-	-	-	-	No ore.
C-6	N.D.	30	10	3	26.02	23.82	
C-7	N.D.	22	-	-	-	-	No ore.
			Webster County				Wilcox Ore
	(Elev. from topo.map)						
W-1	470	110	-	-	-	-	No ore. Float on hillslope 15-20 ft. below test hole elev.
W-2	480	150	6	1.0	-	-	Limonite ore, 1 bed or concretion penetrated at 6 ft.
W-3	520	150	-	-	-	-	2" siderite penetrated at 119'
W-4	415	150	8	6.0	-	-	4 layers ore w/aggregate thickness of approx. 20" exposed in road cut.

Test Hole No.	Elev. Land Surface (feet) Determined by Altimeter	Test Hole Depth (feet)	Overburden (feet)	Ore Zones Thicknesses (feet)	Analyses of Ore* Ext. Fe (Percent)	SiO_2	Remarks
			Montgomery County				Winona-Zilpha Ore
M-1	460	30	-	-	-	-	No ore.
M-2	470	12.5	-	-	-	-	No ore.
M-3		13	-	-	-	-	Drilled.
M-4		60	-	-	-	-	Drilled.
M-5		32	10.5	2.5	24.02	-	
M-6		32	7	1	33.65	36.03	
M-7		10.5	-	-	-	-	Lost hole in water sand.
M-8		18	-	-	-	-	No ore.
M-9		30	7	2	24.66	16.45	
M-10		22	8	4	30.35	13.4	
							Wilcox Ore
Mwx-1	425	100	-	-	-	-	Drilled near abandoned strip mine at Lodi. No ore.
Mwx-2	460	60	-	-	-	-	Drld. as above. No ore.
Mwx-3	432	100	6	3.25	-	-	4 beds of ore in 34 ft. zone.
Mwx-4	430	60	25	1	-	-	Float material on slopes ridge.
		Grid Pattern Test Holes					Test Hole drilled to determine thickness only (See Text).
P-1	436	70	6	.75	-	-	1 bed or concretion penetrated at 6 ft.
P-2	440	70	2.5	.5	-	-	2 beds or concretions penetrated in 10 ft.zone.
P-3	439	70	36	1.0	-	-	1 bed or concretion penetrated at 36 ft.
P-4	438	80	1	5.0	-	-	8 beds or concretions penetrated in 53 ft.zone.
P-5	430	80	5.5	1.5	-	-	1 bed penetrated at 5.5 ft.
P-6	439	80	17	0.5	-	-	1 bed penetrated at 17 ft.
P-7	446	90	21	1.4	-	-	3 beds or concretions penetrated in 22 ft.zone.
P-8	437	70	19.5	0.5	-	-	2 beds or concretions penetrated in 13 ft.zone.

Test Hole No.	Elev. Land Surface (feet) Determined by Altimeter	Test Hole Depth (feet)	Overburden (feet)	Ore Zones Thicknesses (feet)	Analyses of Ore* Ext. Fe (Percent)	Analyses of Ore* SiO_2 (Percent)	Remarks
P-9	435	80	27	2.0	-	-	Cuttings contained small amounts of limonite at depth of 27-65 ft.
P-10	434	100	-	-	-	-	No ore.
P-11	431	80	-	-	-	-	No ore.
P-12	431	70	13.5	2.5	-	-	4 beds or concretions penetrated in 45 ft.zone.
P-13	435	80	55	1.0	-	-	1 bed or concretion penetrated at 55 ft.
P-14	431	70	-	-	-	-	No ore.
P-15	427	70	-	-	-	-	No ore.
P-16	425	70	-	-	-	-	No ore.
P-17	419	60	-	-	-	-	No ore.
P-18	435	70	7.5	1.0	-	-	1 bed or concretion penetrated at 7.5 ft.
P-19	437	80		-	-	-	No ore.
P-20	440	80	31	.16	-	-	2" of ore penetrated at 31 ft.
			Benton County (Flat Rock Church)				Wilcox Ore
B-1	583	170	68	3.0	-	-	2 beds or concretions 8" & 12" thick between 68 ft.& 71 ft.
B-2	543	90	-	-	-	-	No ore.
B-3	620	150	52	.58	-	-	1 bed or concretion 7" thick at 52 ft.
B-4	551	120	20	1.0	-	-	1 bed or concretion 12" thick at 20 ft.
B-5	554	100	5.5	25.5	-	-	2 beds or concretions 18" & 13" between 5.5 ft.& 31 ft.
B-6	552	84	-	-	-	-	No ore. Located in area where ore had been mined.
B-7	560	100	-	-	-	-	No ore, possibly too low in section.
				(Winborn)			Wilcox Ore
B-8	470	230	3.5	83.0			3 beds or concretions = 12", 4" & 4" between 3.5 ft.& 85.5 ft. Ledge at 68.5 ft.had been mined on north slope of hill.

Test Hole No.	Elev. Land Surface (feet) Determined by Altimeter	Test Hole Depth (feet)	Overburden (feet)	Ore Zones Thicknesses (feet)	Analyses of Ore* Ext. Fe (Percent)	Analyses of Ore* SiO_2	Remarks
			(Winborn con't.)				Wilcox Ore
B-9	480	110	-	-	-	-	No ore.

Test Hole No.	Elev. from Topo. map	Test Hole Depth (feet)	Overburden (feet)	Gross Zone Thickness	Wgt. Spl. (pounds)	Ore Recovered** (% of Spl. Wgt.)	
		Kemper County					Porters Creek-Naheola Ore (Screened to plus 1/16 in.)
K-1	400	50	9	23	-	-	9-25 ft. siderite nodules sparse, 25-32 ft. siderite nodules concentrated. (Drld.).
K-2	372	30	1	3	55.0	17.3	Compares w/25-32 ft. in test hole K-1. (Cored).
K-3	385	40	3	7	-	-	Compares w/25-32 ft. in test hole K-1. (Drld.)
K-4	517	50	14	36	-	-	Penetrated 8 zones siderite up to 1.5 ft. thick to depth 44 ft. Bot 6 ft. of hole contained much siderite. (Drill hole).
K-5	479	15	0	15	200.2	20.7	Ore at surface. Ore zone not penetrated. (cored).
K-6	490	20	9	11	251.5	20.1	Ore zone not penetrated. (Cored).
K-7	475	50	11	34	-	-	6 concretions up to 1.5 ft. thick. Aggregate thick 5.75 ft. (Drld.)
K-8	423	50	18	1	-	-	One concretion 1 ft. thick at 18 ft. (Drld.).
K-9	510	90	16	44	-	-	6 concretions up to 2.5 ft. thick. (Drld.).

Test Hole No.	Elev. from Topo. map	Test Hole Depth (feet)	Over-burden (feet)	Gross Zone Thick-ness	Wgt. Spl. (pounds)	Ore** Recov-ered (% of Spl. Wgt.)	Remarks
		Kemper County con't.					Porters Creek-Naheola Ore
K-10	340	10	2	4	85.5	29.2	Ore at surface just below hole elevation. (Cored).
K-11	414	90	75	8	-	-	Zone crop outs in road cut 1/2 mile west of test hole. (Drld.)
		Newton County					Winona-Zilpha Ore (Screened to plus 1/16 in.)
N-1	-	25	4	11	136	13.3	Very low % ore recovery.
N-2	-	22	6	13	250	12.2	Very low % ore recovery.
N-3	-	19	4	19	-	-	Very low % ore recovery.
N-4	-	7	0	6.5	-	-	Very low % ore recovery.

*Weight averages calculated from Table I.
**Percent ore concentrate after washing. No chemical analysis performed.

Over most of the area sufficient quantities of ground water are available at relatively shallow depths for the purpose of washing the ore. The topography is such that surface water reservoirs and tailing ponds can be inexpensively constructed at washer sites.

PHYSIOGRAPHY

The iron ore-bearing formations underlie terrane that makes up a part of the North Central Hills physiographic belt. Narrow, deep stream valleys dissect the province leaving narrow, sharp divides.

Topographic relief over much of the area is 150 to 200 feet above stream valleys. Most elevations are between 300 and 500 feet above sea level; high points range up to 650 feet.

Except for small scale farming, largely in the narrow stream valleys, most of the land is covered with timber. Most of the timber growth is scrub oak and pine. A few areas have been re-forested with pines.

HISTORY OF MINING

Lowe[6] relates an "iron boom" incident in the early 1880's at the town of Duck Hill in Montgomery County. Specimens were obtained and analyzed with encouraging results but prospecting failed to find commercial ore beds. The "boom" ended, perhaps more suddenly than it had started.

A similar incident reported by Lowe[7] took place at Enterprise in Clarke County in 1887. There seems to have been more basis for the excitement here, inasmuch as at least one shipment of ore was sent to Birmingham where it was smelted. The pig iron was put on exhibit at Enterprise, but even this failed to attract capital and the interest dwindled.

In 1911 a company was organized by Birmingham operators, and considerable acreage in Marshall and Benton Counties was taken under option. A railroad spur and loading tipple were erected near Potts Camp in Marshall County, and several carloads of ore were shipped. In 1912 the business was chartered under the name of the Memphis Mining and Manufacturing Company.[8] This organization constructed a small capacity char-

coal blast furnace at Winborn in Benton County in 1913.[9] That same year the U.S.G.S. Mineral Resources reported 20,000 tons of ore being mined in Mississippi. The blast furnace, with a capacity of ten tons per day, reportedly produced 125 tons of pig iron before operations were discontinued.

During the 1930's the George S. Mepham Paint Company mined iron carbonate at Flat Rock Church in Benton County.[10] The ore was shipped to the Company's factory at East St. Louis, Illinois, for roasting and grinding for pigment. This operation was continued for many years (Figure 5).

According to the U. S. Bureau of Mines, one producer shipped 97 tons of iron ore to blast furnaces in Birmingham, Alabama in 1937. The brown ore contained 46.68 percent iron, 0.55 percent manganese and 0.08 percent phosphorus. This ore was strip mined from the upper Wilcox beds in Lafayette County east of Abbeville in the hills south of the Tallahatchie River.

In the late 1940's, citizens of Kilmichael, Montgomery County, organized a company to mine the limonite and carbonate ore of the Wilcox in eastern Montgomery and western Webster Counties. Shipments began moving in late 1950 to furnaces at Birmingham. At one time the Kilmichael Mining Corporation (later incorporated as the Kilmichael Ore Corporation) had approximately 10,000 acres under lease for iron ore mining in this area. The Columbus and Greenville Railroad records show movements of ore from Kilmichael and Stewart, Mississippi, to total 37 carloads from 1950 through 1959. Total tonnage came to 2,004 long tons. Of this total, 22 carloads carrying 1,174 tons were shipped in 1951.

Copies of furnace receipts on eleven carloads shipped by the Kilmichael Ore Corporation showed an average analysis of 48.95 percent Fe plus Mn as received. The average price per gross ton of these eleven carloads was $5.93 at the furnace. The average freight charge was $2.43, leaving the mining company $3.50 per ton for mining and concentrating. The Corporation has been inoperative since 1959.

In Kemper County two prospectors took leases on approximately 10,000 acres in the Porterville area in the early 1950's. Although no mining was attempted, a mining company took

samples from several prospect pits on three or four different properties in the area. Information from these pits showed favorable ore in respect to quality, quantity and accessibility. It is not known if these leases are still in effect.

GEOLOGY AND CHARACTER OF IRON ORE

PORTERS CREEK-NAHEOLA ORE

The ore zone lies between the typically massive, conchoidally fractured clay of the Porters Creek formation and the laminated, muscovitic, silty clay of the Naheola formation (Figure 1). It consists of glauconite and sandy and silty clay with interbeds of siderite concretions and nodules.

In southeastern Kemper County the zone ranges from three to five feet in thickness. To the northwest along strike in north central Kemper County, the zone thickness increases to 35 feet in Test Holes K-4 and K-7. The ore zone probably includes the Matthews Landing marl member of the Porters Creek formation as described by Hughes.[11]

Immediately below this zone there is considerable ore present in the upper 20 to 30 feet of the Porters Creek formation. However, the masses seem to be more discrete and less concentrated than in the zone above. This appears to be correlative to the ore zone described by Vestal near Dancy in Webster County and other areas where iron concretions have been reported in association with the Porters Creek formation.

A total of 11 test holes were cored or drilled in Kemper County along this belt. Some ore was found to be present in all holes, indicating a more or less continuous bed across the County along strike.

PORTERVILLE AREA

This area is located about two miles southwest of Porterville, Kemper County. Here a ridge extends northwest from U.S. Highway 45 through Section 30 and Section 31, T. 10N., R. 18E., and Section 25 and Section 36, T. 10N., R. 17E., (Figure 3).

The Naheola is at the surface overlying the Porters Creek formation. Two ore beds are present in the area with a combined thickness of up to five or six feet.

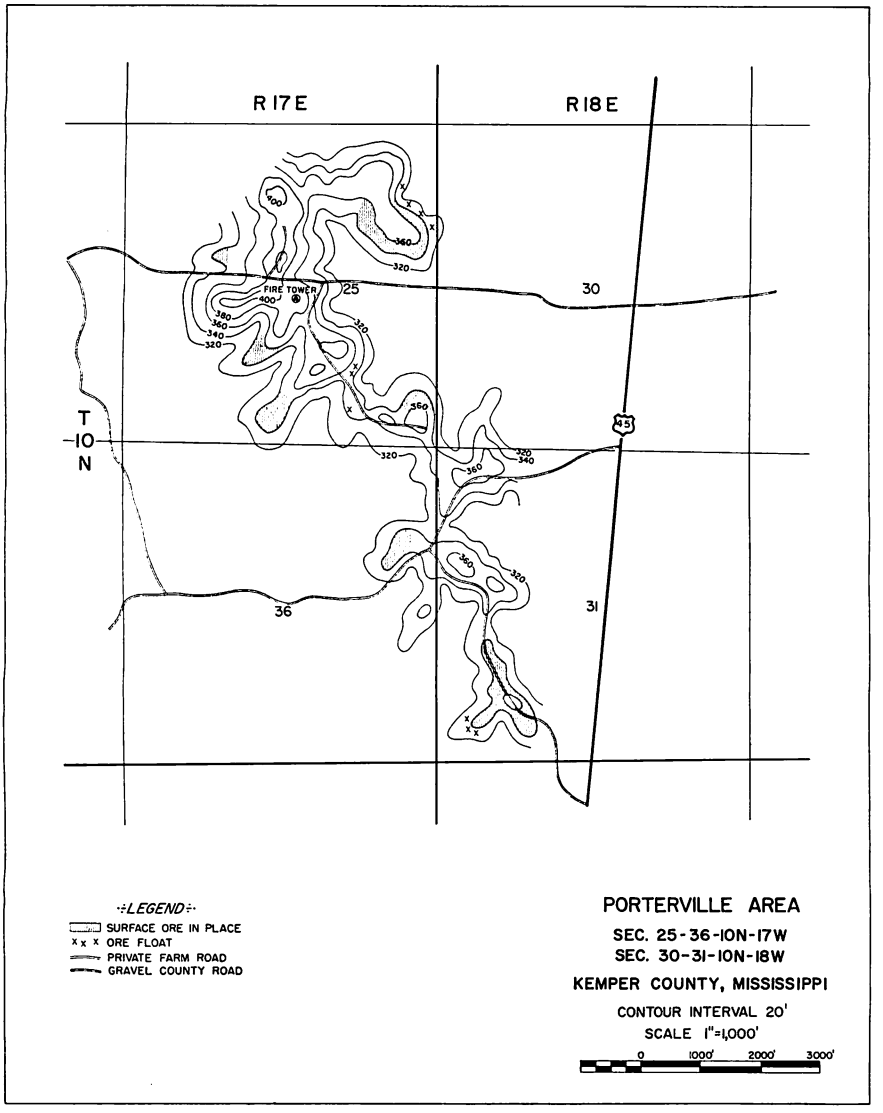

Figure 3.—Topographic map of the Porterville Area showing surface ore.

In the mid 1950's a mining company dug several prospect pits along the crests of the ridge and its spurs. The ore thicknesses averaged 1.7 feet with a maximum of four feet of overburden. The beds yielded about 1,550 pounds of ore for each

1.5 cubic yards of material removed. The per acre yield on this basis for 1.7 feet of ore is about 2,000 long tons.

The material in this area would require little, if any, beneficiation other than washing to remove the sand and clay particles. A drying process to drive off the excess moisture would be of value in up-grading the ore.

Chemical analyses from surface ore in the Porterville area of southeastern Kemper County range from 39.32 percent to 53.21 percent iron (Fe) with manganese (Mn) ranging from 0.35 percent to 1.40 percent. The average of nine samples was 47.06 percent and 0.83 percent for iron and manganese respectively. Analyses of four samples of Porters Creek-Naheola ore from the Porterville area are shown:

	1	2	3	4
Metallic iron	52.00%	53.21%	51.30%	48.48%
Manganese	1.07%	.77%	1.40%	1.18%
Phosphorous	.33%	.41%	.38%	.43%
Insoluble matter	9.54%	9.04%	8.59%	11.57%

WILCOX ORE

The Wilcox group crops out in an arcuate band extending from Tennessee through Benton and Tippah Counties south and southeast through Lauderdale County into Alabama (Figure 1). The width of the outcrop is about three to four miles at the Tennessee line, increasing to approximately 30 miles in east-central Mississippi. Surface units of this group attain an aggregate thickness of about 900 feet in the area of its broadest outcrop.

The Wilcox topography is moderately rugged with hills commonly rising 200 to 300 feet above the valleys of the major streams and their tributaries. These hills compose the eastern portion of the North Central Hills physiographic belt.

The Wilcox consists of alternating beds of sand, clay, lignite and silt. Most clays are silty or sandy and the silts and sands contain interbedded clay. Bedding is very irregular, and at many places, the sediments exhibit varying degrees of cross-bedding.

Iron ore is present throughout the entire thickness of the Wilcox group; however, the larger concentrations appear to be contained in the upper 100 to 150 feet.

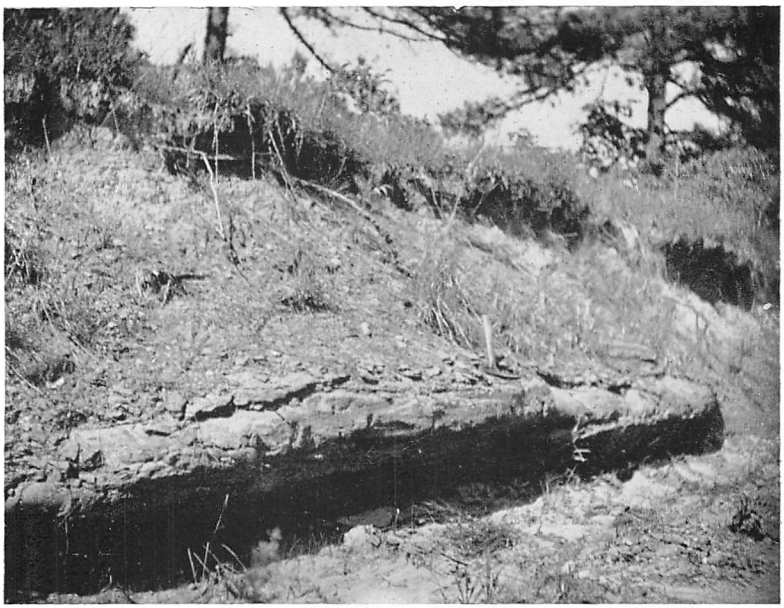

Figure 4.—Bed of iron ore (SW. 1/4, Sec. 22, T. 19 N., R. 8 E.) 3 miles north from Stewart. MGS Bull. 75, Fig. 27. F.E. Vestal photo, 1952.

Scattered throughout this section are numerous concretionary masses and a few very thin beds of iron ore (Figure 4). The shapes of the individual masses are usually defined by curved surfaces, with no two axes the same length. In size they range from several feet in length and width and one or two feet in thickness to less than an inch in any one of its dimensions (Figure 5).

Iron minerals which make up these concretions are siderite ($FeCO_3$), hematite (Fe_2O_3) and limonite ($2Fe_2O_3 \cdot 3H_2O$).

Where found below the zone of oxidation, the concretions consist of siderite with inclusions of silt and clay in varying amounts. Upon exposure to weathering, the siderite concretions are altered to the hydrated oxides of iron. These iron oxides commonly form concentric shells around a siderite core. Where more complete alteration of the entire mass has taken place, the

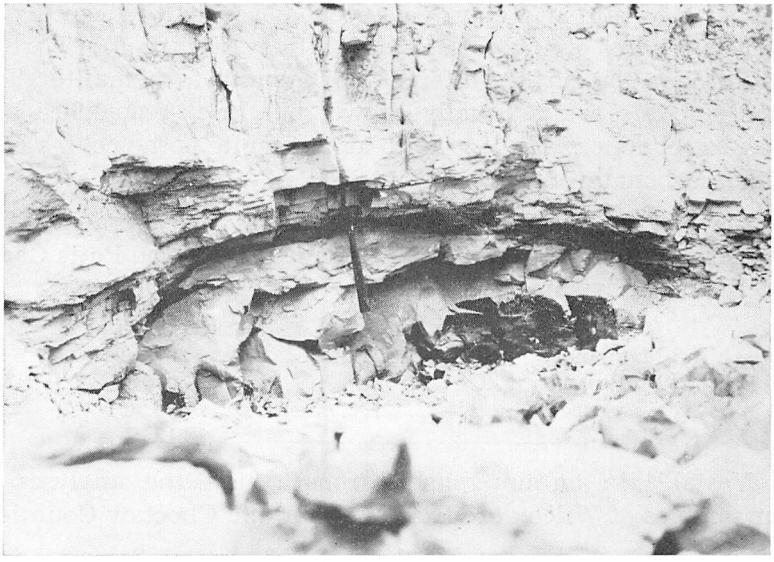

Figure 5.—Kidney-shaped siderite concretion in pits of George E. Mepham Paint Company near Flat Rock Church, Benton County. This is an unusually thick mass of ore. The length of the geologic pick (scale) is 15.5 inches. Photo by F.F. Mellen, 1936.

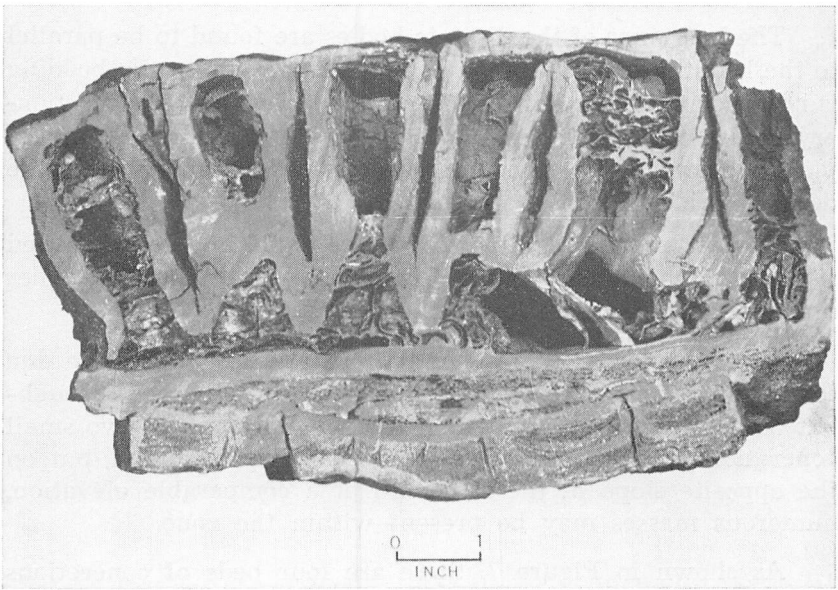

Figure 6.—Cross section of a limonite concretion showing the septarian pattern caused by differential concentration of iron hydroxide in the process of alteration from iron carbonate (siderite). Photo by Richard J. Hughes, September, 1963.

inclusions of silt and clay leave void space in the centers of the concretions giving a septarian effect (Figure 6). Rarely, dehydration has further altered the limonite to hematite. The color of oxide ore is usually brown, but brick-red, ochre and black are common. Light-gray to almost white is the color range of the carbonate ore.

Lowe[12] gives the following results as an average of 17 samples of oxides and carbonate (calcined) from the Potts Camp and Hickory Flat areas:

Metallic iron	55.07 %
Manganese	4.072%
Phosphorus	0.079%
Sulphur	1.15 %
Silica	13.12 %

Vestal,[13] in an unpublished report, lists the analyses of four samples of Wilcox ore from Webster and Choctaw Counties:

	1	2	3	4
Metallic iron	47.28%	46.38%	47.28%	53.51%
Manganese	0.44%	0.55%	0.66%	1.13%
Phosphorus	0.24%	0.15%	0.11%	0.18%
Silica	11.10%	11.70%	11.80%	9.80%

The long axes of the discrete bodies are found to be parallel to the bedding plane of the enclosing strata. Where the bedding is near horizontal or slightly dipping, a series of the concretionary bodies may extend over a large area and crop out in many places. However, at some places cross-bedding may limit the deposit to a very small area (Figure 7).

The better concentrations of ore are found in a gray, mottled red, sandy and/or silty clay. Commonly the ore-bearing zones are underlain by more impervious clays.

At most places outcrops of the ore are not impressive due to the manner in which the discrete masses are scattered throughout the containing strata. On a hill slope only one or two small concretions or perhaps only a little float may be found, but on the opposite slope of the same hill at a comparable elevation, numerous masses may be present within the zone.

As shown in Figure 7, there are four beds of concretions in the same zone. A drill hole located on top of this road cut encountered only two of the layers.

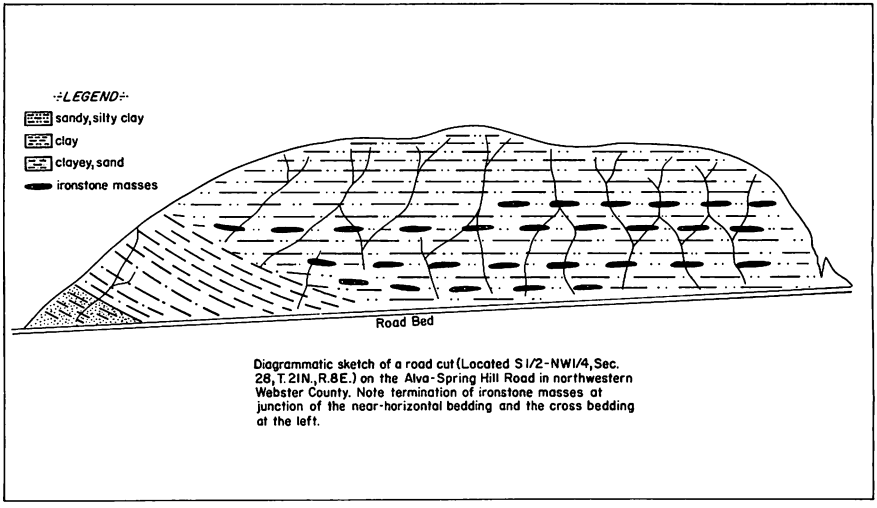

Figure 7.—Diagrammatic sketch of a road cut on the Alva-Spring Hill road showing a mode of existence of the iron ore concretions.

Vestal,[14] in 1951, made tonnage estimates in Webster and parts of Choctaw and Montgomery Counties. The average of these estimates is 1,024 long tons per acre. He arrived at these figures by taking the total thickness of the layers of ore masses observed in a zone on outcrops. The aggregate thickness was multiplied by the number of square feet in the area to determine the volume of inferred ore. The figure of 237.5 pounds per cubic foot was computed on the basis of specific gravity of limonite. These figures were multiplied to determine the number of tons in the area. This figure was reduced by 4/5ths to allow for external irregularities and void space in the concretions, discontinuity of the beds and other factors of uncertainty.

In a later unpublished report, Vestal re-evaluated some of the areas in northwestern Choctaw and western Webster Counties and increased his estimates to between 2,000 and 2,500 tons per acre. These figures were based partially on the actual yield from new prospect trenches in the area.

In Lafayette County, Attaya[15] followed a procedure similar to that of Vestal in arriving at tonnage estimates. However, he assumed the volume of actual ore to be 1/4th the volume of a continuous bed of equal thickness. The bulk weight of the

ore was determined to be 194 pounds per cubic foot by actual tests.

SOUTH ALVA AREA

This area is located in eastern Montgomery County in the southeast quarter of Section 12, T. 20N., R. 7E. (Figure 6). A ridge extending northeast from the Lodi-Alva road a distance of approximately 3/4 of a mile has showings of ore float on the slopes and along the crest. This ore is in the upper Wilcox group which crops out in the area. A small spur extends eastward from the main ridge for a distance of 900 feet and has a width of about 50 feet at the crest.

Test holes were drilled on a grid pattern with 100 feet between holes along the crest of the ridge spur, and infill holes were drilled in the three westernmost squares (Figure 8). Ore

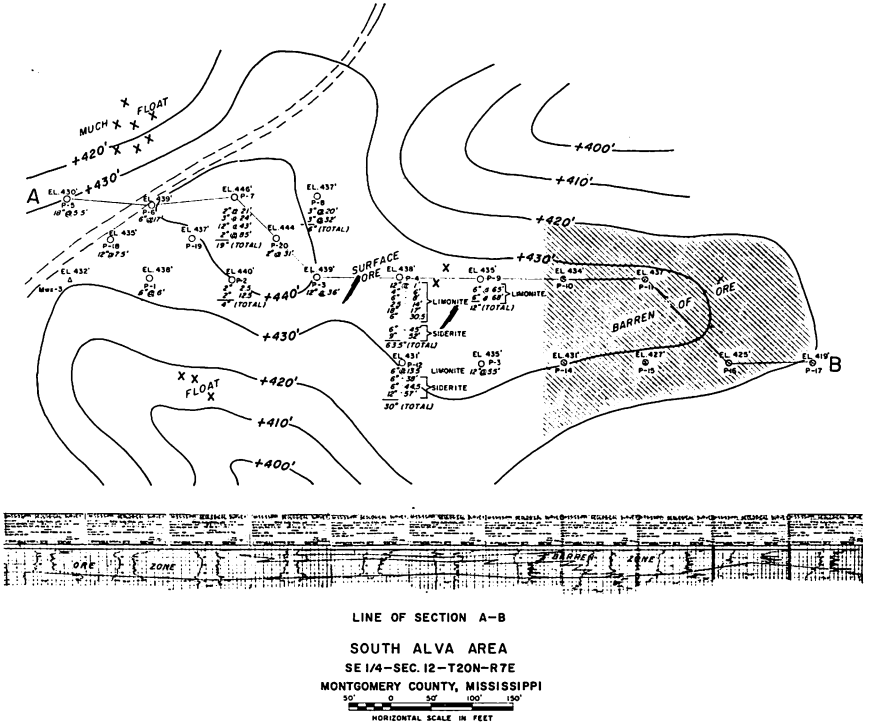

Figure 8.—Topographic map of the South Alva Area with test hole locations and a cross section of area depicted on the electric logs of the test hole along line A-B. Refer also to Figure 9. If needed, full scale Widco logs may be consulted in the Survey's open files.

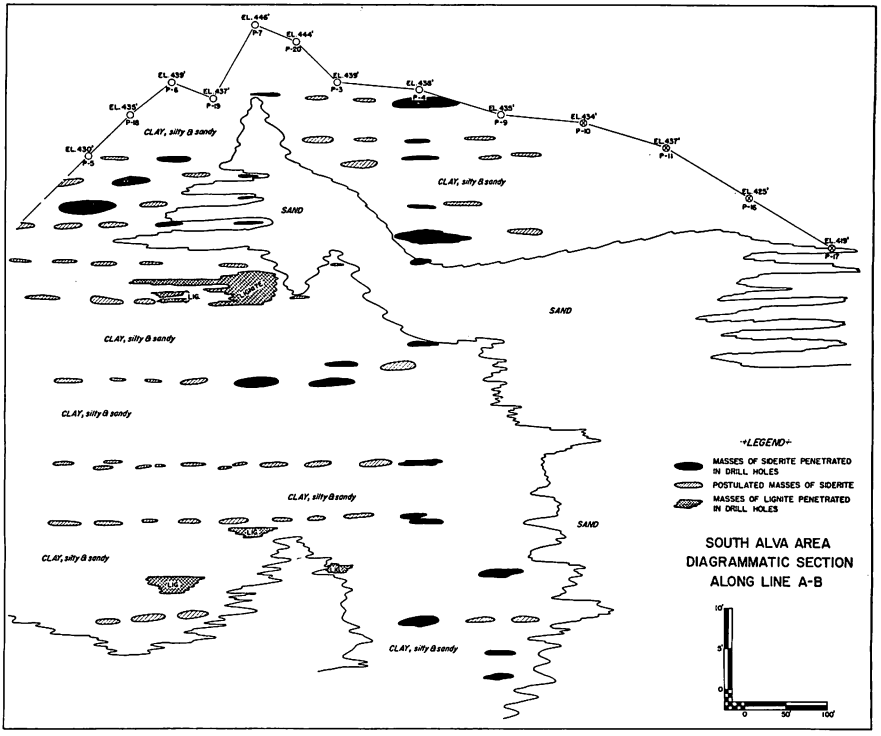

Figure 9.—Diagrammatic cross section along line A-B in South Alva Area showing actual and postulated ore. Compare with Figure 8.

was penetrated in 13 of the 20 holes. As much as five feet of ore was penetrated in one of the test holes. The average thickness of ore for the 20 holes was 0.89 feet. Using the weight of 194 pounds per cubic foot as determined by Attaya, the tonnage is computed to be 3,488.80 long tons of ore per acre. No allowance is made for the discontinuity of beds or other factors considered by Vestal and Attaya, as these things would be averaged out by the thickness and number of the beds penetrated (Figure 9). Optimum spacing of the test holes may be better determined with additional experimental drilling.

WINONA-ZILPHA ORE

The Winona-Zilpha outcrop belt extends from Yalobusha County south and southeast through Clarke County into Alabama. The maximum width of the outcrop belt is about 10

miles in central Attala County, but elsewhere along strike it is more commonly two to four miles in width (Figure 1).

Although there is a definite but gradational break between the Winona and Zilpha formations of the Claiborne group, the formations are considered as a unit in this study for simplicity. The zone of interest is primarily the upper three to five feet of the glauconitic, sideritic and fossiliferous Winona sands and the lower 10 feet of the Zama member[16] of the Zilpha formation. This part of the Zama member is characterized by glauconitic clay and beds of glauconite which contain siderite. The siderite in this zone is commonly nodular or concretionary. Locally it may form a matrix binding glauconite grains together.

On exposure of glauconite and siderite to the oxidizing zone, the iron of the two minerals is altered to limonite. This action forms irregular thin beds and masses of knotty and warty concretionary ironstones and limonitic sandstone having a distinctive rusty red color. The outcrop of this zone forms a moderately low relief cuesta. The younger Zilpha clay forms a bench of well-rounded undulating hills to the west.

North of central Attala County along strike, the Zama member is probably represented by the 1.5 feet of "Marine Zilpha" referred to by Priddy[17] in western Montgomery and eastern Carroll Counties.

The uppermost bed of the Zama member is described by Parks[18] as "10 to 12 feet of dark green-gray glauconite and glauconitic silt with thin interbeds of concretionary siderite." This is separated from the lower beds of the member by eight to 10 feet of gray clay. Along strike in northwestern Attala County, the upper bed is not recognizable.

Southeast of Hesterville in central Attala County, 12 core holes (A-4 through A-15) were drilled. They were spaced over an area of a little less than a township (Figure 1). The thickness of the ore zone in these holes averaged 8.5 feet. The average iron (Fe) content in the unbeneficiated samples was 29 percent. Concentration of the ore would probably increase this figure an additional 15 percent or more.

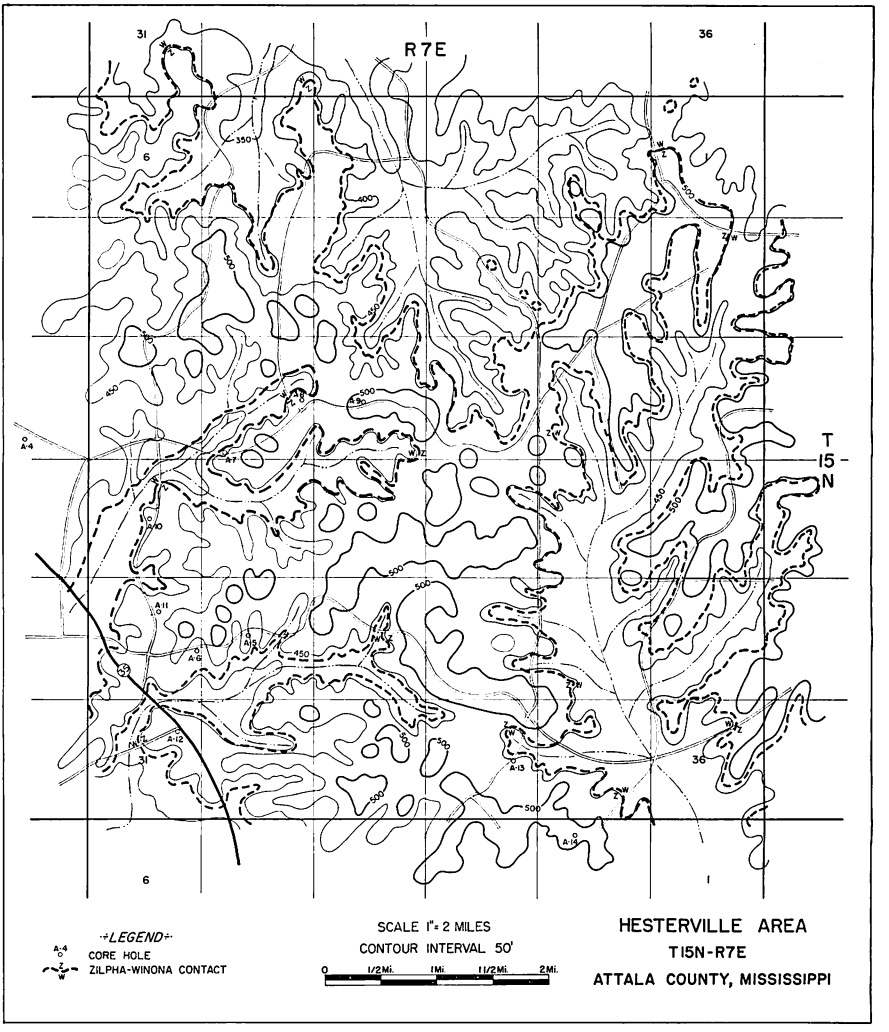

Figure 10.—Topographic map of Hesterville Area showing test hole locations. Contact of Winona and Zilpha formations is after Parks, MGS Bulletin 99.

Where the upper bed of the Zama member is present, as much as 15 to 17 feet of clay is interspersed between the ore zones. The ore zones contain waste material to ore in the ratio of approximately six to one by visual estimates.

HESTERVILLE AREA

This area covers approximately a township (T. 15N., R. 7E.) lying east and southeast of Hesterville, Attala County (Figure 10). Twelve test holes in the Winona-Zilpha which crops out in the area show ore zones with thickness ranging from 1.5 to 17.5 feet with an average for the 12 holes being 8.5 feet.

A visual estimate of the waste to ore ratio is about six to one or 1/7 of the volume of the zone would be ore concentrate. On the basis of 194 pounds per cubic foot of ore, the zone of 8.5 feet would yield 4,816 tons per acre.

Table 3 shows the iron content of the unbeneficiated materials to have a low average of 21.04 percent and a high average of 34 percent. These percentages are, of course, too low to be commercial; however, it is believed that concentrates of the ore will have a much higher iron content.

Perhaps the most suitable area for mining this material would be in the eastern part of the area where more of the zone is above drainage and overburden is less.

SUMMARY

The investigation of the Porters Creek-Naheola formations of the Midway group, the Wilcox group and the Winona-Zilpha formations of the Claiborne group in north and north-central Mississippi indicates potential commercial iron ore deposits.

Two types of ore found in these zones are iron carbonate ($FeC0_3$) and the hydrated oxides of iron ($2Fe_20_3 \cdot 3H_20$). The hydroxides of iron are found at or near the surface as an alteration product of the carbonate. Many concretions show partial oxidation with a shell of limonite and a core of siderite. In the alteration process dehydration of the hydroxides forms small amounts of hematite (Fe_20_3).

Chemical analyses of samples taken in the course of this study and previous investigations show average iron content as follows:

Porters Creek-Naheola	47.06% Fe	
Wilcox	48.95% Fe	
Winona-Zilpha	29.00% Fe	(unbeneficiated)

Estimates of inferred recoverable ore were made on an area in each of the three horizons. The Porterville area in Kemper County contains ore in the Porters Creek-Naheola zone with an average thickness of 1.7 feet under a maximum of four feet of overburden. The estimated yield is approximately 2,000 long tons per acre.

Ore of the upper Wilcox section in the South Alva area in Montgomery County is found in eight ledges with an average aggregate thickness of 0.89 foot down to a depth of 50 feet. The estimated yield in this area is 3,488 long tons per acre.

The ore in the Hesterville area of Attala County is found in the Winona-Zilpha zone. Here the average thickness of the zone is 8.5 feet with a waste to ore ratio of six to one. Estimate of the yield is 4,816 long tons per acre under as much as 40 feet of overburden. Chemical analyses indicate the necessity of concentrating the ore and possibly the need to up-grade the concentrate by addition of richer Wilcox ore.

TEST HOLE RECORDS

ATTALA COUNTY

Core Hole A-4

Location: Approximately 75 feet south of an east-west road (Cen. NE.1/4, SW.1/4, Sec. 13, T.15N., R.16E.) and 1.1 mile east of the Hesterville junction on State Highway 35.

Elevation: 428 feet (altimeter)

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—clay loam, red-brown, silty.
		Zilpha formation
8.0	10.0	Clay, gray mottled red, silty.
1.0	11.0	**Limonite concretions.**
2.0	13.0	Glauconite sand, dark-green, slightly clayey.
18.0	31.0	Clay, chocolate-brown, blocky; becoming dark-gray in bottom 4 feet and containing disseminated lignite.
2.0	33.0	Clay, gray-green, slightly silty, slightly glauconitic.
2.0	35.0	**Siderite,** tan; is as a layer and as irregular nodules in dark-gray clay.
14.0	49.0	Clay, green, slightly sandy and silty; contains streaks and nodules of hard to soft **siderite;** becomes more sandy in bottom 6 feet.
		Winona formation
1.0	50.0	Sand, green, glauconitic, water-saturated.

Core Hole A-5

Location: Approximately 20 feet south of east-west road (NW./cor. NE.1/4, SW.1/4, Sec.29, T.15N., R.7E.), 0.9 mile east of junction with north-south road.

Elevation: 421 feet (altimeter)

Thickness (feet)	Depth (feet)	Description
		Zilpha formation
6.0	6.0	Clay, light-gray mottled red, silty.
2.5	8.5	Clay, as above; contains **limonite concretions.**
1.5	10.0	Clay, as above; contains streaks of glauconite.
4.0	14.0	Clay, gray, slightly glauconitic; contains much ferruginous staining and some **limonite concretions.**
2.0	16.0	Clay, light-gray, firm, blocky, glauconitic; contains streaks of ferruginous staining.
1.5	17.5	Clay, red-brown; contains inclusions of coarse-grained glauconite.
4.5	22.0	Clay, as above; becomes more glauconitic, slightly sandy, fossiliferous.
		Winona formation
1.5	23.5	Sand, light-brown, slightly glauconitic; contains concretions of gray-green glauconitic sand.
1.5	25.0	Sand, dark red-brown, glauconitic; contains soft **limonite concretions** having gray-green glauconitic sand inside.
6.0	31.0	Sand, gray-green, slightly glauconitic; contains streaks red-brown clay and some irregular limonite partings (water- saturated).

Core Hole A-7

Location: On road right-of-way on north side of east-west road (SW.1/4, SW.1/4, SW.1/4, Sec.17, T.15N., R.7E.), 0.7 mile east of intersection of north-south road.

Elevation: 431 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Clay loam, gray-brown, sandy.
		Zilpha formation
4.0	6.0	Clay, gray mottled red, blocky, silty.
2.0	8.0	Clay, light-gray, glauconitic; has ferruginous staining.
4.0	12.0	Clay, chocolate-brown, slightly micaceous, sparsely glauconitic.
1.0	13.0	Glauconite, dark-green; is in tan, sideritic (?) clay matrix containing streaks of olive-green, slity clay.
3.0	16.0	Silt, buff-brown, slightly sandy, slightly glauconitic, clayey.
1.0	17.0	Silt, light-gray; as above, slightly micaceous.
12.0	29.0	Clay, brown, blocky, slightly micaceous.
5.0	34.0	Clay, dark-gray, silty; contains glauconitic silt streaks.
1.0	35.0	**Siderite,** tan, nodular; in clay as above.
3.0	38.0	Glauconite, red-brown staining; contains abundant **limonite concretions** and streaks of brown, silty clay.
6.0	44.0	Glauconite, green-brown, slightly sandy, very fossiliferous; contains layers of partially oxidized **siderite.**
		Winona formation
4.5	48.5	Sand, gray-green, very glauconitic; contains streaks of olive-green, silty clay.
2.5	51.0	Sand, as above, stained red-brown; contains many irregularly shaped **limonite concretions.**
1.0	52.0	Sand, red-brown, slightly glauconitic.

Core Hole A-8

Location: Approximately 50 feet east of a north-south road about 500 feet north of junction with east-west road (E.1/2, SW.1/4, NE.1/4, Sec.17, T.15N., R.7E.).

Elevation: 457 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—clay loam, red-brown, silty.
		Zilpha formation
7.0	9.0	Clay, light-gray mottled red.
3.0	12.0	Clay, as above, sparsely glauconitic; contains **abundant layers** and **concretions** of **limonite.**
		Winona formation
5.0	17.0	**Limonite concretions;** contains inclusions of coarse-grained dark-green glauconite imbedded in sand; gray-green, glauconitic and fossiliferous throughout.
5.0	22.0	**As above** with increase in sand content.
1.0	23.0	Sand, green-brown, glauconitic.
1.0	24.0	**Limonite concretions** in glauconitic sand.
3.5	27.5	Sand, gray-green with red-brown staining, glauconitic; contains thin streaks red-brown, silty clay and a few small **limonite concretions.**
1.5	29.0	Sand, as above; contains limonite cemented concretions of glauconitic sand.
3.0	32.0	Sand, red-brown; contains glauconitic streaks cemented with limonite.
5.0	37.0	Sand, gray-green, glauconitic.

Core Hole A-9

Location: In road ditch on north side of east-west road (SE. cor. SE.1/4, NW.1/4, Sec.16, T.15N., R.7E.), 0.7 mile east of junction of north-south road.
Elevation: 474 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
		Zilpha formation
10.0	10.0	Clay, gray, blocky; contains infrequent pockets of silt, some red mottling and limonite stains along joints.
1.0	11.0	Clay, as above; contains pockets of glauconitic silt.
3.5	14.5	Clay, gray to chocolate-brown, blocky; has limonite staining along joints.
2.0	16.5	Clay, chocolate-brown, blocky; contains glauconitic silt laminae in bottom 6 inches and a 2-inch limonite concretion at bottom.
3.5	20.0	Clay, gray to chocolate-brown, slightly silty, sparsely glauconitic.
3.0	23.0	Clay, as above; contains abundant **limonite concretions** and layers. (Correlates with the 9-12 foot interval in A-8).
1.0	24.0	Clay, gray-brown; contains scattered coarse-grained glauconite with streaks of siderite (?).
		Winona formation
5.0	29.0	**Limonite concretions** imbedded in glauconitic sand, fossiliferous.
5.5	34.5	As above; contains **fewer concretions** and an increase in quartz sand.
4.5	39.0	Sand, gray-green, glauconitic; contains streaks of olive-green, silty clay and a few limonite concretions.
3.5	42.5	Sand, brown, glauconitic, clayey, slightly limonitic, very fossiliferous; large shark's tooth noted at 41.5 feet.
2.5	45.0	Sand, gray-green, glauconitic; contains streaks of green-brown, silty clay.

Core Hole A-10

Location: Approximately 25 feet from west side of north-south road (NE.1/4, NE.1/4, SW.1/4, Sec.19, T.15N., R.7E.), 1.0 mile south of intersection with east-west road.
Elevation: 422 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
5.0	5.0	Soil and colluvium.
		Zilpha formation
2.0	7.0	Clay, gray, sparsely glauconitic; contains limonite concretion in top 6 inches.
2.0	9.0	Clay, as above; top foot contains many **limonite concretions.**
1.0	10.0	Glauconite, red-brown, sandy.
17.0	27.0	Clay, chocolate-brown, blocky, bentonitic (?); has ferruginous staining along joints.
3.0	30.0	Clay, as above; contains fibrous selenite in jointing.
1.0	31.0	Clay, chocolate-brown, blocky, scattered glauconite grains; becoming very glauconitic in bottom 3 inches.
1.0	32.0	Clay, as above; contains many **limonite concretions.**
1.5	33.5	Clay, green-black; contains coarse-grained glauconite and gray-tan siderite layers and nodules.
1.5	35.0	Clay, as above, fossiliferous; contains **limonite concretions.**
		Winona formation
4.0	39.0	Glauconite, gray-green; in sideritic clay matrix; contains some ferruginous staining and a few **limonite concretions;** very fossiliferous.
7.0	46.0	Sand, brown, glauconitic, ferruginous staining, loose and friable.

Core Hole A-11

Location: Approximately 75 feet east of north-south road (SW.1/4, NE.1/4, Sec.30, T.15N., R.7E.), 0.3 mile north of intersection of east-west road.

Elevation: 428 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
		Kosciusko formation
3.0	3.0	Sand, orange-red, medium-grained; contains 1-inch bed of hard siltstone near base.
		Zilpha formation
2.0	5.0	Clay, gray mottled red
16.5	22.5	Clay, chocolate-brown; contains streaks dark-green, coarse-grained glauconite.
2.5	25.0	Clay, dark-gray, some limonite stain, finely micaceous; contains streaks of fine-grained glauconite.
2.0	27.0	Clay, light-gray, glauconitic, limonite stain; contains **siderite nodules** in top 6 inches.
3.0	30.0	Clay, gray-brown, slightly glauconitic; contains selenite along joints; bottom 6 inches contains much dark-green glauconite.
1.0	31.0	Clay, as above; contains 6-inch layer of **siderite nodules.**
16.0	47.0	Clay, dark-gray, carbonaceous, finely micaceous in part, hard, conchoidally fractured, plastic.
2.5	49.5	**Siderite,** tan-gray, fossiliferous; is as layers and nodules and as matrix between glauconite grains.
1.5	51.0	Clay, dark-gray; contains streaks and pockets of sideritic, glauconitic sand.
2.0	53.0	**Siderite,** tan-gray; is as layers and nodules.
3.0	56.0	**Siderite** (?), dark-brown in gray-green glauconitic clay, fossiliferous.
		Winona formation
2.0	58.0	Sand, dark-green, very glauconitic, fossiliferous.

Core Hole A-12

Location: On highway right-of-way in south corner junction State Highway 35 and gravel road to the west (NE.1/4, SW.1/4, NE.1/4, Sec.31, T.15N., R.7E.), 4.4 miles north of intersection State Highways 12 and 35 in Kosciusko.

Elevation: 417 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
		Zilpha formation
6.0	6.0	Clay, gray mottled red, slightly silty; has streaks ferruginous staining.
3.0	9.0	Clay, gray, very glauconitic; contains 3 inches platy limonite at top.
3.0	12.0	Clay, as above, less glauconitic, very silty; contains 3 thin beds **limonite concretions.**
2.0	14.0	Clay, medium-gray, slightly silty.
1.0	15.0	Clay, green-tan, glauconitic, silty.
12.0	27.0	Clay, gray-brown, blocky; contains streaks of silt; has ferruginous stain along joints; contains selenite in lower 7 feet.
1.0	28.0	**Siderite,** partially oxidized, brown exterior and gray interior; contains large coarse-grained glauconite throughout.
1.5	29.5	Clay, gray-green, glauconitic, slightly fossiliferous.
1.0	30.5	Silt, gray-brown, clayey, slightly glauconitic.
1.5	32.0	Siderite, brown and gray, partially oxidized.
1.0	33.0	Clay, gray; contains streaks glauconite weathered brown.
2.0	35.0	Clay, gray-brown; contains coarse-grained glauconite scattered throughout.

Winona formation

3.0	38.0	Glauconite, green, coarse-grained; is in hard buff, crumbly matrix (siderite) (?); very fossiliferous.
3.0	41.0	Clay, gray-green, very glauconitic, slightly sandy; contains lumps of hard, very calcareous material; very fossiliferous.
6.0	47.0	Sand, green-brown, fossiliferous; contains streaks of green to olive-drab clay and calcareous lumps.

Core Hole A-13 (Drilled)

Location: On east side State Highway 43 (NE.1/4, NW.1/4, SE.1/4, Sec.34, T.15N., R.7E.), approximately 0.25 mile south of intersection of an east-west road.

Elevation: 496 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, red-brown, silty.
		Zilpha formation
8.0	10.0	Clay, gray, plastic, slightly silty.
15.0	25.0	Clay, chocolate-brown, blocky; contains selenite in lower 3 feet.
15.0	40.0	Clay, gray-green, glauconitic, slightly silty, sparsely lignitic.
4.0	44.0	Clay, as above; contains tan, glauconitic **siderite nodules.**
8.5	52.5	Clay, green, very glauconitic, slightly sandy.
5.0	57.5	Clay, medium-gray to chocolate-brown, carbonaceous.
5.0	62.5	Clay, green, glauconitic; contains thin streaks of tan, glauconitic **siderite.**
8.5	71.0	**Siderite,** tan, glauconitic (sandy texture with sideritic cement).
		Winona formation
9.0	80.0	Sand, green, fine- to medium-grained, glauconitic, fossiliferous.

Core Hole A-14

Location: Approximately 500 feet north of northeast-southwest road (NE.1/4, NE.1/4, NW.1/4, Sec.2, T.14N., R.7E.), in pasture behind house 2.9 miles northeast of junction with State Highway 43.

Elevation: 492 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
1.0	1.0	Soil, red, sandy, silty.
		Kosciusko formation
1.0	2.0	Sand, red, fine-grained, clayey.
		Zilpha formation
2.0	4.0	Clay, gray to light-brown, jointed; has ferruginous staining along joints.
18.0	22.0	Clay, as above; becoming chocolate-brown and blocky; has selenite along joints, silty streaks; contains inclusions of glauconite at 15 to 17 feet.
5.5	27.5	Clay, dark-gray, waxy; contains pyrite nodules at 23.5 feet and coarse-grained, dark-green glauconite at 26 to 27.5 feet.
4.5	32.0	Clay, gray-brown, waxy, glauconitic; contains tan, slightly glauconitic **siderite.**
4.0	36.0	Clay, brown, waxy; contains streaks glauconite.
2.0	38.0	Clay, gray-brown, silty, very glauconitic.
7.0	45.0	Clay, dark-gray, waxy, slightly silty, fossiliferous.
4.0	49.0	Clay, gray-green, glauconitic; contains tan **siderite** nodules.
1.0	50.0	Clay, gray-green, glauconitic, silty.
2.0	52.0	Clay, dark gray-brown; contains streaks of gray siltstone.
1.5	53.5	Clay, dark-gray, glauconitic; contains **siderite nodules,** tan, glauconitic.

		Winona formation
3.5	57.0	Glauconite, green; in matrix of brown sideritic (?) clay; contains a few siderite nodules.
5.0	62.0	Sand, green-tan, medium-grained; contains streaks of bright-green, silty clay; fossiliferous.

Core Hole A-15

Location: Approximately 0.4 mile north of airport entrance (SW.1/4, SE.1/4, SE.1/4, Sec.2, T.14N., R.7E.), on west side of road across from vacant house.

Elevation: 492 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil, gray-brown, silty, sandy.
		Zilpha formation
3.0	5.0	Clay, light-gray, sparsely glauconitic.
9.0	14.0	Clay, chocolate-brown, blocky, waxy; contains streaks of silt and ferruginous staining along joints.
1.0	15.0	Clay, light-gray and chocolate-brown; light-gray fraction sparsely glauconitic.
4.0	19.0	Clay, light-gray; contains streaks of dark-green glauconite and **nodules of siderite** partially oxidized.
1.0	20.0	Clay, as above; stained deep red by ferruginous material above.
2.5	22.5	Clay, gray-green, glauconitic, silty; contains 6-inch layer of **limonite nodules** at 21.5 feet.
1.5	24.0	Clay, chocolate-brown, glauconitic streaks, silty.
3.0	27.0	Sand, green-tan, fine-grained, glauconitic, clayey; contains streaks of olive-green, silty clay.
1.5	28.5	Clay, chocolate-brown, slightly silty.
2.5	31.0	Clay, dark-gray, hard, very silty; shows bedding.
3.0	34.0	Clay, dark-gray, waxy, blocky; contains large glauconite grains in bottom 1-foot.
5.0	39.0	Clay, gray-green; contains large glauconite grains and **siderite nodules throughout.**
2.5	41.5	Clay, as above; **siderite nodules** are more sparse.
		Winona formation
2.5	44.0	Sand, green-tan, fine- to medium-grained, glauconitic, possibly sideritic; contains thin streaks olive-green, silty clay.
1.0	45.0	Sand, as above; is less glauconitic; is saturated with water.

Core Hole A-17

Location: Atop embankment in old road on north side State Highway 19 (SW. cor. SW.1/4, NW.1/4, Sec.36, T.14N., R.8E.), 0.3 mile east of junction of road to the north.

Elevation: 523 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
4.0	4.0	Old road-bed material.
		Zilpha formation
9.5	13.5	Clay, light-gray, blocky; has streaks ferruginous stain.
1.5	15.0	Clay, as above; contains crumbly **limonite concretions** and **layers.**
4.0	19.0	Clay, light-gray, glauconitic, ferruginous stained.
		Winona formation
12.0	31.0	Sand, red-brown; contains glauconite partially altered to limonite.

Core Hole A-18

Location: Approximately 100 feet northeast of northwest-southeast county road (NW.1/4, NE.1/4, Sec.13, T.13N., R.8E.), on edge of cultivated field.

Elevation: 554 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
		Kosciusko formation
12.0	12.0	Sand, orange-red, medium-grained.
		Zilpha formation
3.0	15.0	Clay, light-gray, slightly silty.
2.0	17.0	Clay, chocolate-brown, blocky.
2.0	19.0	Clay, dark-gray, slightly silty.
5.0	24.0	Clay, as above; glauconitic.
5.0	29.0	Glauconite, green, sandy; has tan, sideritic clay matrix.
1.0	30.0	**Siderite,** tan, glauconitic.
3.0	33.0	Glauconite, dark-green, slightly sideritic.
0.5	33.5	**Siderite,** as at 29 to 30 feet above.
1.5	35.0	Clay, dark gray-green, glauconitic, sandy.
7.5	42.5	Clay, dark-brown, blocky, waxy.
1.5	44.0	Clay, gray to brown; has silty laminae.
1.0	45.0	**Limonite concretions.**
2.0	47.0	Clay, light-gray, glauconitic, sandy; contains **limonite concretions** scattered throughout.
1.0	48.0	**Limonite concretions.**
3.0	51.0	Clay, gray-green, very glauconitic, possibly sideritic, fossiliferous.

Core Hole A-19

Location: On northeast side Kosciusko-Center road at sand pit (SE.1/4, NE.1/4, Sec.26, T.13N., R.8E.), approximately 0.9 mile northwest of store at Center, Mississippi.

Elevation: 493 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
		Kosciusko formation
5.0	5.0	Sand, red-buff to yellow, medium-grained.
		Zilpha formation
5.0	10.0	Clay, light-gray, very plastic.
5.0	15.0	Clay, chocolate-brown, blocky, waxy, slightly silty.
11.0	26.0	Clay, dark-gray, blocky, waxy; contains occasional streaks of silt.
7.0	33.0	Clay, as above; becoming glauconitic and slightly micaceous.
2.0	35.0	Clay, as above; contains **siderite nodules.**
1.0	36.0	**Siderite,** tan, glauconitic, hard; contains streaks of green clay.
2.0	38.0	Clay, dark gray-brown, very glauconitic.
2.0	40.0	**Siderite,** tan, very glauconitic.
3.5	43.5	Clay, brown, waxy, glauconitic, contains **siderite in upper foot.**
3.5	47.0	Clay, gray-brown, glauconitic; contains **siderite nodules.**
		Winona formation
2.0	49.0	Sand, tan-green, glauconitic, fossiliferous.
3.0	52.0	Sand, as above; interbedded with streaks of dark-green, clayey silt.

Core Hole A-20 (Drilled)

Location: On northeast side Kosciusko-Center road (NW.1/4, SW.1/4, Sec.25, T.13N., R.8E.), approximately 0.5 mile southeast Core Hole A-19.

Elevation: 474 feet (altimeter)

Thickness (feet)	Depth (feet)	Description
		Zilpha formation
15.0	15.0	Clay, light-gray, slightly silty.
2.5	17.5	**Siderite,** tan to brown, glauconitic, partially oxidized.
2.5	20.0	Clay, light-gray, slightly glauconitic, silty, waxy.
3.0	23.0	Clay, gray, glauconitic.
9.0	32.0	Attempted to core with 1 1/4 inch core barrel. Cored as broken **siderite** for entire 9 feet. Recovered 1 foot **siderite,** gray, glauconitic, hard. Core barrel jammed.
		Winona formation
3.0	35.0	**Siderite,** gray-tan, glauconitic.
2.5	37.5	Glauconite, green; contains **siderite nodules,** sandy, fossiliferous.
2.5	40.0	Sand, gray-green, meduim-grained, glauconitic, very fossiliferous.
7.5	47.5	Sand, as above; less fossiliferous.
5.0	52.5	Sand, gray-green; contains coarse-grained, dark-green glauconite
		Tallahatta formation (Neshoba member)
30.0	82.5	Sand, gray, fine-grained, slightly glauconitic, very argillaceous.
2.5	85.0	Sand, as above; contains red-yellow clay inclusions.
5.0	90.0	Sand, gray, fine- to- medium-grained; contains streaks clay.

Core Hole A-21 (Drilled)

Location: Approximately 100 yards north of triangle formed by road intersection (Se. Cor. SE.1/4, NE.1/4, Sec.24, T.13N., R.8E.), on north side of road curving to the west where dim farm trail leads north.

Elevation: 551 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
		Kosciusko formation
8.0	8.0	Sand, red-orange, medium-grained.
		Zilpha formation
4.5	12.5	Clay, light-gray mottled red, plastic.
2.5	15.0	Clay, as above; mixed with chocolate-brown clay.
5.0	20.0	Clay, chocolate-brown, plastic; has some ferruginous staining.
2.5	22.5	Clay, as above; contains dark gray, waxy clay.
5.0	27.5	Clay, dark-gray, waxy, blocky.
4.0	32.0	Clay, as above; contains dark-green, coarse-grained glauconite.
8.0	40.0	**Siderite,** tan, glauconitic.
2.5	42.5	Sand, gray-green, very glauconitic.
2.5	45.0	Clay, bright-green, glauconitic.
2.5	47.5	Clay, dark-gray, plastic.
3.5	51.0	Clay, light-gray, sparsely glauconitic; contains limonitic streaks.
6.5	57.5	**Siderite,** gray-tan, partially oxidized to limonite; interbedded with gray, glauconitic clay.
		Winona formation
12.5	70.0	Sand, buff-green, fine- to medium-grained, glauconitic.

Core Hole A-22

Location: Approximately 25 feet east of road in front of vacant tenant house (NW.1/4, SW.1/4, Sec.12, T.13N., R.8E.), about 0.5 mile northwest A-18.

Elevation: 529 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, gray-brown, silty.
		Zilpha formation
4.0	6.0	Clay, light-gray mottled red, plastic.
2.0	8.0	Clay, as above; contains streaks glauconite.
2.0	10.0	Clay, chocolate-brown; has ferruginous staining.
2.0	12.0	Clay, gray-tan, plastic; contains 6-inch bed bentonitic clay at 10.5 feet.
2.0	14.0	Clay, buff, glauconitic throughout; contains thin beds of glauconite.
1.0	15.0	**Siderite,** tan to brown, partially oxidized to limonite.
1.5	16.5	Clay, chocolate-brown, glauconitic in part.
3.5	20.0	Sand, green-tan, glauconitic; contains thin beds of olive-green, silty clay (1/2-to 1-inch thick).
10.0	31.0	Clay, gray-brown, waxy, blocky, slightly silty, micaceous streaks.
		Winona formation
1.0	32.0	Sand, tan-green, medium-grained, glauconitic, fossiliferous, sideritic (?).
4.0	36.0	Sand, as above; contains **siderite concretions** partially oxidized to limonite.
18.0	54.0	Sand, green-buff, fossiliferous, slightly clayey.
		Tallahatta formation (Neshoba member)
8.0	62.0	Sand, gray-green, fine- to medium-grained; has some ferruginous staining; contains a few clay partings.

Core Hole A-23

Location: Approximately 30 yards northeast of a southeast-northwest road on a field trail through a pine grove (SE.1/4,NE.1/4, Sec.3, T.13N., R.8E.).

Elevation: 517 feet (altimeter).

Thickness (feet)	Depth (feet)	Description
		Zilpha formation
5.0	5.0	Clay, gray, red mottled.
2.0	7.0	Clay, red-brown, glauconitic; contains **limonite concretions** and ferruginous stains throughout.
2.0	9.0	Clay, light-gray, glauconitic; has streak of ferruginous stain.
7.0	16.0	Clay, gray, very glauconitic; contains much ferruginous staining and infrequent streaks of platy limonite.
2.5	18.5	Clay, light-gray to dark-gray, blocky, waxy.
8.5	27.0	Clay, dark-gray, blocky, waxy; contains streak of silt; bottom foot contains coarse-grained glauconite.
3.0	30.0	Clay, dark gray-green, glauconitic; contains **siderite nodules;** hard siderite ledge in bottom 3-inches.
		Winona formation
1.0	31.0	Sand, brown-green, glauconitic, very ferruginous.
10.0	41.0	Sand, as above, clayey; contains some ferruginous staining.

BENTON COUNTY

Core Hole B-1 (Drilled)

Location: On south side Hickory Flat-Blue Mountain road approximately 0.25 mile east of first road to south, east of Oklimeter Creek (SE.1/4, NE.1/4, Sec.17, T.5S., R.2E.). Immediately south of a dim woods trail leading north from gravel road.

Elevation: 583 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
1.0	1.0	Soil—Loam, gray, silty.
		Wilcox group (undifferentiated)
1.0	2.0	Sand, red and white, frosted, medium- to coarse-grained.
18.0	20.0	Clay, gray mottled lavender.
4.0	24.0	Clay, blue-gray, plastic.
1.0	25.0	Clay, as above; becoming lignitic.
4.0	29.0	Lignite, soft.
3.0	32.0	Clay, chocolate-brown, carbonaceous.
17.0	55.0	Clay, blue-gray, plastic.
2.0	57.0	Clay, brown, lignitic; contains thin streaks lignite.
3.0	60.0	Clay, white, kaolinitic.
8.0	68.0	Clay, as above; contains streaks of lignite.
7.5	75.5	Cored interval. Recovered 10-inches of tan, hard, **siderite.**
4.5	80.0	Clay, green-gray, slightly silty.
5.0	85.0	Clay, brown, lignitic; contains streaks lignite.
17.0	102.0	Kaolin, white, soft.
11.0	113.0	Clay, light-gray, slightly silty.
1.0	114.0	Quartzite, light-gray, very hard.
		Porters Creek formation (?)
56.0	170.0	Clay, dark-gray, micaceous; contains silty streaks.

Core Hole B-2

Location: Approximate center NW.1/4, Sec.16, T.5S., R.2E.

Elevation: 543 feet (plane table).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, gray-brown, silty.
		Wilcox group (undifferentiated)
5.0	7.0	Clay, red; contains streaks of ferruginous sand.
12.0	19.0	Clay, gray-white, slightly silty.
1.0	20.0	Clay, dark-brown, carbonaceous, lignitic.
5.0	25.0	Sand, white, fine-grained, angular crystals, possibly kaolinite.
2.0	27.0	Clay, gray, lignitic; contains lignite streaks.
13.0	40.0	Kaolin, white, soft.
10.0	50.0	Sand, light-gray, fine-grained.
13.0	73.0	Clay, light-gray, slightly silty.
1.0	74.0	Quartzite, light-gray, very hard.
16.0	90.0	Clay, dark-gray, micaceous, silty.

Core Hole B-3 (Drilled)

Location: On north side of road leading west at Flat Rock Church (NW.1/4, NW.1/4, NE.1/4, Sec.16, T.5S., R.2E.).

Elevation: 620 feet (plane table).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil and road fill.

Wilcox group (undifferentiated)

16.0	18.0	Sand, red and white, frosted, medium- to coarse-grained.
0.5	18.5	Ferruginous siltstone.
1.5	20.0	Clay, medium-gray, hard.
3.0	23.0	Clay, light-gray; contains streaks of carbonaceous clay.
2.0	25.0	Clay, brown, carbonaceous; contains thin bed of lignite at top.
5.0	30.0	Clay, white to light-gray, plastic.
10.0	40.0	Clay, medium-gray, slightly silty.
2.5	42.5	Clay, buff; contains streaks of ferruginous sand.
9.5	52.0	Sand, tan to buff, fine-grained; has mealy clayey texture.
10.0	62.0	Cored interval. Recovered 4-inches of siderite and limonite and 9.5 feet of sand, as at 42.5-52.0 feet.
26.0	88.0	Sand, as above; becoming gray at 65 feet.
14.0	102.0	Sand, gray, fine- to medium-grained, disseminated lignite.
7.0	109.0	Kaolin, white, soft.
1.0	110.0	Clay, gray, kaolinitic, silty.
7.0	117.0	Kaolin, very light-gray, soft.
3.0	120.0	Clay, gray, carbonaceous, slightly lignitic.
		Porters Creek formation
80.0	120.0	Clay, dark-gray, slightly micaceous, tough.

CORE HOLE B-4 (Drilled)

Location: Approximately 600 feet south of road leading west from Flat Rock Church on dim woods trail (100 feet north 10 feet west SE. cor. SW.1/4, SW.1/4, Sec.9, T.5S., R.2E.).

Elevation: 551 feet (plane table)

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil, gray, silty loam.
		Wilcox group (undifferentiated)
2.5	4.5	Clay, red-brown, sandy.
0.5	5.0	Ferruginous sandstone, brown.
7.0	12.0	Clay, gray mottled brown and red.
7.0	19.0	**Bentonite,** tan, crumbly.
1.0	20.0	Clay, tan to buff, sandy, silty.
10.0	30.0	Cored interval. Recovered 1-foot of gray-white **siderite,** and 3-feet of gray, sandy, bentonitic clay.
7.0	37.0	Clay, as cored above.
4.0	41.0	Lignite and lignitic clay.
6.0	47.0	Sand, white, fine-grained, angular crystals, possibly kaolinite.
0.5	47.5	Wood fragments from buried log.
2.5	50.0	Clay, light-gray, very plastic.
18.0	68.0	Kaolin, white, soft.
		Porters Creek formation (?)
52.0	120.0	Clay, medium-gray to dark-gray, finely micaceous, very slightly silty.

Core Hole B-5 (Drilled)

Location: Approximately 200 feet east of woods trail leading north from B-1 on Hickory Flat-Blue Mountain road (SE. cor. SE.1/4, NE.1/4, Sec.17, T.5S., R.2E.).

Elevation: 557 feet (plane table)

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil, red, sandy.
		Wilcox group (undifferentiated)
3.5	5.5	Clay, gray mottled red.

1.5	7.0	Limonite, dark-red.
14.0	21.0	Clay, gray-tan, bentonitic; becomes darker at 17 feet.
6.0	27.0	Clay, chocolate-brown, carbonaceous.
1.5	28.5	Clay, green-gray, plastic.
2.5	31.0	Cored interval. Recovered 13-inches of gray-white **siderite.**
9.0	40.0	Clay, gray, bentonitic, slightly sandy.
4.0	44.0	Lignite, black to brown.
2.0	46.0	Sand, tan, fine-grained, angular crystals.
16.0	62.0	Kaolin, blue-gray, soft.
		Porters Creek formation (?)
38.0	100.0	Clay, dark-gray, slightly micaceous.

Core Hole B-6 (Drilled)

Location: Approximately 150 yards west of house and 200 yards north of Hickory Flat-Blue Mountain road (SE.1/4, SW.1/4, NE.1/4, Sec.17, T.5S., R.2E.).

Elevation: 552 feet (plane table).

Thickness (feet)	Depth (feet)	Description
3.0	3.0	Soil and fill in old depression on ridge.
		Wilcox group (undifferentiated)
15.0	18.0	Clay, gray, kaolinitic (?).
9.5	27.5	Clay, dull vari-colored, rotten, flaky.
2.5	30.0	Lignite.
8.0	38.0	Clay, as at 18-27.5 feet; contains streaks of green clay.
1.0	39.0	Lignite.
13.5	52.5	Clay, brown, carbonaceous, lignitic; alternating with green clay.
10.5	63.0	Kaolin, white, soft.
21.0	84.0	Clay, chocolate-brown, carbonaceous; grading into dark-gray clay.
0.5	84.5	Quartzite, gray, dense, hard (could not penetrate).

Core Hole B-7 (Drilled)

Location: On north side Hickory Flat-Blue Mountain road (SW.1/4, SW.1/4, NE.1/4, Sec.17, T.5S., R.2E.), approximately 0.5 mile east of bridge across Oklimeter Creek.

Elevation: 560 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
3.0	3.0	Soil and road fill.
		Wilcox group (undifferentiated)
5.0	8.0	Clay, gray mottled red, sandy.
7.0	15.0	Clay, gray, very plastic when wet; contains brown to gray pisolites (bauxitic).
3.0	18.0	Kaolin, light gray, soft.
6.0	24.0	Clay, brown, very carbonaceous; contains streak of soft, brown lignite at top.
6.0	30.0	Clay, green; contains streaks of gray, slightly silty clay.
6.0	36.0	Clay, gray, slightly silty, finely micaceous.
13.0	49.0	Clay, brown, very carbonaceous; contains streaks of lignite.
14.0	63.0	Kaolin, gray-white; very sandy at 50-53 feet.
37.0	100.0	Clay, dark-gray, slightly silty, finely micaceous; contains 2-inch streak quartzite at 87 feet that probably marks the top of the Porters Creek formation.

Core Hole B-8 (Drilled)

Location: Atop ridge in SE.1/4, NW.1/4, Sec.31, T.5S., R.1E., approximately 600 feet east of road leading north to U. S. Highway 78.

Elevation: 470 feet (topographic map)

Thickness (feet)	Depth (feet)	Description
1.0	1.0	Soil, gray, sandy.
		Wilcox group (undifferentiated)
2.5	3.5	Clay, buff and gray mottled, silty, jointed.
1.0	4.5	Limonite concretion, brown, hollow.
5.5	10.0	Clay, gray, slightly silty; has ferruginous staining throughout.
5.0	15.0	Clay, brown, carbonaceous, lignitic.
4.0	19.0	Clay, gray, slightly carbonaceous.
1.0	20.0	Lignite, brown, soft, rotten.
5.0	25.0	Clay, gray-brown, very plastic.
4.0	29.0	Clay, gray-buff, silty.
1.0	30.0	Clay, gray, very plastic, slightly carbonaceous.
0.5	30.5	Lignite.
9.5	40.0	Clay, dark-gray; contains alternating beds of lignite 6 to 12 inches thick.
2.0	42.0	Lignite, black.
3.0	45.0	Clay, blue-green, very plastic.
23.5	68.5	Clay, brown, lignitic; contains streaks of blue-green clay.
3.0	71.5	Cored interval. No recovery; 4-inch ledge at top possibly siderite.
13.5	85.0	Clay, as 45 to 68.5 feet.
0.3	85.3	4-inch ledge, possibly siderite.
53.7	139.0	Clay, gray, slightly silty, micaceous, plastic; contains alternating beds of lignite and vari-colored clay.
69.0	208.0	Sand, gray, medium-grained; contains streaks of silty clay.
22.0	230.0	Clay, dark-gray, slightly silty, slightly micaceous.

Core Hole B-9 (Drilled)

Location: Approximately 1300 feet east of road leading north to U. S. Highway 78 on ridge in NE.1/4, NW.1/4, Sec.31, T.5S., R.1E.

Elevation: 480 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil, gray, silty, sandy.
		Wilcox group (undifferentiated)
14.0	16.0	Clay, buff, gray, tan, slightly silty.
1.0	17.0	Clay, brown, lignitic.
2.0	19.0	Lignite.
11.0	30.0	Clay, brown, lignitic; contains alternating streaks of lignite.
15.0	45.0	Clay, blue-green, very plastic.
23.0	68.0	Clay, gray, slightly silty, slightly micaceous.
12.0	80.0	**Siderite** (?), gray, firm, non-calcareous; interbedded with gray clay.
5.0	85.0	Clay, gray, slightly silty.
5.0	90.0	Clay, tan-buff, sandy in part; contains streaks of ferruginous sand.
15.0	105.0	Sand, gray, fine-grained; contains streaks of sandy clay.
5.0	110.0	Clay, gray, silty; contains streaks lignite and brown lignitic clay.

CARROLL COUNTY

Core Hole C-4

Location: On north side of Winona-McCarley road where road makes right angle turn to north (SW. cor. NE.1/4, NW.1/4, Sec.13, T.19N., R.4E.), approximately 0.7 mile south of McCarley.

Elevation: Not available.

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil and fill in road ditch.
		Kosciusko formation (?)
5.0	7.0	Sand, orange-red, medium- to coarse-grained.
		Zilpha formation
12.0	19.0	Clay, gray, blocky, plastic; contains silty streaks.
1.0	20.0	Sand, red-brown, glauconitic; has ferruginous staining.
0.5	20.5	**Siderite,** tan, glauconitic, hard, slightly fossiliferous.
3.0	23.5	Glauconite, dark-green; has slightly sandy, clay matrix.

Core Hole C-5

Location: On south side of McCarley-Winona road approximately 1.3 miles east of C-4 (NE.1/4, SW.1/4, Sec.18, T.19N., R.5E.) by drive leading to tenant house.

Elevation: Not available.

Thickness (feet)	Depth (feet)	Description
3.0	3.0	Soil and fill in road ditch.
		Zilpha formation (?)
8.0	11.0	Clay, gray mottled red, slity.
2.0	13.0	Glauconite, weathered red-brown; contains **limonite nodules** and **concretions.**
7.0	20.0	Clay, dark gray-green, very glauconitic, sandy; contains nodules and layers of sideritic material.

Core Hole C-6

Location: Approximately 0.1 mile south of bridge across Big Sand Creek in yard of vacant tenant house 75 feet east of road, (SE.1/4, NW.1/4, NW.1/4, Sec.17, T.19N., R.5E.)

Elevation: Not available.

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil, buff-brown, silty
		Zilpha formation (?)
6.0	8.0	Clay, gray mottled red, silty.
6.0	14.0	Sand, red-brown, very argillaceous, sparingly glauconitic; contains **limonite concretions** and **nodules.**
16.0	30.0	Sand, buff-brown, clayey, glauconitic in part; contains streaks of clay with ferruginous staining and particles throughout.

KEMPER COUNTY

Core Hole K-1 (Drilled)

Location: Approximately 2 miles east of DeKalb city limits on top of hill at junction of State Highway 16 and a field road in the SE. cor. NE.1/4, NE.1/4, Sec.25, T.11N., R.16E.

Elevation: 400 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, gray, silty.
		Naheola formation
2.0	4.0	Clay, gray-green, silty, micaceous.
5.0	9.0	Sand, light yellow-buff, clayey, micaceous.
16.0	25.0	Clay, gray, silty, very micaceous, tough; contains **siderite nodules** and **concretions throughout.**
		Porters Creek formation (Matthews Landing marl member)
7.0	32.0	Clay, gray-green, marly, glauconitic, slightly fossiliferous; contains **siderite nodules throughout.**
		Porters Creek formation
18.0	50.0	Clay, dark-gray, micaceous.

Core Hole K-2 (Drilled)

Location: Approximately one-half mile southeast of State Highway 16 on a farm ridge road leading southeast from a point where Highway 16 curves to the northeast (NE.1/4, SW.1/4, Sec.30, T.11N., R.17E.).

Elevation: 370 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
1.0	1.0	Soil—Loam, red-brown, silty, sandy.
		Porters Creek formation (Matthews Landing marl member)
3.0	4.0	Clay, green-buff, very clayey, micaceous; contains **limonite concretions.**
3.0	7.0	Clay, as above; contains no limonite.
6.5	13.5	Clay, gray; contains streaks of silt and mica along jointing.
6.0	19.5	Clay, as above, sandy; contains **limonite concretions.**
		Porters Creek formation
10.5	30.0	Clay, dark-gray, tough, slightly micaceous.

Core Hole K-3 (Drilled)

Location: Approximately 500 yards southeast of K-1 and 600 yards northwest of K-2 (NE.1/4, SW.1/4, NW.1/4, Sec.30, T.11N., R.17E.).

Elevation: 390 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, light-colored, silty.
		Naheola formation
8.0	10.0	Clay, red and buff, silty and sandy, micaceous; contains **limonite concretions.**
15.0	25.0	Clay, gray, micaceous, silty.
		Porters Creek formation (Matthews Landing marl member)
5.0	30.0	Clay, green-gray, marly, glauconitic, micaceous; contains **siderite nodules** throughout.
		Porters Creek formation
10.0	40.0	Clay, dark-gray, slightly micaceous; conchoidally fractured.

Core Hole K-4

Location: Approximately 4.5 miles northeast of the city limits of DeKalb in the Flinkote Forest (NW.1/4, NE.1/4, SW.1/4, Sec.36, T.12N., R.16E.).

Elevation: 517 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, brown, sandy, silty.
		Naheola formation
3.0	5.0	Sand, red, fine-grained, very clayey; has limonitic staining.
3.0	8.0	Sand, buff to red, fine-grained; has limonitic staining.
0.5	8.5	Limonite, brown, very hard, sandy.
5.5	14.0	Sand, gray-green, glauconitic, clayey.
0.3	14.3	Limonite, brown.
		Porters Creek formation (Matthews Landing marl member)
4.6	19.0	Clay, green-gray, marly, glauconitic, micaceous, plastic.
1.0	20.0	**Siderite,** light-gray, glauconitic.
1.0	21.0	Clay, gray-green, glauconitic; contains **8-inch ledge of siderite.**
1.5	23.5	Clay, as above; contains **6-inch ledge of siderite.**
1.5	25.0	**Siderite,** tan, glauconitic.
3.0	28.0	Clay, gray-green, glauconitic, micaceous.
1.0	29.0	**Siderite,** hard to soft, light-gray.
2.0	31.0	Clay, gray-green, as above.
1.0	32.0	**Siderite,** 10-inches thick with clay as above.
		Porters Creek formation
11.0	43.0	Clay, dark-gray, conchoidally fractured; contains scattered siderite nodules.
1.0	44.0	Clay, as above; contains 10-inch ledge of **siderite.**
6.0	50.0	Clay, gray-green, glauconitic, sandy, micaceous; contains **siderite nodules** throughout.

Core Hole K-7 (Drilled)

Location: East side of State Highway 39, 0.8 mile south of Spring Hill Church (NW.1/4, SW.1/4, SW.1/4, Sec.34, T.12N., R.16E.).

Elevation: 470 feet (topographic map)

Thickness (feet)	Depth (feet)	Description
		Naheola formation
11.0	11.0	Sand, white to buff-red, fine- to medium-grained.
0.5	11.5	**Limonite** altered from siderite.
3.5	15.0	Clay, dark-brown to gray, silty, micaceous.
		Porters Creek formation (Matthews Landing marl member)
4.5	19.5	Sand, dark-green, glauconite.
1.0	20.5	**Siderite,** gray, glauconitic.
3.5	23.5	Clay, dark-gray; interbedded with glauconite.
1.5	25.0	**Siderite,** gray-tan, nodular.
1.0	26.0	Clay as above.
0.3	26.3	**Siderite,** tan, glauconitic.
1.5	30.8	Clay, dark-gray, very finely micaceous.
1.5	32.3	**Siderite,** gray-tan glauconitic.
2.7	35.0	Sand, dark-green, glauconitic, micaceous.
9.0	44.0	Clay, gray, micaceous; interbedded with dark-green glauconite.
1.0	45.0	**Siderite,** tan, glauconitic.
		Porters Creek formation
5.0	50.0	Clay, dark-gray, waxy, conchoidally fractured, slightly micaceous.

Core Hole K-8 (Drilled)

Location: Approximately 1000 feet south-southwest of K-7 on west side of State Highway 39 (NE. cor. Sec.39, T.11N., R.16E.).

Elevation: 420 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
3.0	3.0	Soil—Loam, brown, sandy.
		Naheola formation
7.0	10.0	Clay, tan to buff-brown, silty, micaceous.
		Porters Creek formation (Matthews Landing marl member)
8.0	18.0	Clay, dark-gray, micaceous, interbedded with dark-green glauconite; contains **two 2-inch ledges of siderite.**
1.0	19.0	**Siderite,** tan, glauconitic.
26.0	45.0	Clay, as above.
		Porters Creek formation
5.0	50.0	Clay, dark-gray, finely micaceous, conchoidally fractured, waxy.

Note: This hole is located on a large "slump" block or the downthrown side of a fault. A definite break in the bedding between K-7 and K-8 was evident in the fresh road cut exposed at time of drilling. Top of Porters Creek formation indicates 45 feet of displacement between the two core holes.

Core Hole K-9

Location: Approximately 2 miles north of Spring Hill Church on the east side of State Highway 39 (SE.1/4, SE.1/4, SE.1/4, Sec.16, T.12N., R.16E.).

Elevation: 510 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
		Naheola formation
8.5	8.5	Sand, yellow-buff and light-gray, fine-grained, very clayey; contains streaks of ferruginous staining, slightly micaceous in lower 2 feet.
0.3	8.8	Limonite, brown, sandy.
6.2	15.0	Sand, light-gray to white, fine-grained, finely micaceous; contains streaks of platy limonite.
1.0	16.0	Clay, dark-gray; contains thin laminae of glauconitic sand; grades in to dark-green glauconite.
		Porters Creek formation (Matthews Landing marl member)
1.3	17.3	**Siderite,** tan to light gray-brown, glauconitic.
1.2	18.5	Clay, dark-green, very glauconitic.
2.5	21.0	**Siderite,** glauconitic, nodular and concretionary.
6.5	27.5	Clay, dark-gray; contains thin laminae of glauconite.
4.8	32.3	Clay, tan to buff, silty, micaceous.
0.7	33.0	**Siderite,** tan, glauconitic.
		Porters Creek formation
8.0	41.0	Clay, tan to gray, slightly silty and micaceous.
0.8	41.8	**Siderite;** has limonite outer shell.
15.2	57.0	Clay, dark-gray, micaceous; contains streaks of glauconite.
0.5	57.5	**Siderite,** light-gray.
1.5	59.0	Clay, as above.
1.0	60.0	**Siderite,** light-gray.
30.0	90.0	Clay, dark-gray, slightly glauconitic, slightly micaceous; becoming tough and plastic.

Core Hole K-10

Location: Approximately 5 miles southeast of DeKalb on road leading south from the Carters community (Cen. NE.1/4, NE.1/4, Sec.5, T.10N., R.17E.).

Elevation: 340 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, red-brown, sandy.
		Porters Creek formation (Matthews Landing marl member)
4.0	6.0	Clay, marly, glauconitic; contains **abundant limonitic concretions and nodules altered from siderite.**
6.0	12.0	clay, red-brown, silty, micaceous; grades in to gray, blocky clay. Possibly the top of the typical Porters Creek clay is at 8 feet.

Core Hole K-11

Location: Approximately 4 miles southeast of DeKalb on the north side of an east-west road at the SW/cor. NW.1/4, Sec.8, T.10N., R.17E.

Elevation: 414 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
3.0	3.0	Old road bed.
		Naheola formation
7.0	10.0	Clay, light-gray, silty, very finely micaceous.
7.0	17.0	Sand, light-gray, very fine-grained, very clayey, finely micaceous, silty.
1.5	18.5	Lignite, soft, black.
9.5	28.0	Clay, gray-brown, very plastic, carbonaceous; contains thin streaks of lignite.
20.0	48.0	Clay, gray-brown, micaceous; interbedded with fine-grained, micaceous. lignitic sand.
27.0	75.0	Clay, dark-gray, slightly silty, micaceous.
		Porters Creek formation (Matthews Landing marl member)
5.0	80.0	Clay, dark gray-green, glauconitic, micaceous; contains bed of **siderite nodules and concretions** at 76-77 feet; very glauconitic in bottom 3 feet.
0.5	80.5	**Siderite,** tan, glauconitic.
		Porters Creek formation
2.0	82.5	Clay, dark-gray, slightly glauconitic.
0.5	83.0	**Siderite,** tan, glauconitic.
7.0	90.0	Clay, dark-gray, finely micaceous.

MONTGOMERY COUNTY

Core Hole M-1

Location: Approximately 20 feet west of road leading north at Fox community intersection on Winona-Lodi road (NW/cor. NE.1/4, NE.1/4, Sec.16, T.19N., R.6E.), in front of vacant tenant house.

Elevation: 460 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
3.0	3.0	Soil, red brown, clayey, silty and sandy.
		Zilpha formation
7.5	10.5	Clay, gray mottled red, blocky.
4.5	15.0	Clay, gray, blocky; glauconite interbedded.
		Winona formation

2.0	17.0	Sand, gray-green, slightly micaceous, glauconitic; glauconite partially oxidized red-brown.
3.5	20.5	Sand, gray-green, glauconitic; contains streaks of drab-green, sandy, silty clay.
2.5	23.0	As above except the streaks of clay have oxidized to red-brown.
7.0	30.0	Sand, gray-green, slightly glauconitic; contains streaks green, silty clay.

Core Hole M-2

Location: On north side of field road leading west off gravel road from U. S. Highway 82 to Bethesda Church. (Cen. South line SE.1/4, NE.1/4, Sec.7, T.19N., R.6E.).

Elevation: 470 feet (topographic map)

Thickness (feet)	Depth (feet)	Description
2.5	2.5	Soil—Loam red-brown, sandy.
		Zilpha formation
6.5	9.0	Clay, gray, blocky, slightly silty.
1.0	10.0	Clay, as above; interbedded with gray-green, glauconitic sand.
1.5	11.5	Clay, red-brown, sandy, slightly glauconitic.
		Winona formation
1.0	12.5	**Limonite** and red-brown, sandy, oxidized glauconite; contains gray-green, slightly glauconitic sand.

Core Hole M-5

Location: On southeast side of road leading southwest approximately 0.4 mile from junction with State Highway 407 (North line SE.1/4, SE.1/4, Sec.7, T.18N., R.6E.).

Elevation: Not available.

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil, gray, silty.
		Zilpha formation
8.5	10.5	Clay, gray mottled red, slightly silty.
		Winona formation
17.0	27.5	Sand, green-gray, glauconitic; glauconite partially oxidized.
4.5	32.0	Sand, gray-green, slightly glauconitic.

Core Hole M-6

Location: In church yard on road right-of-way approximately 100 feet north of road intersection (NW. cor. SE.1/4, SE.1/4, Sec.19, T.18N., R.6E.).

Elevation: Not available

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, gray, silty.
		Zilpha formation
5.0	7.0	Clay, gray mottled red, silty.
		Winona formation (?)
1.0	8.0	Sand, red-brown, clayey, glauconitic; contains **ledges of limonite;** glauconite oxidized red-brown.
6.0	14.0	Sand, red-brown to buff, fine- to medium-grained, glauconitic; contains small pockets of glauconitic limonite.
10.0	24.0	Sand, buff to gray-green, slightly glauconitic, clayey.
8.0	32.0	Sand, gray-green, slightly glauconitic, slightly clayey.

Core Hole M-9

Location: On hilltop 2.5 miles east of Winona on south side of Columbus and Greenville Railroad on county road parallel with railroad. (SE.1/4, SE.1/4, SE.1/4, Sec.29, T.19N., R.6E.).

Elevation: Not available.

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil, red-brown, sandy, silty.
		Winona formation
4.0	6.0	Clay, red-brown, sandy.
6.0	12.0	Clay, red, glauconitic, sandy; contains **limonite nodules.**
5.0	17.0	Sand, brown-green, glauconitic, limonitic.
13.0	30.0	Sand, green-buff, glauconitic; contains streaks silty, sandy clay.

Core Hole M-10

Location: Approximately 1.0 mile west of M-9 on north side of road (SE cor. NE.1/4, NE.1/4, Sec.31, T.19N, R.6E.), 1.5 miles east of Winona.

Elevation: Not available.

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil, red-brown, clayey, silty.
		Winona formation (?)
6.0	8.0	Sand, red-brown, glauconitic, very clayey.
4.0	12.0	Sand, buff-green; contains **limonite ledges.**
10.0	22.0	Sand, red-brown, clayey, limonitic; glauconite altered to limonite.

Core Hole Mwx-1 (Drilled)

Location: Approximately one mile north of Lodi (NW.1/4, SW.1/4, Sec.25, T.20N., R.7E.), about 600 feet south of east-west road at southeast corner of an abandoned strip mine by a vacant house.

Elevation: 425 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil, red, sandy loam.
		Wilcox group (undifferentiated)
8.0	10.0	Sand, red, fine- to medium-grained, clayey.
2.5	12.5	Clay, light-gray mottled red, sandy.
10.0	22.5	Clay, light-gray mottled red; contains limonite partings and staining.
2.5	25.0	Clay, medium-gray, slightly silty and carbonaceous.
5.0	30.0	Sand, gray, fine-grained, slightly micaceous, slightly tastes of iron sulphide, fairly clayey.
9.0	39.0	Clay, medium-gray, slightly silty and micaceous; contains streak of limonite at 39 feet.
9.0	48.0	Sand, gray, fine-grained; alternating with medium-gray limonite stained clay.
52.0	100.0	Sand, gray to brown, medium-grained; contains many dark grains and streaks of clay.

Core Hole Mwx-2 (Drilled)

Location: Approximately one mile north of Lodi (NE.1/4, NE.1/4, SE.1/4, Sec.26, T.20N., R.7E.), about 200 feet west of road at junction of road to east.

Elevation: 460 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil, red, sandy clay.
		Wilcox group (undifferentiated)
7.0	9.0	Sand, red, medium-grained.
9.0	18.0	Clay, gray-white, plastic.
18.5	36.5	Sand, gray-buff, medium-grained; contains large mica flakes.
23.5	60.5	Clay, light-gray, plastic; contains 4-inch streak of lignite at top.

Core Hole Mwx-3 (Drilled)

Location: Approximately 2 miles south of Alva on a trail leading northeast of the Alva-Lodi road (NE.1/4, SW.1/4, SE.1/4, Sec.12, T.20N., R.7E.), South Alva Area.

Elevation: 432 feet (plane table).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, gray, sandy, silty.
		Wilcox group (undifferentiated)
4.0	6.0	Clay, red-buff, sandy.
1.5	7.5	**Limonite concretion.**
5.5	13.0	Clay, white, slightly sandy.
0.5	13.5	**Limonite concretion.**
10.5	24.0	Clay, dark-gray and brown, lignitic; contains streaks of lignite.
8.0	32.0	Clay, medium-gray, plastic; contains 3-inch streak of limonite at 30 feet.
4.0	36.0	Clay, dark-brown, lignitic.
3.0	39.0	Clay, gray, plastic.
1.0	40.0	**Siderite concretion;** outer shell is altered to limonite.
2.0	42.0	Clay, medium-gray, plastic.
3.0	45.0	Lignite, brown; contains streaks of lignitic clay.
10.0	55.0	Clay, light-gray, plastic; contains streaks of lignite and lignitic clay.
5.0	60.0	Clay, gray, silty; becomes sandy and contains thin laminae of carbonaceous material.
25.0	85.0	Sand, gray, fine-grained, clayey, carbonaceous, micaceous.
15.0	100.0	Clay, medium-gray, slightly silty and micaceous; contains 3-inch streak siderite at 94 feet.

Core Hole Mwx-4 (Drilled)

Location: Approximately 3/8 mile northeast of Mwx-3 by old house site, NE.1/4, NW.1/4, SE.1/4, Sec.12, T.20N., R.7E.

Elevation: 430 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, gray, sandy, silty.
		Wilcox group (undifferentiated)
8.0	10.0	Clay, gray mottled red, sandy, silty.
5.0	15.0	Clay, light-gray; has some red staining; contains thin streak of limonite at 14 feet.
10.0	25.0	Clay, medium-gray and tan; has limonite staining throughout.

1.0	26.0	**Limonite concretion.**
1.5	27.5	Sand, yellow; has ferruginous staining.
0.5	28.0	Clay, medium-gray, slightly silty.
2.0	30.0	Sand, light-gray, very micaceous.
6.0	36.0	Clay, gray and tan, slightly carbonaceous.
9.0	45.0	Sand, gray, fine-grained, micaceous.
2.5	47.5	Clay, medium-gray, slightly silty.
12.5	60.0	Sand, light-gray, fine-grained, carbonaceous, slightly micaceous.

WEBSTER COUNTY

Core Hole W-1

Location: On south side of road approximately one-eighth mile east of junction of road to south along county line (NW.1/4, SW.1/4, Sec.18, T.20N., R.8E.).

Elevation: 470 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
5.0	5.0	Soil and colluvium (red sandy clay in road ditch).
		Wilcox group (undifferentiated)
7.0	12.0	Clay, gray mottled red, slightly silty.
2.0	14.0	Clay, gray, sandy; has ferruginous staining and limonitic partings.
5.0	19.0	Clay, brown, carbonaceous, lignitic.
10.0	29.0	Clay, gray-brown, slightly carbonaceous.
3.0	32.0	Lignite, black, brittle.
3.0	35.0	Clay, bright-green, plastic.
15.0	50.0	Clay, medium-gray, slightly silty, micaceous; becoming sandy at 48 feet.
15.0	65.0	Sand, medium-gray, very fine-grained, clayey, slightly micaceous; contains streaks of clay as above.
45.0	110.0	Sand, gray-buff, medium- to coarse-grained.

Core Hole W-2

Location: On north side of road approximately one-fourth mile east of junction with north-south road (NW.1/4, NE.1/4, Sec.19, T.20N., R.8E.).

Elevation: 480 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, light-gray, sandy.
		Wilcox group (undifferentiated)
4.0	6.0	Clay, red, sandy.
1.0	7.0	**Limonite concretion**
3.0	10.0	Clay, light-gray mottled red.
2.5	12.5	Clay, brown, carbonaceous.
10.0	22.5	Clay, light-gray, plastic, very slightly silty in part.
6.5	29.0	Clay, white, sandy; has ferruginous staining near top.
2.0	31.0	Clay, white, plastic.
19.0	50.0	Sand, light-gray to tan, fine-grained, clayey.
22.0	72.0	Sand, red, fine- to medium-grained; contains many dark grains.
18.0	90.0	Clay, medium-gray, slightly silty; contains streaks of very fine-grained, slightly micaceous sand.
60.0	150.0	Sand, medium-gray, fine-grained, argillaceous, micaceous, carbonaceous in part; contains thin streak of lignitic clay at 139 feet.

Core Hole W-3 (Drilled)

Location: On east side of old logging trail leading southwest from "S" curve in north-south road (SE.1/4, SW.1/4, Sec.19, T.20N., R.8E.), approximately three-eighths mile southwest of junction of trail and road.

Elevation: 520 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, gray, sandy.
		Wilcox group (undifferentiated)
10.0	12.0	Sand, red-orange, fine- to medium-grained, clayey.
83.0	95.0	Sand, white, fine-grained, finely micaceous; contains infrequent thin streaks of white clay.
3.5	98.5	Sand, red-brown, coarse-grained; has ferruginous cementing material.
41.5	140.0	Clay, medium-gray, very plastic; contains 2-inch streak of siderite at 119 feet.
1.0	141.0	Clay, white, very plastic.
9.0	150.0	Clay, medium-gray, slightly silty.

Core Hole W-4 (Drilled)

Location: On top of hill at an old house site on southeast side of road leading from Alva to Spring Hill School (SW.1/4, NW.1/4, Sec.28, T.21N., R.8E.), approximately one mile east of junction of a northbound road.

Elevation: 410 feet (topographic map).

Thickness (feet)	Depth (feet)	Description
2.0	2.0	Soil—Loam, gray-brown, silty.
		Wilcox group (undifferentiated)
16.0	18.0	Clay, gray mottled red, silty and sandy; contains 4-inch limonite concretion at 8 feet and a 6-inch concretion at 16 feet.
12.0	30.0	Clay, light-gray; interbedded with fine-grained, slightly micaceous sand.
10.0	40.0	Sand, tan, fine-grained, very clayey; contains streaks of clay.
31.0	71.0	Sand, tan, fine-grained, micaceous.
8.0	79.0	Clay, gray, slightly silty, micaceous.
1.0	80.0	Clay, green, plastic.
35.0	115.0	Clay, medium-gray, slightly silty, micaceous.
35.0	150.0	Clay, gray, sandy; contains streaks of fine-grained sand having carbonaceous laminae.

MANGANIFEROUS MATERIAL

Manganese is an essential mineral for any industrial nation because of its necessity in the manufacture of steel. The United States, the world's largest consumer of manganese, has a use distribution as follows: metallurgical, 92 percent; chemical and miscellaneous, 5 percent; and dry cell battery manufacture, 2 percent. Industrial consumtion in 1961 was 1,717,805 short tons of manganese ore (35% Mn or more). The domestic production of ore was 46,088 short tons, while imports from Africa, Brazil, India, Mexico and other countries came to 2,100,000 short tons.

Because of small domestic reserves of commercial quality of manganese ore the United States has listed it as a strategic mineral since 1916. The Nation's domestic resources of manganese consist of large deposits of low-grade ore and open-hearth furnace slags. According to the U. S. Bureau of Mines the 1961 price of imported ores was approximately $0.90 per long ton unit, based on metallurgical grade ore with 48 percent Mn from India.

Manganese minerals are found in chemical forms of the oxide, the carbonate, and the silicate. Most all commercial deposits are of secondary formation and the oxide form is predominant.

Commercial mineral forms and theoretical chemical percent Mn are as follows:

Mineral	Composition	Percent Mn
Pyrolusite	MnO	63
Manganite	$Mn_2O_3 \cdot 2H_2O$	62.4
Psilomelane	$MnO \cdot MnO_2 \cdot 2H_2O$	45-60
Hausmanite	Mn_3O_4	72.5
Rhodochrosite	$MnCO_3$	47.6
Rhodonite	$MnSiO_3$	41.6
Bementite	$2MnSiO_3 \cdot H_2O$	39.1

Psilomelane and pyrolusite are the oxide forms which are the chief source of manganese.

The four modes of origin are given as hydrothermal, sedimentary, residual concentrations and metamorphosed deposits. As stated previously, most of the commercial deposits are of

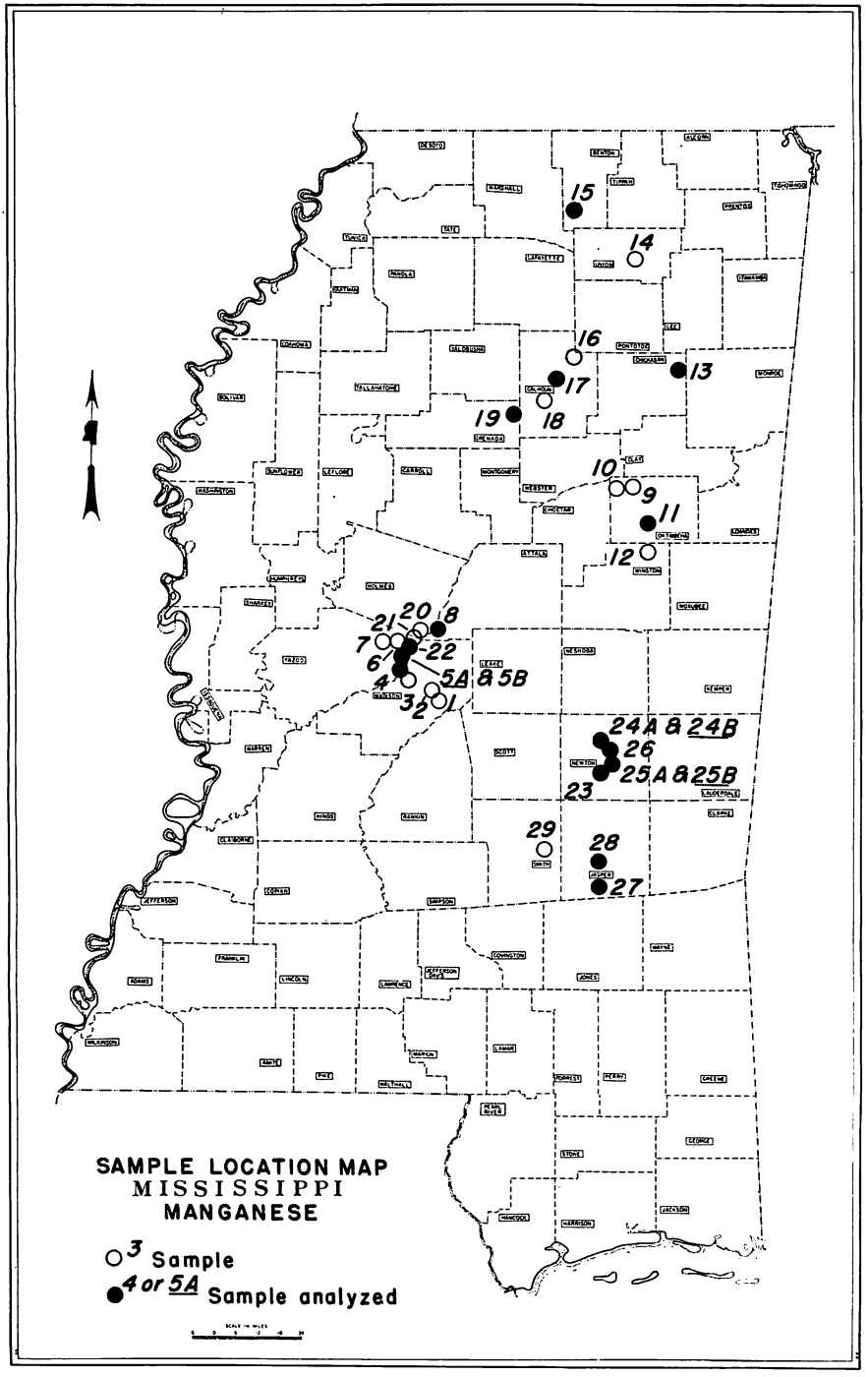

Figure 11.—Map of Mississippi showing locations of manganiferous materials sampled and analyzed.

secondary formation, being concentrations of the more sparsely distributed minerals.

In Mississippi occasional reports of black or brown oxides of manganese present in very small percentages in soils, surficial deposits and the sediments of various geologic formations are made. Lowe (1915, Bull. 12) lists several soil analyses that have a manganese oxide content ranging from 0.01 to 0.7 percent. Analyses of some of the marls and limestones presented by Logan (1916, Bull. 13) show a content of manganese dioxide of from 0.03 to 0.4 percent.

Manganese is present in most of the iron ores that have been analyzed. Lowe's (1913, Bull. 10) analyses showed as much as 12.30 percent metallic manganese in the iron ore of Benton and Marshall Counties. Several other analyses show contents which average between four and five percent of manganese.

A period of less than two weeks was spent collecting samples of manganiferous material for chemical analyses in the north and central portions of the State. (Figure 11). Soil surveys, conducted by the U. S. Department of Agriculture in cooperation with the Mississippi Agricultural Experiment Station, were used as a guide in locating areas for sampling those soil series which have been reported as "buckshot" soil. The soils found to contain the greater abundance of these nodules or "buckshot" masses are the lower phases of those series known as the Lintonia loam, the Memphis silt loam, Bibb fine sandy loam and others in areas of poor drainage. Commonly these nodules are formed at the hard pan zone (Table IV).

The nodules are usually brown on the weathered exterior having a dark-brown to black interior. They range in size up to one-half inch in diameter, but commonly much smaller. Accumulations of the nodules are found to be as much as one foot thick in places. Often the surface will be barren of vegetation and the concretions weather out on the surface as "gravel." In some places the thick accumulation of the concretions seem to coalesce and form an indurated bed. Such deposits were sampled in Yazoo County on the Lloyd Dixon property (Sample Mn-22) in the Big Black River valley and also in Newton County in the Okahatta Creek valley on the "Sam" Smith

TABLE IV

Sample No.	Location	Soil Association	Geologic Outcrop Belt	Remarks
1	200 yds. E. road-house on N. side State Hwy.16. NW¼ SW¼, Sec.13, T.9N, R.3E, Madison Co.	Grenada silt loam	Moodys Branch	Weathered Moodys Branch fm., 8 in.zone at base soil zone; concretionary on surface.
2	S. side State Hwy. 43, 2 mi. SW Sharon, SW/c NE¼ NW¼, Sec. 11, T.9N, R.3W, Madison Co.	Grenada silt loam	Moodys Branch	Weathered Moodys Branch fm.; concretionary on surface.
3	On NE side State Hwy. 16, 0.25 mi. NW intersection with east-west road; NE¼ NW¼ Sec.36, T.10N, R.2E, Madison Co.	Grenada silt loam	Poss. Moodys Branch	Concretionary on surface. May be soil on Yazoo clay.
4	100 yds. W. State Hwy. 16, 0.25 mi. SE junction with road to north, NW¼ NW¼ Sec.9, T.10N, R.2E, Yazoo Co.	Weathered bed rock	Yazoo	Approx. 10 ft. above Moodys Branch, 6 to 8 in. thick.
5-A	East side railroad 0.5 mi. N. Vaughn P.O., SE/c NE¼ Sec. 12, T.11N, R.2E, Yazoo Co.	Lintonia loam	Old Terrace over Cockfield	Concretionary surface material.
5-B	Same as 5-A	Lintonia loam	Old Terrace over Cockfield	Sample dug from about 8 in. below surface.
6	Approx. 0.5 mi. NW of No.5 loc. in bottom of ditch. SW¼ SE¼ Sec.1, T.11N, R.2E, Yazoo Co.	Lintonia loam	Cockfield	Gravel from bottom of ditch through Sam Dixon place.
7	On farm-to-market road 432, 0.25 mi. W. junction with road to north. SW¼ SW¼, Sec.20, T.12N, R.2E, Yazoo Co.	Weathered bed rock	Cockfield	Gravel zone at base of "loess" mantle.
8	Approx. 0.25 mi. N. of intersection Goodman-Sallis road and a north-south road. NE¼ NE¼ Sec.22, T.13N, R.4E, Attala Co.	Collins silty clay loam	Kosciusko	Alluvial fill in Big Black River valley top lower terrace.

Sample No.	Location	Soil Association	Geologic Outcrop Belt	Remarks
9	Approx. 10 mi. NW Starkville approx. 200 yds. north U.S. Hwy. 82 on gravel road. SE¼ SE¼ Sec.14, T.19N, R.12E, Oktibbeha Co.		Porters Creek	Poss. an old terrace on Porters Creek clay.
10	Approx. 1 mi. W. No.9 in SW/c NW¼ Sec.14, T.19N, R.12E, Oktibbeha Co.		Porters Creek	Poss. an old terrace on Porters Creek clay.
11	Approx. 5.5 mi. SW Starkville on W. side State Hwy. 25, 300 yds. N. of Talking Warrior River bridge. NE¼ Oktibbeha Co.		Porters Creek	Poss. old stream bed on P.C. clay (measured section).
12	Approx. 2 mi. NE Betheden 0.25 mi. NE road junction to south. SW¼ Sec.18, T.16N, R.14E, Winston Co.		Porters Creek	Poss. old terrace material.
13	Immediately W. city limits of Okolona on State Hwy.41, SW/c NE¼ NW¼ Sec.27, T.12S, R.5E, Chickasaw Co.	Oktibbeha clay	Selma	Brown soil formed on top of Chalk.
14	Approx. 0.25 mi. S. New Albany city limits on State Hwy. 15. NW/c NE¼ Sec.20, T.7S, R.3E, Union Co.		Clayton	Residuum soil over Clayton fm.
15	2 mi. N. junction with N. bound road and old Hickory Flat-Winborn road. SE¼ NW¼ Sec.17, T.5S, R.1E, Benton Co.	Weathered bed rock	Basal Wilcox	Hills above Oklimeter Creek.
16	On State Hwy. 32 two mi. W. junction farm-to-market 341. NW¼ SW¼ Sec.7, T.12S, R.1E, Calhoun Co.		Porters Creek	Upper terrace of Skuna River valley.
17	1 mi. S. city limits of Bruce on N. side Skuna River. SW/c Sec.6, T.13S, R.1W, Calhoun Co.		Poss. Wilcox	Alluvial fill in Skuna River valley.

Sample No.	Location	Soil Association	Geologic Outcrop Belt	Remarks
18	Skuna River alluvial valley on unimproved road 3 mi. W. Pittsboro. SE¼ SW¼ SW¼ Sec. 15, T.13S, R.2W, Calhoun Co.		Poss. Wilcox	Alluvial fill in Skuna River valley.
19	On old State Hwy.8 in Grenada Reservoir 0.5 mi. W. Calhoun Co. line. NW/c NE¼ Sec.1, T.22N, R.7E, Grenada Co.	Collins silty clay loam	Poss. Wilcox	Alluvial fill in Yalobusha River valley.
20	On W.side U.S. Hwy. 51 right-of-way 2 mi. N. Pickens. NE¼ NW¼ Sec.1, T.12N, R.3E, Holmes Co.	Lintonia loam	Cockfield	Alluvial fill in Big Black River valley.
21-A	Approx. 3.5 mi. SW Pickens on Vaughn road. SE/c Sec.30, T.12N, R.3E, Yazoo Co.		Cockfield	Upper loamy soil.
21-B	Same as 21-A		Cockfield	Subsoil.
22	Approx. 0.25 mi. W. confluence Cypress Creek with Big Black River. SE¼ SE¼ Sec.6, T.11N, R.3E, Yazoo Co.	Collins silty clay loam	Cockfield	Big Black River swamp bottom alluvial fill.
23	One-half mi. SW Decatur P.O. on H.E. Wiggs property. NE¼ SW¼ Sec.19, T.7N, R.12E, Newton Co.	Bibb fine sandy loam	Kosciusko	Alluvial fill in small valley of Decatur Branch, H.E. Wiggs property.
24-A	Approx. 200 yds. NW of Geo. Addy house in ditch and field. SE¼ SE¼ Sec.6, T.7N, R.12E, Newton Co.	Ochlockonee loam	Kosciusko	Alluvial fill in Reives Branch of Okahatta Creek, Geo. Addy place.
24-B	Same as 24-A	Ochlockonee loam	Kosciusko	Concretions from ditch in alluvium.
25-A	In ditch bank on N. side J.B. "Sam" Smith's barn. SW¼ SW¼ Sec. 17, T.7N, R.12E, Newton Co.	Bibb fine sandy loam	Kosciusko	Valley fill of Okahatta Creek, Sam Smith place.
25-B	Same as 25-A	Bibb fine sandy loam	Kosciusko	Concretions from ditch bank by Sam Smith's barn.

Sample No.	Location	Soil Association	Geologic Outcrop Belt	Remarks
26	In J.B. "Sam" Smith's pasture about 0.4 mi. N. of house. SW¼ NW¼ Sec.17, T.7N, R.12E, Newton Co.	Bibb fine sandy loam	Kosciusko	Concretions from ditch in Sam Smith's pasture.
27	Approx. 100 yds. S. I.P. Hosey house in ditch. NE¼ NE¼ Sec. 21, T.1N, R.18E, Jasper Co.	Orangeburg sandy loam	Vicksburg	Ditch in I.P. Hosey's field draining into Tallahoma Creek.
28	Approx. 1.5 mi. NE of Lake Como and 150 feet N. Junction of road to north and farm-to-market road 528. SE/c NE¼ Sec.32, T.2N, R.11E, Jasper Co.	Orangeburg fine sandy loam	Vicksburg	Residue of Vicksburg ls. on road bank.
29	On S. side State Hwy. 18 at junction with road to the south 0.5 mi. W. Sylvarena intersection. NW/c SW¼ Sec.16, T.2N, R.9E, Smith Co.	Ruston fine sandy loam	Vicksburg	Road cut at Sylvarena in Vicksburg residuum.

(Sample Mn-25B & Mn-26), H. E. Wiggs (Sample Mn-23) and George Addy (Sample Mn-24B) properties.

The origin of the nodules is not known to the writer. Some of the present stream bottoms are covered with "gravels" probably weathered from the alluvium as the present stream cuts its way through. In places where roads have been graded through the alluvial fill, one can see the concretions have weathered from the road cuts and accumulated in the drainage ditches.

The material sampled in Oktibbeha County (Sample Mn-9, Mn-10, Mn-11) appeared to be accumulations which represented an old terrace deposit on the Porters Creek clay. Sample Mn-28 was collected in Jasper County from the residuum of the Vicksburg limestone.

A total of 34 samples was collected from outcrops along road right-of-ways and in stream beds from throughout north Mississippi. No facilities or method for making field determinations were available; hence, the samples were collected by visual estimates. Part of each sample was ground in the Survey's burr mill and divided in two parts. One part was kept as reference material along with the remaining bulk sample in the Survey office. After the samples were ground, fifteen of them appeared to contain the higher percentage of manganese and these were chosen for chemical analyses (Table V). When the results of the analyses were returned to the Survey the Director had three members of the staff, including the writer, to arrange the reference samples in order of highest manganese content. The results are shown in Table VI. Sample No. Mn-28, which contained the highest percentage of manganese, was rated seventh place by visual estimate. This was due to the high content of iron oxide which masked the coloring of the manganese oxide.

The analyses do not suggest that manganese is present in commercial quantities; however, a more thorough program of sampling may uncover materials of considerably better quality.

No estimates as to quantities have been attempted; however, Samples Mn-23, Mn-25B, Mn-26 represent thicknesses of 10 to 12 inches of the material and an areal extent of several acres with not more than two feet of overburden.

TABLE V

Manganese Samples

Lab.No.[1]	Sample No.	Fe %	Fe_2O_3 Equiv.%	Mn %	MnO_2 Equiv.%	Insol. %	Location	County	Property
338,857	Mn-4	4.1	5.8	0.28	0.44	80.0	Cen.NW¼, Sec.9, T.10N,R.2E	Yazoo	W.H. Brister
338,858	Mn-5A	7.7	11.0	1.8	2.9	76.8	SE/c NE¼, Sec.12, T.11N, R.2E	Yazoo	Lloyd Dixon
338,859	Mn-8	2.0	2.8	0.09	0.14	93.6	NE/c Sec.22, T.13N, R.4E	Attala	County Road right-of-way
338,860	Mn-11	1.9	2.7	1.9	3.0	56.1	NE¼ SE¼, Sec.31, T.18N, R.14E	Oktibbeha	Right-of-way, State 25
338,861	Mn-13	5.4	7.7	0.17	0.27	71.4	SW/c NE¼ NW¼, Sec.27, T.12S, R.5E	Chickasaw	Right-of-way, State 41
338,862	Mn-15	3.9	5.5	1.5	2.4	80.2	SE¼ NW¼, Sec.17, T.5S, R.1E	Benton	County Road right-of-way
338,863	Mn-17	3.3	4.7	0.12	0.19	80.5	NW/c SW¼ SW¼, Sec.6, T.13S, R.1W	Calhoun	Right-of-way, State 9
338,864	Mn-19	1.6	2.3	0.10	0.16	90.5	NW/c NW¼ NE¼, Sec.1, T.22N, R.7E	Grenada	Grenada Reservoir
338,865	Mn-22	4.5	6.5	1.19	2.9	81.0	SE¼ SE¼, Sec.6, T.11N, R.3E	Yazoo	Lloyd Dixon
338,866	Mn-23	13.3	19.0	4.5	7.1	59.5	NE¼ SW¼, Sec.19, T.7N, R.12E	Newton	H.E. Wiggs
338,867	Mn-24B	16.7	23.9	6.4	10.1	49.5	SE¼ SE¼, Sec.6, T.7N, R.12E	Newton	George Addy
338,868	Mn-25B	11.5	16.5	4.3	6.8	65.8	NE/c SW¼ SW¼, Sec.17, T.7N, R.12E	Newton	J.B. "Sam" Smith
338,869	Mn-26	6.5	9.2	4.2	6.7	71.6	SW¼ NW¼, Sec.17, T.7N, R.12E	Newton	J.B. "Sam" Smith
338,870	Mn-27	3.2	4.5	0.9	1.5	87.6	NE¼ NE¼, Sec.21, T.1N, R.11E	Jasper	I.P. Hosey
338,871	Mn-28	23.0	32.8	7.4	11.7	39.1	SE¼ NE¼, Sec.21, T.1N, R.11E		County Road right-of-way

[1]Mississippi State Chemical Laboratory number.

Sample No.	Actual Order by Analysis	Order by Visual Estimate	Mn Content (Percent)
Mn-28	1	7	7.4
Mn-24-B	2	1	6.4
Mn-23	3	2	4.5
Mn-25-B	4	5	4.3
Mn-26	5	4	4.2
Mn-11	6	8	1.9
Mn-22	7	10	1.9
Mn-5-A	8	6	1.8
Mn-15	9	3	1.5
Mn-27	10	9	0.9
Mn-4	11	11	0.28
Mn-13	12	12	0.17
Mn-17	13	13	0.12
Mn-19	14	14	0.10
Mn-8	15	15	0.09

Table VI

Showing order by actual Mn content as compared to order by visual estimate of Mn

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Mr. Z. P. Hawkins, Traffic Manager, Columbus & Greenville Railway Company, kindly furnished dates and tonnages of ore shipped from Kilmichael.

The Mississippi State Chemical Laboratory, through the cooperation of State Chemist Dr. M. P. Etheredge, ran the analyses shown in Table V, viz. percentages of iron, manganese, and insoluble substances of 15 samples.

Note on "bentonite": On October 26, 1963 Kern and Mellen augered a hole to a depth of 17.1 to sample the material logged as "bentonite" in the interval 12.0 to 19.0 feet in Core Hole B-4, Benton County. This, and other logs in this series record "bentonite" or "bentonitic clay" in the Fearn Springs formation. Knowing that true bentonite has elsewhere been recorded at this horizon in Mississippi, the Survey was anxious to insure a correct identification. Our auger hole was located about 30 feet south of Core Hole B-4, and sampled tan silty clay that is greatly different from the overlying gray plastic clay. The clay does not, however, appear to be a true bentonite as is being mined commercially or as was cored in the basal Fearn Springs in the Pine Dale Community. The Survey has samples from the auger hole on hand, and these will be studied further.

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