BASAL OTTAWA LIMESTONE, CHATTANOOGA SHALE, FLOYD SHALE,
PORTERS CREEK CLAY, AND YAZOO CLAY
IN PARTS OF ALABAMA, MISSISSIPPI AND TENNESSEE AS
POTENTIAL HOST ROCKS FOR UNDERGROUND EMPLACEMENT OF WASTE

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February 28, 1976

MASTER

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POTENTIAL HOST ROCKS FOR UNDERGROUND
EMPLACEMENT OF WASTE
IN PARTS OF ALABAMA, MISSISSIPPI AND TENNESSEE

By

Frederic F. Mellen¹

ABSTRACT

Impermeable rock units, preferably at least 500 feet thick and lying 1000 to 3000 feet below land surface, were sought in the region consisting roughly of the western 3/5ths of Tennessee and the northern 3/5ths of Alabama and Mississippi. All rock sequences, Cambrian through Eocene, were examined in varying detail, except the Cretaceous Selma Chalk and except the diapiric salt. These rocks were studied for their relative impermeable homogeneity, their continuity, their background of structural and seismic stability and their hydrologic associations. The Central Mississippi Ridge of north-central Mississippi is overlain by a long-stable mass of Porters Creek Clay 500-700 feet thick, in an area roughly 50-60 miles wide and about 150 miles long. The Yazoo Clay, where best developed in the west-central and southwest part of Mississippi, is in the 400-500 foot thickness range, but locally exceeds 500 feet. The entire area mapped is underlain by the Louann Salt which has produced many deep-seated salt domes and numerous piercement salt domes. Salt flow has complicated shallow structural geology throughout that area. The Chattanooga Shale rarely exceeds 60 feet in thickness in the region studied and is generally much thinner and is absent in many places. In the lower part of the Middle Ordovician (Ottawa Megagroup), the Murphreesboro and associated dense limestones appear to offer a potential disposal unit 250-400 feet thick, having the advantages of rock competency and freedom from association with prolific aquifers in the overburden or beneath. Other less conspicuous stratigraphic units are reviewed.

INTRODUCTION

This investigation was made under the general supervision of Mr. George D. Brunton for Union Carbide Corporation, Nuclear Division. The work was actually begun in September, 1974, with intensified collecting of well logs and geological publications on the area assigned.

The assignment was to prepare a series of structure and isopach maps on the northern 3/5ths of Alabama and Mississippi and the contiguous southern part of Tennessee, using best available data from my own and public sources,

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of the Murphreesboro Limestone, the Chattanooga Shale (Devonian), the Porters Creek Clay (Midway-Paleocene) and the Yazoo Clay (Jackson-Eocene). Also, "I will search the stratigraphic section of the subject area for additional impermeable rock of the order of 500 feet and lying in the optimum depth range of 1000-3000 feet and will cover any such units in the written report, and will, if time and costs permit, prepare preliminary maps of such additional possible disposal units. This part of the study will cover the Carboniferous rocks, especially the sequence identified by U. S. G. S. (Meriwether, et al., 1973) as the Floyd Shale. The text will cover generally the related hydrology, seismicity, physical characteristics of the rocks, and drilling density. There will be tables of well data keyed to the maps supplied." The completed report is to be delivered by March 1, 1976.

The writer was furnished a copy of U. S. G. S.-4339-5, a 1973 open file report on "Shale, mudstone, and claystone as potential host rocks for underground emplacement of waste." Continuing reference is made to this report, especially to its figure 2-B, the seismic risk and earthquake map.

In the preparation of this report the writer utilized all published and manuscript reports and all non-confidential well information and maps in his library. Correspondence with the geological surveys of Alabama, Mississippi and Tennessee was carried on, and much valuable assistance was rendered by the correspondents. One of the greatest problems is the failure of companies and governmental agencies to provide early release of geophysical well logs through commercial reproduction companies so that quality log copies are readily available.

Many thousands of wells have been drilled to varying depths for oil and gas in the region covered. The information on most of these wells is readily available, but on some wells drilled by miscellaneous industrial firms and

governmental agencies nothing is available - not even record knowledge of their having been drilled. Fortunately, the geological surveys and oil and gas boards of the three states have been doing splendid work in keeping these unknowns to a minimum.

Plate II, the oil and gas development map, is the best map available to show locations of oil and gas wells and dry holes in Alabama and Mississippi. Such a detailed map was not available to me in Tennessee.

Plates I and I-A were constructed on the latest editions of the Alabama, Mississippi and Tennessee 1:500,000 base maps of the U. S. G. S. These maps were spliced together and well-spotting was done on a film positive composite. Wells used in this study were spotted by template in the center of the sections, making the degree of inaccuracy seldom more than one-half mile.

The structures of the three major subjects, the Porters Creek, the Yazoo Clay and the basal Middle Ordovician, as well as their outcrop belts, are all shown on the single Plate, I. The thicknesses of the Porters Creek Clay and the Yazoo Clay are shown on Plate I-A. No thickness map was prepared for the basal Middle Ordovician because of difficulty in establishing the top of the unit. The base of the unit, as subsequent discussion will show, is well-defined in most of the region.

The arrangement of units is not in stratigraphic sequence, but in the order in which the work was completed. The metric system is not used in this report.

This report was not prepared for, nor has it been edited for, publication. This report is reconnaissance in nature, and it must be understood that future detailed exploration is necessary before any host rock is used as an outgrowth of this study. The wells shown on Plates I and I-A and in the Appendix are only those selected by the writer for purposes of this study.

Porters Creek Clay

Outcrop

The Porters Creek Clay was named in 1864 by J. M. Safford from outcrops 1.5 miles west of Millington, Hardeman County, Tennessee (see Hughes, 1958, for discussion of nomenclature and priority of Porters Creek over Black Bluff and Sucarnoochee). Porters Creek has its source in T. 1 S., R. 3 E., Tippah County, Mississippi, and flows northerly through the stratigraphic type locality which bears its name.

In Tennessee the new map by Parks and Russell (1975) describes the Porters Creek of the outcrop as: "Chiefly olive-gray to brownish-gray clay with subordinate lenses, interbeds, and partings of fine-grained sand; locally contains glauconite and marine fossils. At places, the clay and sand are intersected by clastic dikes. Thickness 45 to 200 feet."

In Alabama MacNeill (1946) describes the units of the Midway Group as follows, in descending order: Naheola: "Interlaminated and interbedded gray silty clay and fine gray sand. Coal Bluff marl member at top in Marengo, Wilcox, and western Butler Counties, very fossiliferous glauconitic sand and laminated clay shale.

"Porters Creek formation, dark-gray fossiliferous clay to the west, thinning and passing to lighter calcareous clay in eastern Wilcox and Butler Counties; includes Matthews Landing marl member at top, a very fossiliferous glauconitic sandy clay marl to the west, passing to a much thicker section of interbedded clay, marl, marlstone, sand and sandy limestone in Wilcox and Butler Counties. Clayton formation: fossiliferous indurated calcareous sandstone and marl in the extreme west, passing eastward to a thick section of fossiliferous fine gray sand with indurated ledges, gray silty clay shale, loose sand, hard crystalline coarse sandy limestone, and massive light gray

fine sandy limestone in Wilcox and Butler Counties. Clayton formation includes all beds of Midway age in Crenshaw County and eastward, the uppermost of which are equivalent to the Porters Creek formation of western Alabama; along Chattahoochee River it consists entirely of sandy and argillaceous limestone."

In Mississippi, the Porters Creek Clay is much thicker on the outcrop than in Tennessee or Alabama. In Winston County (lower central part of its Mississippi outcrop belt) the unit reaches its maximum outcrop thickness in the Eastern Gulf Region.

The writer (1939) described the deposition and physical characteristics of the Midway Group as follows: "After the deposition of the marine Prairie Bluff Chalk [Cretaceous], there was a long period of which there is left no accessible sedimentary record. During this time-interval the soft Cretaceous beds were undergoing compaction, the shoreline of the ancient gulf was retreating toward the south and southwest, and the Cretaceous beds were being lifted above sea-level and subjected to the ordinary processes of weathering and erosion. After several million years, perhaps, the region sank below sea-level again, swift currents played over the shallow sea floor, removing all the ancient soil that may have existed, wearing the Cretaceous beds to an uneven surface, and depositing the abraded argillaceous chalk pebbles, silt, and fossils of Cretaceous age in a heterogenous mixture with argillaceous, calcareous sand, and small fossils of Clayton age. Due to this unevenly worn Cretaceous surface, the thin Clayton formation is absent in parts of the outcrop area of western Noxubee County. Its thickness beneath the surface in northeastern Winston will probably exceed 8 or 10 feet in but few places, and in some places the formation will be absent as in a few localities along the outcrop in Oktibbeha and Noxubee counties.

"The contact between the Clayton formation and the Porters Creek formation is not marked by an unconformity; rather, it is a gradational contact. The transition zone varies in thickness, and in most places is indicated by arenaceous, calcareous clay. The basal part of the Porters Creek (50 feet more or less) is mostly a fine-grained silty clay containing foraminiferal shells, and enclosing erratic lenses, commonly two to four inches thick and a few feet in diameter, of sandy, glauconitic, calcareous material through which are scattered small molluscan and foraminiferal fossils.

"Small marine gastropod, pelecypod, and crab fossils, are found as molds in the lower two-thirds or three-fourths of the formation, but, due to the conchoidal and hackly fracture of the clay, and possibly also to their rarity, the fossils are difficult to discover. They are present, for instance, in the highway bank at Loakfoma, 150 feet southwest of the C. J. Moorehead residence (N. 1/2, NW. 1/4, Sec. 17, T. 16 N., R. 14 E.); northeast of Fearn Springs beside the road on the L. H. Fleetwood place (NE. 1/4, NE. 1/4, Sec. 25, T. 14 N., R. 14 E.); and near Singleton (SW. 1/4, Sec. 4, T. 15 N., R. 14 E.). Similar fossils are found also above and below the thin highly fossiliferous lenses in the Porters Creek on Highway 14, 0.2 mile east of the county line, 4.0 miles west of Mashulaville, Noxubee County.

"Above the sandy basal part of the formation are 350 to 450 feet of fine-grained slightly silty dark-gray or black carbonaceous jointed clay, which weathers to a dove-gray clay having a conchoidal fracture. This part of the formation appears to be massive, but close examination reveals very fine laminae running through even the purest lumps of clay. [Fig. 1]

"The upper 50 to 100 feet of the Porters Creek clay in Winston County are very silty, in part glauconitic, micaceous, and sandy; the clay is distinctly laminated, and in places contains beds and lenses of sand up to a foot or more in thickness. A single small piece of lignitized wood was found

Figure 1. Clay typical of the middle part of the Porters Creek Formation, 300 feet east of Loakfoma School (SE. 1/4, SW. 1/4, Sec. 8, T. 16 N., R. 14 E., Winston County, Mississippi; near test hole sample 53AP1, see Table of analyses, Figure 3, and Plate 1), February 14, 1938.

Figure 2. Clay typical of the upper part of the Porters Creek Formation, silty laminated, containing impure siderite concretions, at spillway of Haynes Mill, now Vernon's Mill (NW. 1/4, Sec. 11, T. 13 N., R. 14 E., Winston County, Mississippi), April 12, 1938.

near the top of the formation in northern Winston. This part of the formation [Fig. 2] contains beds of silty siderite of no economic value. It is equivalent to the Naheola formation of Alabama.

"Cross-bedded fine-grained micaceous sand crops out just below the sandy bauxitic clay on the public road on the J. J. Moody farm (NW. 1/4, SE. 1/4, Sec. 33, T. 14 N., R. 14 E.), and a similar sand was found in test hole 119 at Fearn Springs. This material undoubtedly is typical of the Naheola formation. There is also much argillaceous, micaceous cross-bedded and laminated sand at this position south of Perkinsville Cemetery (Sec. 4, T. 14 N., R. 14 E.), and on the R. G. Brown, Jr. property (SW. 1/4, SE. 1/4, Sec. 21, T. 14 N., R. 14 E.). Because within Winston County the Naheola is weakly developed, it is not regarded as a separate unit, but is included in the Porters Creek formation. Locally the Naheola equivalent has been removed by erosion and younger materials deposited in its place.

"Computations of the regional dip per mile, multiplied by the width of outcrop (allowing for the difference in elevation of the northeastern and southwestern contacts) give a thickness of approximately 500 feet. Another set of computations, based on the discovery of Porters Creek clay in a test hole at the intersection of the public road and the Winston-Noxubee County line, indicates a thickness of 565 feet. Logs of various deep wells penetrating the formation in Winston County seem to indicate a greater thickness. Crider (6) reported a thickness of 100 to 210 feet along the outcrop in Mississippi, Lowe (11) 200 feet or more, and Grim (16) 800 feet. Grim's figure was obtained from a deep well in central Mississippi. It is interesting, therefore, to know that the thickness along the outcrop in Winston County is comparable to the greater thicknesses reported from deep wells.

"The average strike of the Eocene beds in Winston County is approximately N. 35° W.

"Most geologic writers have accepted as a fact the idea that at least part of the Porters Creek clay was marine, but without citing definite proof. On the basis of collections made by the present writer and of studies made by M. L. Thompson, it is now thought that the entire formation was deposited beneath marine waters."

The Porters Creek Clay varies in chemical and mineralogical composition because of increases in sand and lime and in silt, mica, and siderite. Table 1 lists 12 analyses from 7 counties along the Mississippi outcrop belt:

Table 1

ANALYSES OF PORTERS CREEK CLAY

Sample No.	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	MgO	CaO	Na ₂ O	K ₂ O	SO ₃	P ₂ O ₅	Cl	Other Non-vol. Solids	Ign.	Total
LMA-7(6-34') ^a	61.10	14.63	6.93		1.62	0.71	0.67	2.79	-	-	-	1.51	10.44	100.00
LMA-9(7-52') ^b	61.23	15.26	6.25		0.78	0.53	0.61	2.00	-	-	-	3.36	9.98	100.00
LMA-22(2-32') ^c	62.74	18.44	7.74		2.32	1.10	0.24	1.65	0.11	0.12	Nil	-	5.82	100.00
D185(0.3-33.2') ^d	67.05	14.38	3.84	0.42	1.39	2.31	0.83	Trace	0.13				6.56	
MA8A-2(23-41') ^e	66.03	16.46	4.60	0.49	0.55	3.82	0	0					7.50	
M55-3(9-25.0') ^f	67.39	16.60	5.84	0.81	0.87	1.97	0.53						6.01	
M88-2(10.2-57.1') ^g	63.04	17.28	5.63	0.90	1.62	3.35	0.61						6.51	
M82-7(22.5-26.0') ^h	68.36	15.98	7.49	0.98	1.27	0.25	0.26						5.52	
M82-6(19.2-22.5') ⁱ	68.61	19.57	1.90	0.86	0.49	0.28	1.11						6.07	
53AP1(2-37.7') ^j	61.87	21.12	6.07	1.05	0.94	1.42	0.93	0.24	0.55				7.07	101.26
55AP1(0.5-34.7') ^k	63.60	17.81	6.54	1.05	1.32	1.10	0.97	1.09	0.96				6.36	100.80
A26A-C1(0-25') ^l	72.58	17.64	1.67	0.25	0.32	0.71	0.02	0	0.67				6.95	

^aAnalysis by Mississippi State Chemical Laboratory, MGS Bull. 103, p. 44; Maben, Webster Co., Mississippi
^bAnalysis by Mississippi State Chemical Laboratory, MGS Bull. 103, p. 44; Rhondale, Kemper Co., Mississippi
^cAnalysis by Shilstone Testing Laboratory, MGS Bull. 103, p. 44; Myrtle, Union Co., Mississippi
^dAnalysis by Mississippi Geological Survey, M. R. Livingston, MGS Bull. 45, p. 135; Sec. 10, T. 8., 2E., Union Co., Mississippi
^eAnalysis by Mississippi Geological Survey, B. F. Mandlebaum, MGS Bull. 53, p. 75; Sec. 5, T. 20, R. 13, Clay Co., Mississippi
^fAnalysis by Mississippi Geological Survey, B. F. Mandlebaum, MGS Bull. 53, p. 75; Sec. 29, T. 16, R. 3, Clay Co., Mississippi
^gAnalysis by Mississippi Geological Survey, B. F. Mandlebaum, MGS Bull. 53, p. 75; Sec. 31, T. 15, R. 3, Clay Co., Mississippi
^hAnalysis by Mississippi Geological Survey, B. F. Mandlebaum, MGS Bull. 54, p. 93; Sec. 33, T. 8, R. 1, Pontotoc Co., Mississippi
ⁱAnalysis by Mississippi Geological Survey, B. F. Mandlebaum, MGS Bull. 54, p. 102; Sec. 33, T. 8, R. 1, Pontotoc Co., Mississippi
^jAnalysis by Mississippi Geological Survey, T. E. McCutcheon, MGS Bull. 38, p. 140; Sec. 17, T. 16, R. 14, Winston Co., Mississippi
^kAnalysis by Mississippi Geological Survey, T. E. McCutcheon, MGS Bull. 38, p. 140; Sec. 18, T. 16, R. 14, Winston Co., Mississippi
^lAnalysis by Mississippi Geological Survey, M. R. Livingston, MGS Bull. 42, p. 183; Sec. 4, T. 4, R. 3, Tippah Co., Mississippi

Sample 53AP1 is selected as probably being the nearest to a typical outcrop Porters Creek composition. The composition is:

Figure 3. Thermal dehydration curve of Porters Creek Clay sample 53AP1, Winston County, Mississippi. McCutcheon, 1939.

Figure 4. Thickness of Porters Creek Clay in the lower Mississippi Embayment. Outcrop is shown in black. The thin area at the northeast corner of Louisiana is the Monroe-Sharkey Uplift. The thin area in south-central Mississippi is the Jackson Dome. Rainwater, 1964, p. 17.

Silica (SiO_2)	61.87%
Alumina (Al_2O_3)	21.12
Iron oxide (Fe_2O_3)	6.07
Titania (TiO_2)	1.05
Magnesia (MgO)	0.94
Lime (CaO)	1.42
Sodium oxide (Na_2O)	0.93
Potassium oxide (K_2O)	0.24
Sulphur trioxide (SO_3)	0.55
Ignition loss	7.07
TOTAL	101.26%

This sample was air-dried, then dried for 1 hour in an oven at 110°C . before analysis. Although the shale is almost black when fresh, indicative of organic content, I am not aware of any studies of the organic constituents which are lost with the hygroscopic and combined moisture at 110°C . and on ignition. Additional information on dehydration of this clay is afforded by Fig. 3. Concerning this, McCutcheon (Mellen & McCutcheon 1939) states: "The thermal dehydration curve of clay 53AP1 may be compared to that of montmorillonite; however, the steepness of the curve between 450°C . and 550°C . suggests Kaolin minerals as a secondary constituent."

The thinness of the Porters Creek Clay in Tennessee and the presence of vertical sand dikes cutting the unit greatly reduce the feasibility of use of the unit for underground waste disposal. In Alabama, the unit is less than the desired 500 feet, it is complicated by lateral gradation to silty, sandy and limy strata, and by faulting of appreciable (100 feet or more) magnitude. The Porters Creek Clay in the central part of its outcrop belt in Mississippi reached the prescribed thickness of 500 feet, it is relatively uniform in composition and free from complicating lithologic gradations.

Minor faults are known to cut the Cretaceous-Paleocene and the Paleocene-Eocene contacts, but faults of more than about 20 feet of displacement have not been reported or observed. The Porters Creek outcrop belt has no history of seismicity, but is mapped in seismic risk zone 1.

Subsurface

A regional view of the Porters Creek outcrop distribution and subsurface thickness (south of the Tennessee line) is shown in Figure 4.

The Porters Creek Clay underlies the Mississippi Embayment from its northern extremity in southern Illinois to the Gulf of Mexico. It underlies a small area in southern Illinois, the southeasterly part of Missouri and passes southwesterly through eastern and southern Arkansas into Texas. On the east limb of the embayment it underlies most of the Jackson Purchase area of western Kentucky, most of west Tennessee and all of Mississippi except the Cretaceous and pre-Cretaceous areas as shown on Figure 5. It extends southeasterly across southern Alabama where it is progressively thinner, sandier and limier east of the Alabama River. Its optimum depth and thickness for prospective waste disposal (1000-3000 feet below the surface and at least 500 feet in thickness) lies in central, north central and northwest Mississippi. In our study area the Porters Creek Clay of Illinois, Missouri, Tennessee and Alabama is considered to be below specifications and is generally excluded from the following discussion.

In the mapped area of Mississippi the Porters Creek Clay varies from 268 feet in Benton County near the Tennessee line to 304 feet in Leflore. Subsurface data was determined from selected electrical logs and are shown tabulated in Appendix A and mapped on Plate 1 and Plate 1-A. Figure 6, a structure map contoured on the top of the Cretaceous, is a very close representation (within 20-100 feet) of the base of the Porters Creek Clay. This map covers a larger area and on a much smaller scale than Plate 1.

Figure 5. Generalized geology of the Mississippi Embayment. From Hosman, et al., 1968, p. D3.

Figure 6. Contour map showing configuration of the top of the Cretaceous System. This is approximately the base of the Porters Creek Clay - a variation commonly in the range of 10'-100' due to development of the Clayton Formation or "calcareous Midway" between the Porters Creek and the Cretaceous chalk. From Cushing, et al., 1964, p. B9.

GEOLOGIC MAP OF MONTGOMERY COUNTY MISSISSIPPI

Figure 7. Kilmichael Dome, Montgomery County, Mississippi, as mapped by R. R. Priddy (1943-1, Pl. I). At first believed to be of endogenic origin, geologists now tend to support an exogenic (astroblemic) origin. Numbers indicate dry oil-gas exploratory wells (see Plate 1, this report): 2. Gulf Refining Co. No. 1 Parker (1940); 3. Billups Brothers No. 1 Townsend (1952); and 4. J. W. Black No. 1 Patterson (1945). A seismic line has shown the Cretaceous strata dip 1000 feet in 1 mile north from the No. 1 Parker suggesting that the Porters Creek Clay in the vicinity of the No. 1 Parker is concealed only by thin mantle. We referred to this in the text as a "crypto-explosive" structure rather than by the old term "crypto-volcano."

With the exception of the Kilmichael¹ crypto-explosive structure (Figure 7, Plate 1), there are no other known structurally disturbed areas in the Mississippi area of study. Elsewhere, the Porters Creek Clay is believed to be relatively undisturbed by folding or faulting and is relatively a homogeneous impermeable mass of marine clay or clay-shale. On electrical log interpretations of lithology it appears that the top 50-200 feet of the Clay in some wells is characteristically increasingly silty upwards. In these cases it is believed that there is no measurable or effective permeability. Similarly, a few wells, notably those approaching Tennessee and Arkansas, and easterly in Alabama, show marly characteristics at the base of the Porters Creek. It is extremely rare that silty or limy characteristics show on the electrical logs in the middle part of the unit.

Chemical analyses of outcrop samples were presented above; but no such analyses are available from subsurface samples. It is thought that the subsurface chemical and mineralogical compositions of the Porters Creek Clay in the subsurface are similar to those on the surface. Cores from some wells are available for analysis and study in the Mississippi Geological Survey Sample Library.

Very thin beds of light-gray bentonite (perhaps around 2") are present in the top and in the base (around 50-60 feet above) of the typically dark-gray

¹The Kilmichael structural area, which has been repeatedly referred to in this report, includes most of T. 19 N., R. 7 E., 2 to 8 miles north of the village of that name. Although the area is complicated by intense faulting and reverse dips, all of the numerous small disturbed areas are but a part of a single large structure 8 to 10 miles in diameter, centering near the common corners of Sections 22, 23, 26, and 27. This structure has a roughly circular outline; a central uplift exposing highly faulted beds of the Wilcox series and probably strata of the Midway series; and outside the uplift a sequence of marginal fault blocks consisting of first a graben, second a horst, and third a poorly defined succession of grabens and horsts involving successively younger beds. Priddy, 1943, pp. 42-43.

Figure 8. Electrical log cross section to illustrate the relatively uniform westerly dip and composition of the Porters Creek Clay and the method used in this report for picking the top and bottom of the unit. See also Plate 1 for location of section.

carbonaceous Porters Creek. Although both clays are largely montmorillonitic, that is not proof that the great mass of the unit had a volcanic origin.

On the electrical logs resistivity characteristically decreases downward (Figure 8). The lower 200 feet or so commonly has a uniformly very low resistivity. Sample returns from the Porters Creek are normally medium to dark-gray plastic mud, but from approximately the bottom 200 feet, more or less, the clay-shale is firmer and splintery. How much of this phenomenon is compositional and how much is due to dehydration the writer does not know. The Porters Creek Clay washes out badly in rotary drilling, especially with clear water. One of the characteristics of the formation is the abundant sporadic concretions or ledges of siderite throughout the unit. They were called "Midway boulders" by early rotary drillers. Commonly, washouts develop above and below these ledges, which are drilled to very close gauge. In numerous cases electrical log sondes have difficulty in the Porters Creek Clay.

Sharkey Platform Area

(Humphreys, Issaquena, Sharkey & Washington Counties)

This is an area in western Mississippi along the Mississippi River and not far north of the Mississippi Power & Light Company's Grand Gulf nuclear power plant, under construction. The Sharkey Platform (eastward extension of the Monroe Uplift) is underlain by truncated Mesozoic strata into which much igneous rock has been intruded and through which numerous volcanic vents were active in late Upper Cretaceous times. Many exploratory wells have been drilled in this Area, but only small amounts of oil and gas have been found. This Area is underlain in part by the Louann Salt, but salt movement is not conspicuous and the Area is believed to be relatively stable. Plates 1, 1A, and Appendix A(pages 52-69.) give some basic data on the Porters Creek Clay, but much more detailed work can be done on a larger scale map.

Yazoo Clay

The Yazoo Clay conformably overlies the Moodys Branch Marl and conformably underlies the Forest Hill Sand. In Yazoo County it is roughly divisible into two facies. The lower 350 feet, more or less, are remarkably uniform lithologically. This facies is a fairly homogeneous silty calcareous fossiliferous gummy, plastic montmorillonitic clay. The upper facies of the Yazoo Clay, gradational with the lower, contains approximately 150 feet of material less homogeneous than the sub-jacent beds. The facies contains relatively pure beds of massive gummy non-calcareous Montmorillonitic clay, beds of interlaminated silt and silty clay, a thin bed of bentonite, lentils of limestone and marl (SE. $\frac{1}{4}$, NW. $\frac{1}{4}$, Sec. 6, T. 9 N., R. 3 W.), and scattered large vertebrae of the Zeuglodon whale. The bed of bentonite indicates volcanic activity during the age of accumulation. The beds of interlaminated silt and silty clay indicate the transitional relationship with the Forest Hill member of the Jackson. The lentils of limestone and marl are also suggestive of the shoaling of the sea during the late Yazoo time.

Figure 9. Geologic section of the Bluff at the south side of Yazoo City.

Slumping and the development of gypsum are the two great surface phenomena of the Yazoo Clay. Gypsum is abundant in the two arbitrary facies of the Yazoo.

Figure 10. Outcrop on the face of an enormous landslip (?) exposing the thin bed of bentonite in the upper facies of the Yazoo Clay southeast of Satartia (SW. $\frac{1}{4}$, SE. $\frac{1}{4}$, Sec. 31, T. 10 N., R. 3 W.), October 10, 1938. The light-colored parallel streaks in center of photograph are interbeds of silt on the surfaces of which are efflorescences of gypsum (selenite) and associated plates and particulate aggregates of limonite.

Figure 11. Landslide topography which was produced by a slip that extended to the top of the Loess on the east side of the first spur ridge, east of the Yazoo River. MGS Bull. 27, Fig. 5.

Southeasterly from Yazoo County (refer to Plate 1) toward the Alabama line the Yazoo Clay is progressively thinner and is broken into facies known, in upward sequence, as North Twistwood Creek Clay, Cocoa Sand, Pachuta Marl, Shubuta Clay, and the Red Bluff Clay (?). Farther east in Alabama, Georgia and Florida the Yazoo Clay is represented by the Ocala Limestone. The Pachuta Marl facies in the lower part of the Yazoo Clay can be traced in samples and electrical logs westerly from its type locality in Clarke County, Mississippi, to Copiah County.

In the area investigated for this study, Claiborne, Warren, Yazoo, Hinds, Copiah, Simpson, Rankin and Smith Counties, the Yazoo Clay ranges in thickness from less than 300 feet to slightly more than 500 feet. Electrical logs indicate the tendency for the clay to develop marl beds, some of which are porous and carry small volumes of water. Figure 12 illustrates the electrical log characteristics and other geologic features of the subsurface Yazoo Clay. The entire area is underlain by thick Louan Salt which has

produced a great many piercement salt domes, shown on the index map and on Plate 1. These domes have complicated the geology by faulting which is known to extend through surface bedrock.

The Yazoo Clay in the area examined rarely exceeds 500 feet in thickness, is not very deeply buried (to about 1900 feet) and is very variable in composition as Table 2 shows.

Table 2
ANALYSES OF YAZOO CLAY

Sample No.	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	MgO	CaO	Na ₂ O	K ₂ O	SO ₃	P ₂ O ₅	Cl	Other Non-vol. Solids	Ign.	Total
C2-(19.5-62') ^a	41.58	14.92	7.15	0.75	0.60	18.03	0.31	0.03	2.10	-	-	-	17.17	
C4-(1.7-34.6') ^b	48.99	17.50	7.70	0.80	0.62	10.24	0.20	0.24	3.32	-	-	-	13.25	
C13-(16.2-49') ^c	39.56	16.08	7.15	0.20	0.14	17.76	0.09	Tr.	1.95	-	-	-	19.57	
C59-(18.7-31.7') ^d	56.84	20.00	6.70	0.65	0.90	7.03	0.19	Tr.	3.57	-	-	-	9.79	
J86-(10.5-24.3') ^e	30.45	12.31	5.16	0.47	0.12	25.00	0.29	-	1.88	-	-	0.09 ¹	23.35	
J86-(24.3-49.5') ^f	27.30	11.62	3.37	0.36	0.25	26.90	0.17	-	3.18	-	-	0.28 ¹	25.03	
J89-(6.2-21') ^g	33.02	14.21	3.70	0.48	0.15	24.03	0.34	-	0.00	-	-	0.21 ¹	22.77	
J89-(6.2-32.3') ^h	25.60	11.41	3.26	0.48	0.23	29.97	0.61	-	1.10	-	-	0.00 ¹	26.80	
J4-(6.9-13.0') ⁱ	51.65	22.96	5.16	0.78	2.00	1.11	0.57	-	-	-	-	0.00 ¹	14.80	
J27-(12.4-25.0') ^j	41.97	15.61	5.97	0.69	1.81	17.16	0.25	-	2.61	-	-	0.19 ¹	15.91	
AG43A-(37-47') ^k	30.01	12.47	3.33	-	1.88	26.21	0.02	0.19	0.18	0.08	-	-	24.16	98.53
AF40-(8.5-26') ^l	59.60	20.82	6.26	-	1.77	0.12	0.09	0.78	1.52	0.13	-	-	8.57	99.66
AF40-(26-40.5') ^m	52.20	18.14	6.61	-	1.79	7.47	0.10	0.75	0.64	0.12	-	-	9.19	97.72
AF40-(40.5-50') ⁿ	53.62	19.56	6.22	-	2.14	5.72	0.09	0.92	0.22	0.11	-	-	9.12	99.28
LNA10-(12-62') ^o	36.20	14.18	4.14	-	0.58	16.19	0.19	1.02	-	-	-	-	23.66	100.00
LNA20-(22-62') ^p	41.29	17.79	5.24	-	1.93	14.92	0.82	1.06	0.08	0.17	-	-	15.87	99.17

¹MnO₂

^aAnalysis by Mississippi Geological Survey, M. R. Livingston, MGS Bull. 79, p. 81, Sec. 33, T. 12, R. 2W, Yazoo Co., Miss.
^bAnalysis by Mississippi Geological Survey, M. R. Livingston, MGS Bull. 79, p. 81, Sec. 7, T. 11, R. 2W, Yazoo Co., Miss.
^cAnalysis by Mississippi Geological Survey, M. R. Livingston, MGS Bull. 79, p. 81, Sec. 3, T. 10, R. 3W, Yazoo Co., Miss.
^dAnalysis by Mississippi Geological Survey, M. R. Livingston, MGS Bull. 79, p. 94, Sec. 14, T. 9, R. 4W, Yazoo Co., Miss.
^eAnalysis by Mississippi Geological Survey, B. P. Mandlebaum, MGS Bull. 49, p. 117, Sec. 25, T. 8, R. 6, Scott Co., Miss.
^fAnalysis by Mississippi Geological Survey, B. P. Mandlebaum, MGS Bull. 49, p. 117, Sec. 25, T. 8, R. 6, Scott Co., Miss.
^gAnalysis by Mississippi Geological Survey, B. P. Mandlebaum, MGS Bull. 49, p. 117, Sec. 23, T. 7, R. 6, Scott Co., Miss.
^hAnalysis by Mississippi Geological Survey, B. P. Mandlebaum, MGS Bull. 49, p. 118, Sec. 23, T. 7, R. 6, Scott Co., Miss.
ⁱAnalysis by Mississippi Geological Survey, B. P. Mandlebaum, MGS Bull. 49, p. 121, Sec. 11, T. 6, R. 6, Scott Co., Miss.
^jAnalysis by Mississippi Geological Survey, B. P. Mandlebaum, MGS Bull. 49, p. 121, Sec. 15, T. 5, R. 6, Scott Co., Miss.
^kAnalysis by Shilstone Testing Laboratory, MGS Bull. 115, p. 113, Sec. 5, T. 8, R. 5, Rankin Co., Miss.
^lAnalysis by Shilstone Testing Laboratory, MGS Bull. 105, p. 177, Sec. 5, T. 7, R. 1W, Hinds Co., Miss.
^mAnalysis by Shilstone Testing Laboratory, MGS Bull. 105, p. 177, Sec. 5, T. 7, R. 1W, Hinds Co., Miss.
ⁿAnalysis by Shilstone Testing Laboratory, MGS Bull. 105, p. 177, Sec. 5, T. 7, R. 1W, Hinds Co., Miss.
^oAnalysis by Mississippi State Chemical Laboratory, MGS Bull. 103, Sec. 7, T. 1N, R. 14, Clarke Co., Miss.
^pAnalysis by Mississippi State Chemical Laboratory, MGS Bull. 103, Sec. 26, T. 6, R. 5, Rankin Co., Miss.

For the reasons discussed, the Yazoo Clay does not appear promising for nuclear waste disposal in the area examined. On the other hand, the area is seismically inactive. Also, carefully detailed drilling may disclose locations suitable for disposal of certain types of waste. South of the area of piercement salt domes the Yazoo Clay is deeper and might be better suited for waste disposal, but this is in the area of Wilcox and Tuscaloosa oil and gas production and the most intensively drilled part of Mississippi.

Chattanooga Shale

The writer has had experience with the Chattanooga Shale in the Central Basin, Highland Rim areas of Tennessee, throughout northern Alabama, northern Mississippi, northern Arkansas, southern Illinois, and south-central Kentucky in all of which region the Chattanooga Shale rarely exceeds 60 feet in thickness and generally is much thinner. Therefore, in the area of this study, the Chattanooga Shale is much thinner than the 500 feet desired for waste disposal. In very local areas such as some of the crypto-explosive areas of Tennessee, the Chattanooga exceeds 200 feet in thickness and is reported to be as much as 1500 feet thick in east Tennessee; but these localities are exceptional and are outside the area assigned to the writer.

Around the Central Basin of Tennessee, and especially in the Eastern, Southern and Western Highland Rim, the Western Valley of the Tennessee, and in the Valley and Ridge Province of east Tennessee, northwest Georgia and northeast Alabama, and in the northeast corner of Mississippi there are thousands of outcrops of the Chattanooga Shale. This unit is the principal stratigraphic reference of the region, and it has been utilized in the making of many detailed structural maps, for in much of its outcrop it is sharply folded and, in many places, faulted. Only in the Cumberland-Sand Mountain Plateau of east-central Tennessee and northern Alabama, and in a few counties in the Black Warrior Basin of Alabama and Mississippi, does the Chattanooga lie at the optimum required depths of 1000-3000 feet below Land Surface Datum.

In Alabama Butts (1926, p. 159) described the Chattanooga: "Where the Chattanooga is best developed it is mainly a densely black, highly fissile shale. At Blount Springs it includes about 1 foot of sandstone near the middle, and at Arkdell, Lauderdale County, it includes thin sandy layers and passes upward into a few feet of gray shale and sandstone that possibly

should be included in it. In the northwestern counties it has at its base about 1 foot of sandstone, which is thicker in parts of western Tennessee, where it is known as the Hardin sandstone member. The Chattanooga is thickest in Red Mountain east of Big Wills Valley, in the ridges along both sides of Sequatchie Valley, at Blount Springs in the south end of Sequatchie Valley, and in the north end of Murphrees Valley. Throughout the general

Figure 13. Chattanooga Shale on Blount Springs Anticline, Sec. 6, T. 13 S., R. 2 W., Blount County, Alabama. From R. Pavlovic in Seventh Field Trip Guidebook, Miss. Geol. Soc., p. 62, 1949.

region indicated it averages about 20 feet thick, but the thickness differs somewhat from place to place. At the south end of Murphrees Valley it is 10 feet thick, and in its northwestern exposures in Madison and Lauderdale counties, it ranges from 2 to 10 feet thick."

In west-central Tennessee Wells (1933, p. 67) described the Chattanooga: "The Upper Devonian, if present in western Tennessee, is represented by the Chattanooga Shale. Some geologists, however, consider this formation to be of Mississippian age. It crops out in the valleys of southeastern Hardin County, on the hillsides of southeastern Decatur County, and at scattered

localities in northeastern Benton County. It probably underlies much of the area, but it is not continuous in its distribution and may be lacking in places. It consists of a basal member, the Hardin sandstone, and the shale proper. The Hardin member is nowhere very thick, in this area ranging from 2 to 15 feet, but a maximum of 22 feet is reported from Wayne County. The shale is a black fine-grained fissile shale, which splits like slate into very thin flat sheets. It gives a petroliferous odor when hit with a hammer and contains much pyrite. The Chattanooga Shale yields very little water, which is of poor quality. The overlying Fort Payne chert contains abundant water. The impervious Chattanooga Shale deflects the downward circulation of water in the Fort Payne, with the result that along the valleys where the Chattanooga crops out springs are very abundant."

In Mississippi the Chattanooga outcrops were described by Morse (1930). Mellen (1955) described the Chattanooga in the subsurface of northern Mississippi where it is represented by detached sub-Mississippian outliers:

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SUBSURFACE OUTLIERS OF CHATTANOOGA SHALE IN NORTHEASTERN MISSISSIPPI¹

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Previous reports by the writer³ and others have referred to the subsurface absence of the Chattanooga shale in northeastern Mississippi and a small adjacent part of northwestern Alabama. The westward feather edge of the Chattanooga has been shown as an indefinite line trending about N. 20° W. from southwest Fayette County, Alabama, to the Tennessee state line at the center of the north line of Tishomingo County, Mississippi.

Several recent wells have penetrated thin intervals of typical Chattanooga shale at considerable distances (30-50 miles) west of the main body of the formation. Intervening wells, some of which cored the Mississippian-Devonian contact, did not have Chattanooga. It is interpreted that the Chattanooga is locally present in a few widely separated areas of northeast Mississippi as erosional remnants or outliers.

To date the writer has examined and re-examined Chattanooga shale from four wells, one in Monroe County, three in Pontotoc County.

1. Feazel *et al.* Rea No. 1, Sec. 12, T. 15 S., R. 18 W., Monroe County, in the sample 4270-80, interpreted as representing a foot or two of siltstone, hard, dark gray, shaly, sandy, pyritiferous, possibly slightly resinous and sporaceous.

2. L. E. Salmon's Wilson No. 1, Sec. 29, T. 9 S., R. 3 E., Pontotoc County, in samples at 1,850-1,860 and 1,860-1,865 feet, interpreted as representing about 4 feet of shale, dark brown-gray, silty, micaceous, very sporaceous, in part resinous; and siltstone, dark brown-gray, very sporaceous, and sandy.

3. L. E. Salmon's J. D. Naugher No. 1, Sec. 13, T. 10 S., R. 3 E., Pontotoc County, in the sample 2,350-2,355 feet, interpreted as representing the full thickness (5 feet) of the Chattanooga at this point, shale, dark brown-gray, micaceous, in part very pyritiferous, sporaceous, resinous, and bearing conodonts.

4. L. E. Salmon's C. E. Andrews No. 1, Sec. 3, T. 9 S., R. 2 E., Pontotoc County, in samples and by drilling behavior at 1593-1604, interpreted as being 11 feet of the formation. The shale in this well is exceptionally sporaceous and resinous, and is petroliferous and in part fluorescent.

In Muldon gas-condensate field of Monroe County, Union Producing Company's Neal No. 1, Sec. 21, T. 15 S., R. 6 E., in core No. 111 recovered 4 feet of shale, black with slickensides at the depths 6,351-6,355 feet. The shale was overlain in the core by 12 feet of hard gray fractured cherty limestone, and was also underlain by 12 feet of the same type of limestone. Paleontological informa-

¹ Manuscript received, June 16, 1955.

² Consulting geologist. L. E. Salmon has graciously consented to the use of his material. E. H. Rainwater, division stratigrapher, Shell Oil Company, has discussed the subject with the writer and has read the manuscript and offered suggestions. Their contributions are greatly appreciated.

³ Frederic F. Mellen, "Black Warrior Basin, Alabama and Mississippi," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 31, No. 10 (October, 1947), p. 1811.

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tion on the limestones subjacent and superjacent to the shale is lacking, but W. H. Hass⁴ reported on conodonts found in the shale:

at 6,351-55, 4 feet of sandy black shale, somewhat deformed and slickensided, yielded a few conodonts of very late Devonian age... among these were several good specimens of *Spathognathodus inornatus* (Branson & Mch) which is a common fossil in the youngest part of the Chattanooga shale of central Tennessee... none of the conodont genera considered by me to be significant indicators of the Mississippian or of older parts of the Devonian has been seen in the collection from the core... it is my opinion that the shale sample from the Union No. 1 Neal is from the Chattanooga shale sequence.

Undoubtedly, the Chattanooga will be found in many future wells if sampled and examined carefully. The presence of the shale in the wells as here described should be of assistance to the many workers on the Chattanooga shale, and of aid in correlating the subsurface geology of the Black Warrior basin with the stratigraphic geology of the Ozarks, the Arkansas Valley, and the Ouachita provinces west of the Mississippi River. In Mississippi even the scattered distribution of the Chattanooga is helpful in confirming by interval the Mississippian-Devonian boundary in the many wells wherein the Chattanooga is unknown, in which cherty Mississippian limestones rest on cherty Devonian limestones.

⁴ Letter of L. C. Conant, U. S. Geological Survey, to Wilbur H. Knight, Union Producing Company, March 24, 1953.

Figure 14 is an early portrayal of the structure of the Chattanooga, broadly generalized in the outcrop areas of central Tennessee and slightly simplified in the sub-surface of Alabama and Mississippi. Subsequent to

its publication isolated areas (outliers) of the Shale were reported (supra) west of the wavy line where "Chattanooga absent in this area."

Figure 14. Generalized structure map of Chattanooga Shale in parts of Tennessee, Alabama and Mississippi. Mellen, 1947, AAPG Bull. 31 No. 10, p. 1810.

The Chattanooga Shale would appear to be an undesirable waste disposal reservoir in the subject area because of its universal high content of hydrocarbons, because of its natural radioactivity, because of its thinness and local absence, because of its ubiquitous content of iron sulfide which rapidly acidifies in the presence of water and air, and because of the sharp structural relief revealed where there is abundant control. The areas of optimum depth range are limited.

Basal Ottawa Limestone

As used in this report, the term Ottawa (Megagroup) is essentially in the same sense as used by Buschback, et al. (1971): "The Middle Ordovician carbonate rocks between the Maquoketa and the St. Peter Sandstone are assigned to the Ottawa Megagroup (p. 8)." By "Basal Ottawa Limestone," the connotation I seek to make is restriction essentially to the Central Limestone (Murfreesboro) of Wilson plus any impermeable subjacent or superjacent limestones of Middle Ordovician age that are impermeable. This connotation would include some subjacent portion of the Wells Creek (Pond Spring) if locally characteristically impermeable and would include overlying limestone formation of the Black River-Stones River Group (Pierce, Ridley, Lebanon and Carters limestones) if also locally characteristically impermeable.

The relatively impermeable basal Ottawa limestone (chiefly Murfreesboro as identified in well samples in northeast Mississippi and northwest Alabama) is 250-450 feet in thickness and is not known to contain fluids. For this reason, for the reason of its structural competence, for the reason of its presence in an area where earthquakes are rare or unknown, and where most of the overburden rocks of Paleozoic age are relatively dry, the Murphreesboro is believed to be an excellent host rock for nuclear waste disposal.

Concerning the hydrology of the Murphreesboro in the type area, Newcome (1958, pp. 12-13) writes: "Although the Murfreesboro limestone is 400 feet thick and contains many easily dissolved beds, the formation in most places is a poor source of water. This probably is due to the Murfreesboro being covered nearly everywhere by 100 to 600 feet of younger rocks. Exceptions are small areas where the formation crops out in central Rutherford County and at Wilhoite Mills in Marshall County. In the outcrop areas the Murfreesboro yields water to most wells. Records of 47 wells drilled into

the formation in Rutherford County show that the Murfreesboro yielded water to 34 of them. However, elsewhere in the Central Basin where the Murfreesboro is more deeply buried it yielded water to only 20 of 100 wells.

"In the vicinity of Murfreesboro several industries make use of ground water in their processes. In that locality there are at least 12 wells that yield more than 100 gpm each from the Murfreesboro limestone. Most of this water is of good quality. Elsewhere in the Central Basin the Murfreesboro seldom yields water that is not highly mineralized. The formation is a poor source of water except in the areas where it crops out or is very near the land surface."

Logs of many wells drilled by cable tools in northwestern Alabama and northeastern Mississippi show the Murphreesboro limestone (basal Ottawa) to be consistently dry - that fluids were encountered very rarely in the overlying formations and commonly 50-200 feet below the top of the underlying Knox Dolomite. Figure 15 is a partial sample log of a rotary well drilled in 1973 in Prentiss County, Mississippi, to illustrate typical characteristics of this unit.

Jewell (W. B., 1947) described the metasomatism and paragenesis of mineral veins in the Ordovician country rock in Middle Tennessee. Some of these minerals have been found in trace amounts in well samples in northern Mississippi, and it must be assumed, from known distribution of sphalerite, fluorite and other associated minerals, that metasomatism was possibly active in rocks of equivalent ages in Alabama and Mississippi as it was in Tennessee. The porosity developed locally in Middle Tennessee (Newcome, supra) was probably in large part, if not entirely, due to meteoric waters containing carbonic solvent. The sub-lithographic or aphanitic character of the Murphreesboro is broken horizontally by thin dark-mud laminations and vertically by small irregular granular dolomite relict borings, and more

Figure 15. This is a portion of a sample log prepared by the writer (log No. 142) on which curves from the electrical log have been superimposed. The well is Pelto Oil Co. No. 1 Boyd Riddle, Sec. 9, T. 6 S., R. 9 E., Prentiss County, Mississippi. Elevation was 505' DF and TD was 2314'. Formation tops called by the writer are: Wayne (basal Silurian) 1142 (-636); Ordovician, Richmond 1179 (-673); Ordovician, Trenton 1210 (-704); Ordovician, Black River 1256 (-750); Ordovician, Knox 1712 (-1206). The purpose of this figure is to show the lithologic characteristics of the Upper and Middle Ordovician and of the upper part of the Lower Ordovician (Knox). The rocks 1210-1712 are identified as Ottawa Megagroup. The section of interest in this study is 1450-1712 (262') identified as being largely Murphreesboro limestone, plus any impermeable superjacent or subjacent carbonate rock. Many cable tools wells in Mississippi, Alabama and Tennessee have drilled this interval without any fluid entry. It is the most consistently dense part of the Paleozoic rocks over the area of this study.

rarely by mineral veins, usually of calcite, but much more rarely of galena, sphalerite, fluorite, barite, dolomite, etc. The lithologic evidence of well samples indicates deeper water sedimentation of the Murphreesboro over the Wells Creek-Knox terrane and no tendency to develop oolite or coquina reefs as is found both in the Knox and in Ordovician rocks younger than the Murphreesboro. The lower Ottawa (Murphreesboro) limestone appears to be the most consistently thick impermeable horizon in the Paleozoic of the study area.

Plate I shows points of structural control and contours on the top of the Knox Dolomite, about 50-75 feet below the Murphreesboro. While the compatibility of data between the three states is generally good, there was a tendency on the part of the Tennessee contourers to close the contours on the south side of the Nashville Dome without utilizing control from Alabama and Mississippi wells. This lack of certainty is indicated by a series of question marks from Madison County, Alabama, to Alcorn County, Mississippi. As more control is developed along these state lines the contouring can be improved. It is obvious from spreading of contours in northeast Mississippi and northwest Alabama, and from seeming north dip, that faulting has complicated the structural pattern. It is desirable to locate these faults where possible and to avoid highly faulted areas in exploratory drilling for impermeable storage reservoirs.

Other Possible Units

The Floyd Shale of Lower Carboniferous (Chester) age has been mentioned as a unit of sufficient thickness to be considered for waste disposal. Its presence in the Birmingham-Bessemer area is admitted where it is exposed along highly faulted anticlines of the Valley and Ridge province. Elsewhere,

FIGURE 16

in the Black Warrior Basin of Alabama and Mississippi the Chester rocks of equivalent age are producing natural gas and oil in many shallow fields of the 1000-6000 foot depth range where cyclical shelf deposition has produced alternating porous sands and non-porous shales and limestones, in contrast to the deeper water mud-shales of the type Floyd. No uniformly thick Mississippian or Pennsylvanian shales are found in the region in the 1000-3000 foot depth range.

The Silurian shales and shale-limes have been mentioned as a possible disposal horizon. West of the axis of the Nashville Dome these rocks are rarely found over 300 feet in thickness. Southward in the Black Warrior Basin, and in the Valley and Ridge province of Tennessee and northeast Alabama, the impermeable Silurian is locally much thicker. I am not familiar with lithologic details in these latter areas; but in the Black Warrior Basin of Alabama and Mississippi reef porosity might locally be developed as in Illinois, Michigan and other states.

The Selma Chalk may have possibilities, but these are the subject of another investigator.

Granites of pre-Cambrian and Permo-Triassic ages are known, but these are below the 3000-foot depth limitation and the granites are the subject of another investigator.

The Tallahatta (Basic City) Claystone and the Zilpha Clay, both of Claiborne age, are best developed in western Mississippi near the Mississippi River. These units are much thinner than the Yazoo Clay and the Porters Creek Clay, but may be considered later if specifications are amended.

Conclusions

The Porters Creek Clay has its optimum development over the Central Mississippi Ridge in a belt 50-60 miles wide and 150 miles long. The area

has been relatively stable in most parts for the past 70 million years as attested by the conspicuously uniform deposition of Cretaceous rocks, by the widening of the Porters Creek isopach intervals and by the fact that the area is largely in seismic risk zone 1. There are no oil or gas fields in this area now.

The Sharkey Platform north of Vicksburg was mapped on the Porters Creek Clay because of its proximity to the Mississippi River, even though it is deeper than the 3000-foot limit. Where mapped its base lies about 3000-3600 feet below LSD and its thickness ranges from 400 to 700 feet. The area is in seismic risk zone 1.

The Yazoo Clay is largely in the range of 400-500 feet thick around Vicksburg and southeasterly, rarely over 500 feet. In the region surveyed its base lies at the maximum depth of about 2000 feet. The Yazoo Clay area studied is entirely in the Mississippi Interior Salt Dome Basin. Deep, intermediate and shallow diapiric salt has complexly faulted much of the Yazoo Clay area. The area has had many oil and gas exploratory wells and some production. The area is in seismic risk zone 1.

The Chattanooga Shale does not fit the requirements for a waste disposal unit in the region studied.

The Middle Ordovician or Ottawa limestone is 250-450 feet thick and appears to be a continuous unit of impermeable limestone on the stable shelf of the Black Warrior Basin of northeastern Mississippi and northwestern Alabama. It may be suitable for waste disposal in the Cumberland Plateau and the Valley and Ridge provinces of Tennessee and northeastern Alabama. Secondary porosity may locally develop in this dense limestone section, but is much less likely than in the overlying shallower water limestones and in the underlying Knox Dolomite. Most of the area is in seismic risk zone 1,

but the eastern part is in zone 2. More detailed information from this unit is needed: geophysical logs, cores, paleontological studies, and studies of metasomatic mineralization.

Other rock units were omitted from the assignment or do not fit the requirement of 500 feet thickness at depths of 1000-3000 feet below LSD.

Thick unconsolidated fresh water sands lie in the overburden above the Porters Creek Clay and the Yazoo Clay in the areas of optimum development of these units in Mississippi. The basal Middle Ordovician limestone in south-central Tennessee and in north Alabama is beneath overburden of younger Paleozoic rock in which aquifers are poor and relatively rare. Westerly, thick water-bearing sands and gravels of Tuscaloosa, Eutaw and Selma age overlap on the dense Paleozoic rocks of Pennsylvanian and Mississippian ages which overlie, in sequence, the older Devonian, Silurian, and Ordovician sediments in which zones of porosity are rare.

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APPENDIX A		BASIC DATA FOR: PORTERS CREEK CLAY								PAGE: 1
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS	
ALABAMA CHOCTAW	1	28	15 N	4 W	274 6009	745 -471	1145 -871	400	Top 100'± of unit appears sl silty; bottom 75'± of unit appears marly	
	2	21	13 N	3 W	204 4515	1147 -943	1534 -1330	387	Top 100'± of unit appears sl silty	
	3	32	13 N	3 W	--- 3235	1287 ----	1674 ----	387	Good shale section	
	4	18	12 N	4 W	234 12493	1619 -1385	2040 -1806	421	Top 160'± of unit appears progressively silty upward	
	5	23	12 N	4 W	313 4015	1675 -1362	2050 -1737	375	Top 65'± of unit appears v sl silty & marly	
	6	31	11 N	2 W	89 4025	2050 -1961	2400 -2311	350	Top 100'± of unit appears sl silty	
CLARKE	1	34	12 N	1 E	81 3690	920 -839	1200 -1119	280	Top 60'± of unit appears silty	
	2	11	10 N	1 W	--- 3495	1790 ----	2085 ----	295	Top 50'± of unit appears sl silty	
	3	11	10 N	1 E	454 3507	1700 -1246	1956 -1502	256	Good shale section	
	4	11	9 N	5 E	139 4338	1240 -1101	1373 -1234	133	Top 100'± of unit appears sl silty	
MARENGO	1	23	14 N	1 E	175 3586	260 -85	523 -348	263	Top 90' of unit appears progressively silty upward	
	2	32	14 N	1 E	231 4020	512 -281	784 -553	272	Top 20'± of unit appears silty	
	3	35	14 N	2 E	286 2510	310 -24	627 -341	317	Top 80'± of unit appears silty	
	4	18	13 N	1 E	198 3400	618 -420	962 -764	344	Top 75'± of unit appears silty	
	5	18	12 N	1 E	180 4230	866 -686	1193 -1013	327	Top 100'± of unit appears sl silty	
	6	9	12 N	3 E	259 7622	627 -368	890 -631	263	Top 73'± of unit appears sl silty	
WILCOX	1	33	12 N	5 E	116 2319	808 -692	1028 -912	220	Appears marly 35-62' below top of unit	
	2	4	11 N	5 E	285 2014	600 -315	803 -518	203	Appears sl marly 37-60' below top of unit	

APPENDIX A		BASIC DATA FOR: PORTERS CREEK CLAY								PAGE: 1
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS	
MISSISSIPPI ATTALA	1	29	16 N	9 E	496 4512	892 -396	1563 -1067	671	Halliburton 2 curve log run 5-15-40	
	2	4	16 N	6 E	286 5748	1309 -1023	1970 -1684	661		
	3	29	15 N	6 E	353 5017	1667 -1314	2303 -1950	636		
	4	35	15 N	9 E	580 5030	1060 -480	1700 -1120	640		
	5	5	14 N	9 E	511 6217	1081 -570	1751 -1240	670		
	6	3	14 N	7 E	528 5262	1525 -997	2163 -1635	638	Drilled & logged in 1940	
	6a	3	14 N	7 E	520 3575	1545 -1025	2155 -1635	610	Drilled & logged in 1966	
	7	12	14 N	6 E	450 3721	1693 -1243	2295 -1845	602		
	8	28	14 N	5 E	318 5202	1951 -1633	2620 -2302	669		
	9	28	13 N	4 E	245 10767	2605 -2360	3248 -3003	643		
	10	33	13 N	5 E	290 4534	2285 -1995	2968 -2678	683		
	11	4	13 N	6 E	329 7091	1772 -1443	2440 -2111	668		
	12	28	13 N	6 E	342 8018	1924 -1582	2568 -2226	644		
13	1	12 N	5 E	292 3617	2140 -1848	2798 -2506	658			
BENTON	1	3	3 S	1 E	613 930	390 +223	658 -45	268	City of Ashland No. 3	
CALHOUN	1	16	11 S	1 W	450 1887	206 +244	630 -180	424	MGS-B6 - 2 curve log interpretation MGS has samples	
	2	24	12 S	2 W	395 1945	735 CSG.	735 -340	290+	MGS-C1 - 2 curve log interpretation Surface casing @ 445 in PC	
	3a	31	12 S	1 W	317 1772	165 +151	638 -321	472	USGS-D2 - 2 curve log interpretation; log poor	

APPENDIX A		BASIC DATA FOR: PORTERS CREEK CLAY								PAGE: 2
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS	
MISSISSIPPI CALHOUN (cont'd.)	3b	31	12 S	1 W	323 1868	182 +141	650 -327	468	MGS-D2 - 2 curve log interpretation MGS has some samples	
	3c	31	12 S	1 W	330 1880	189 +141	662 -332	473	USGS-D4 - 2 curve log interpretation	
	4	33	12 S	1 E	500 2002	106 +394	509 -9	403	USGS-E10 - 2 curve log interpretation	
	5	32	13 S	1 W	367 2040	238 +129	696 -329	458	MGS-G-1 - 2 curve log interpretation MGS has samples	
	6	19	13 S	1 W	360 1790	DS	701 -341	401+	MGS-G3 - 2 curve log interpretation Poor log - no samples	
	7	27	13 S	1 E	400 1360	Outcrop	359 +41	359+	USGS-H3 - 2 curve log interpretation This well in outcrop belt	
	8	13	23 N	8 E	295 2496	CSG.	798 -503	554+	USGS-J1 - 2 curve log interpretation Cased to 244' in Porters Creek?	
	9	11	14 S	1 W	350 1946	52 +298	550 -200	498	MGS-K1 - gamma ray log interpretation Correlation w/MGS-G1 is good	
	10	21	14 S	1 E	318 1445	Outcrop	381 -63	381+	MGS-L1 - 2 curve log interpretation This well in outcrop belt	
	11	11	22 N	9 E	360 2160	CSG.	759 -399	301+	USGS-N29 (MGS-N1) - 2 curve log interpretation. Cased to 458' in Porters Creek	
	12	29	22 N	9 E	340 2295	369 -29	850 -510	481	USGS-N28 (MGS-N2) - 2 curve log interpretation	
	13	4	15 S	1 E	--- 695	39 ---	478 ---	439	MGS-O1 - 2 curve log interpretation Elevation and exact location NA	
	14	3	22 N	10 E	300				MGS-O2 - gamma ray log interpretation	
	15	26	22 N	10 E	403 2019	142 +261	586 -183	444	MGS-O4 - 2 curve log interpretation	
	CARROLL	1	29	21 N	4 E	270 4696	1307 -1037	1970 -1700	663	
2		15	19 N	2 E	155 5007	1685 -1530	2383 -2228	698		
3		21	19 N	3 E	331 4038	1682 -1351	2395 -2064	713		
4		22	19 N	4 E	290 4880	1336 -1046	2060 -1770	724		

APPENDIX A		BASIC DATA FOR: PORTERS CREEK CLAY								PAGE: 3
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS	
MISSISSIPPI CARROLL (cont'd.)	5	22	18 N	5 E	346 5284	1364 -1018	1957 -1611	593	May be thicker: There is an additional 139' impermeable clay above top of unit,	
	6	28	18 N	3 E	398 5955	1855 -1457	2560 -2162	705	as picked	
	7	35	18 N	1 E	127 7263	2083 -1956	2805 -2678	722		
	8	12	17 N	2 E	307 6439	2045 -1738	2750 -2443	705		
	9	2	17 N	3 E	456 3561	1810 -1354	2590 -2134	780		
	10	12	17 N	3 E	325 6000	1750 -1425	2489 -2164	739		
	1	33	18 N	9 E	397 4387	592 -195	1190 -793	598		
CHOCTAW	2	10	17 N	9 E	387 4517	574 -187	1197 -810	623		
	3	24	16 N	11 E	456 14900	340 +116	940 -484	600		
	1	14	4 N	16 E	366 4770	1424 -1058	1890 -1524	466	50' fault in Chalk 110' below base of shale	
CLARKE	2	16	4 N	15 E	409 4057	1773 -1364	2237 -1828	464	1941 Halliburton log. Top may be 40' higher and thickness 504'	
	3	19	4 N	14 E	352 12361	1934 -1632	2493 -2141	509		
	4	10	3 N	14 E	355 12277	2263 -1908	2770 -2415	507		
	5	18	3 N	14 E	338 9340	2411 -2073	2922 -2584	511	Top 70' sl silty	
	6	25	3 N	14 E	360 4010	2437 -2077	2802 -2442	365	200' Fault @ 2600± (-2240)	
	7	16	3 N	15 E	232 11198	1960 -1728	2440 -2208	480		
	8	23	3 N	15 E	339 11442	2004 -1665	2474 -2135	470		
	9	29	3 N	16 E	311 10819	2120 -1809	2440 -2129	320	Upper part of Porters Creek is silted; well may be faulted	

APPENDIX A		BASIC DATA FOR: PORTERS CREEK CLAY							PAGE: 4
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI CLARKE (cont'd.)	10	10	3 N	16 E	425 4033	1850 -1425	2303 -1878	453	
	11	28	3 N	18 E	446 9852	1700 -1254	2110 -1664	410	
COAHOMA	1	36	27 N	3 W	187 17600	2100 -1913	2694 -2507	594	4' marlstone? 120' below top of unit
DESOTO	1	18	2 S	9 W	220 4884	2034 -1814	2503 -2283	469	
GRENADA	1	31	23 N	4 E	293 2873	1210 -917	1888 -1595	678	
	2	35	23 N	4 E	199 2580	992 -793	1625 -1426	633	
	3	28	23 N	5 E	201 3006	870 -669	1503 -1302	633	
	4	25	22 N	6 E	324 3687	765 -441	1373 -1049	608	
	5	26	22 N	4 E	304 4030	1175 -871	1813 -1509	638	
	6	5	22 N	3 E	272 3184	1373 -1101	2072 -1800	699	
	7	31	22 N	3 E	280 4624	1508 -1228	2185 -1905	677	
	8	34	22 N	2 E	146 3821	1480 -1334	2170 -2024	690	
	9	5	21 N	2 E	147 3893	1563 -1416	2226 -2079	663	
	10	6	21 N	7 E	375 7016	810 -435	1395 -1020	585	
HOLMES	1	13	16 N	1 E	159 6051	2460 -2301	3178 -3019	718	3' marl? bed 67' below top of unit
	2	36	16 N	3 E	430 6820	2112 -1682	2818 -2388	706	62' additional impermeable clay above unit
	3	20	15 N	5 E	318 4507	1778 -1460	2450 -2132	672	68' additional impermeable clay above unit
	4	12	15 N	3 E	285 8330	--- ---	2768 -2483	503+	Casing in PC @ -1980

APPENDIX A		BASIC DATA FOR: PORTERS CREEK CLAY							PAGE: 5
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI HOLMES (cont'd.)	5	21	15 N	3 E	245 4161	2350 -2105	3070 -2825	720	65' additional impermeable clay above unit
	6	36	14 N	3 E	285 4540	2428 -2143	3200 -2915	772	Top 100' of unit appears sl silty
	7	18	14 N	4 E	382 5007	2382 -2000	3135 -2753	753	
	8	21	14 N	4 E	281 5010	2180 -1899	2928 -2647	748	Top 200'± appears sl silty
JASPER	1	27	4 N	13 E	382 5472	2228 -1846	2760 -2378	532	Good shale section
	2	23	4 N	12 E	426 12014	2500 -2074	3060 -2634	560	Good shale section
	3	7	4 N	12 E	440 4502	2527 -2087	3143 -2703	616	Good shale section
	4	8	4 N	11 E	485 6315	2885 -2400	3456 -2971	571	Good shale section
	5	34	4 N	12 E	563 6288	2812 -2249	3354 -2791	542	Good shale section
	6	14	3 N	12 E	549 6165	2972 -2423	3518 -2969	546	100' fault in chalk ca. 550' below unit
	7	19	3 N	13 E	470 5067	2863 -2393	3388 -2918	525	Good shale section. In faulted area
	8	27	3 N	13 E	331 12960	2612 -2281	3122 -2791	510	Good shale section
KEMPER	1	15	12 N	15 E	438 12788	200 +238	645 -207	445	
	2	19	11 N	15 E	530 2522	615 -85	1013 -483	398	
	3	12	10 N	14 E	553 2102	820? -267	1175 -622	355	Marly development 175-225' above base of unit
	4	20	10 N	15 E	455 2712	690 -235	1056 -601	366	
	5	14	10 N	15 E	401 2523	475 74	852 -451	377	
LAFAYETTE	1	18	7 S	1 W	388 11188	268 +120	610 -222	342	Bottom of unit is marly

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PORTERS CREEK CLAY

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STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI LAFAYETTE (cont'd.)	2	2	8 S	3 W	490 2256	658 -168	1035 -545	377	
	3	3	8 S	1 W	330 1551	129 +201	480 -150	351	
	4	4	9 S	4 W	436 5010	787 -351	1265 -829	478	Top 70' may be silty
	5	7	10 S	2 W	596 2225	488 +108	1000 -404	512	
LAUDERDALE	1	13	8 N	17 E	257 3290	212 +45	685 -428	473	
	2	11	8 N	15 E	462 4117	750? -288	1258 -796	508?	Top 75' of unit may be silty or washed out
	3	4	8 N	14 E	426 6007	955 -529	1472 -1046	517	
	4	32	7 N	14 E	452 4754	1405 -953	1914 -1462	509	
	5	2	7 N	14 E	411 4520	1068 -657	1560 -1149	492	Top 70' appears to be silty in part
	6	4	7 N	18 E	--- 1000	283 ---	762 ---	479	
	7	27	6 N	18 E	278 6013	--- ---	990 -712	361 ⁺	Casing set in PC @ 629'
	8	7	6 N	17 E	538 5835	991 -453	1445 -907	454	
	9	2	6 N	16 E	473 5040	983 -510	1457 -984	474	
	10	36	6 N	14 E	455 7850	1437 -982	1956 -1501	519	Top 70' appears sl silty in part
	11	12	5 N	14 E	452 5010	1558 -1106	2070 -1618	512	
	12	15	5 N	14 E	396 9918	1675 -1279	2235 -1839	560	
	13	26	5 N	15 E	416 4821	1500 -1084	1980 -1564	480	
	14	3	5 N	18 E	500 [±] 6810	754 -254	1183 -683	429	

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BASIC DATA FOR:

PORTERS CREEK CLAY

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STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI LEAKE	1	26	12 N	7 E	492 5028	1878 -1386	2560 -2068	682	Top 85' of unit appears sl silty
	2	31	11 N	7 E	449 9417	2330 -1881	3019 -2570	689	Top 130'± of unit appears sl silty
	3	8	11 N	9 E	481 4826	1620 -1139	2260 -1779	640	Top 140'± of unit appears sl silty
	4	2	10 N	8 E	359 5012	1675 -1316	2323 -1964	648	Top 145'± of unit appears sl silty
	5	5	10 N	8 E	354 4117	1863 -1509	2497 -2143	634	Top 117'± of unit appears sl silty
	6	27	10 N	8 E	425 6015	1960 -1535	2586 -2161	626	Top 170'± of unit appears sl silty
	7	23	10 N	6 E	450 10900	2550 -2100	3212 -2762	662	Top 50'± of unit appears sl silty
	8	6	9 N	6 E	325 7195	2807 -2482	3541 -3216	734	Top 100'± of unit appears sl silty
	9	29	9 N	6 E	403 5476	3115 -2712	3811 -3408	696	80'± fault ca. 370' above base of unit
	10	28	9 N	6 E	409 6511	3045 -2636	3798 -3389	753	Top 80'± of unit appears sl silty
	11	28	9 N	8 E	351 5522	2100 -1749	2770 -2419	670	Top 110'± of unit appears sl silty
	12	16	9 N	9 E	412 5086	1870 -1458	2430 -2068	610	Top 130'± of unit appears sl silty
LEFLORE	1	3	21 N	1 E	142 4952	1587 -1445	2347 -2205	760	Top 218'± of unit appears sl silty
	2	23	21 N	1 E	144 3277	1585 -1441	2353 -2209	768	Top 85'± of unit appears sl silty
	3	16	21 N	1 E	140 5001	1674 -1534	2430 -2290	756	Top 95'± of unit appears sl silty
	4	20	21 N	1 E	145 5111	1717 -1572	2485 -2340	768	Top 100'± of unit appears sl silty
	5	6	20 N	2 W	126 6344	2290 -2164	3094 -2968	804	Top 90'± of unit appears sl silty
	6	6	20 N	1 E	146 5329	1767 -1521	2527 -2381	760	Top 50'± of unit appears silty

APPENDIX A		BASIC DATA FOR: PORTERS CREEK CLAY								PAGE: 8
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS	
MISSISSIPPI LEFLORE (cont'd.)	7	27	20 N	1 E	131 5454	1705 -1574	2478 -2347	773	Top 135'± of unit appears sl silty	
	8	8	19 N	1 W	130 4394	2150 -2020	2927 -2797	777		
	9	2	18 N	1 E	131 6510	1915 -1784	2705 -2574	790	Top 120'± of unit appears sl silty	
	10	36	18 N	1 W	128 7868	2338 -2210	3075 -2947	737	Top 42'± of unit appears sl silty	
	11	9	17 N	1 E	121 5516	2272 -2151	3058 -2937	786	Top 58'± of unit appears sl silty	
MADISON	1	22	12 N	5 E	361 10204	--- ---	3140 -2779	286+	Casing set in PC	
	2	30	12 N	5 E	361 11243	2688 -2327	3423 -3062	735	Top 150'± of unit appears sl silty	
	3	10	11 N	5 E	404 5021	2688 -2284	3423 -3019	735	Top 100'± of unit appears sl silty	
MARSHALL	1	32	5 S	3 W	395 4004	702 -307	1010 -615	308		
MONTGOMERY	1	36	21 N	5 E	265 3479	899 -634	1620 -1355	721	Top 100'± of unit appears sl silty	
	2	22	19 N	7 E	394 5086	--- ---	--- ---	---	Crypto-explosive area - casing set entirely through PC @ 847 (-453)	
	3	20	19 N	7 E	450 4564	960 -510	1612 -1162	652	Top 150'± of unit appears sl silty	
	4	25	19 N	6 E	363 4012	935 -572	1620 -1257	685		
NESHOB	1	3	12 N	12 E	480 4008	641 -161	1245 -765	604	Top 124'± of unit is progressively silty upwards	
	2	13	12 N	10 E	454 5916	1085 -631	1666 -1212	581	Top 100'± of unit is progressively silty upwards	
	3	28	12 N	10 E	398 6132	1178 -780	1777 -1379	599	Top 120'± of unit is progressively silty upwards	
	4	36	11 N	13 E	503 5430	750 -247	1293 -790	543	Top 123'± of unit is progressively silty upwards	
	5	1	9 N	11 E	557 6876	1310 -753	1960 -1403	650	Top 130'± of unit is progressively silty upwards	

APPENDIX A		BASIC DATA FOR: PORTERS CREEK CLAY							PAGE: 9
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI NESHOB (cont'd.)	6	24	9 N	11 E	478 4327	1360 -882	1962 -1484	602	Top 140'± of unit is progressively silty upwards
	7	18	9 N	13 E	500 4018	1174 -674	1740 -1240	565	Top 100'± of unit is progressively silty upwards
NEWTON	1	14	8 N	10 E	510 4900	1885 -1375	2479 -1969	594	Top 110'± of unit is sl silty
	2	17	8 N	10 E	480 4815	1980 -1500	2572 -2092	592	Top 130'± of unit is sl silty
	3	27	8 N	10 E	531 4781	1991 -1460	2572 -2041	581	
	4	26	6 N	13 E	346 8965	1630 -1284	2153 -1807	523	
	5	9	6 N	11 E	489 5512	2130 -1641	2730 -2241	600	Excellent shale section
	6	17	6 N	11 E	422 8699	2160 -1738	2742 -2320	582	
	7	21	6 N	10 E	484 13011	2612 -2128	3221 -2737	609	
	8	28	6 N	10 E	470 4819	2736 -2266	3322 -2852	586	
	9	16	5 N	10 E	470 6448	2868 -2398	3450 -2980	582	
	10	25	5 N	10 E	490 5010	2830 -2340	3407 -2917	577	Excellent shale section
	11	18	5 N	11 E	475 4898	2741 -2266	3327 -2852	586	Excellent shale section
	12	10	5 N	11 E	386 10565	2347 -1961	2933 -2547	586	Excellent shale section
	13	27	5 N	12 E	454 11062	2229 -1775	2768 -2314	539	Good shale section
	14	28	5 N	13 E	406 10117	1910 -1504	2509 -2103	599	Top 70'± of unit sl silty
	15	23	5 N	13 E	389 8340	1853 -1464	2378 -1989	525	Top 55'± of unit silty (Naheola)
PANOLA	1	24	6 S	7 W	334 3032	1310 -976	1834 -1500	524	Overlain by 110'± silty clay

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BASIC DATA FOR:

PORTERS CREEK CLAY

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STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI PANOLA (cont'd.)	2	31	6 S	8 W	347 3562				
	3	18	7 S	9 W	180 3587	1730 -1550	2308 -2128	578	Overlain by 128'± sl silty clay
	4	18	7 S	7 W	344 3713	1480 -1136	2047 -1703	567	Overlain by 95'± silty clay
	5	19	9 S	8 W	175 2457	1420 -1245	2000 -1825	580	Overlain by 118' silty clay
	6	28	9 S	8 W	219 3135	1405 -1186	1962 -1743	557	Overlain by 115'± silty clay
	7	23	9 S	7 W	360 3264	1255 -895	1800 -1440	545	Top 100'± of unit is sl silty
	8	10	10 S	7 W	250 4964	1165 -915	1730 -1480	565	Top 90'± of unit is sl silty
SCOTT	1	19	8 N	8 E	383 9814	2485 -2102	3156 -2773	671	Top 155'± of unit is sl silty
	2	25	8 N	7 E	395 12005	2720 -2325	3395 -3000	675	Top 165'± of unit is sl silty
	3	23	7 N	9 E	472 11027	2377 -1905	3042 -2570	665	Top 160'± of unit is sl silty
	4	34	7 N	9 E	458 12328	--- ---	--- ---	---	10 3/4" casing @ 3396' w/2300 sx
	5	10	6 N	9 E	450 5094	2754 -2304	3366 -2916	612	Top 185'± of unit is v sl silty
	6	24	6 N	9 E	443 12968	2787 -2344	3372 -2929	585	Good shale section
	7	33	6 N	9 E	483 8814	3053 -2570	3653 -3170	600	Excellent shale section
	8	25	6 N	8 E	483 13516	3120 -2637	3700 -3217	580	Excellent shale section
	9	16	5 N	9 E	551 12876	3195 -2644	3791 -3240	596	Excellent shale section
TALLAHATCHIE	1	27	26 N	3 E	356 4558	1344 -988	1930 -1574	586	Excellent shale section
	2	13	26 N	2 E	357 3505	1500 -1143	2077 -1720	577	Excellent shale section

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STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI					207	1397	2000		
TALLAHATCHIE	3	3	26 N	2 E	3039	-1190	-1793	603	
(cont'd.)					160	1437	2053		
	4	32	25 N	2 E	3976	-1277	-1893	616	92'± clay overlying unit
					245	1300	1918		
	5	5	25 N	3 E	3659	-1055	-1673	618	80'± clay, in pt silty, overlying unit
					233	1280	1870		
	6	28	25 N	3 E	2778	-1042	-1632	590	Top 120'± progressively silty upwards
					285	1208	1826		
	7	36	24 N	3 E	2778	-923	-1541	618	Top 115'± progressively silty upwards
					331	1367	1969		
	8	28	24 N	3 E	3835	-1036	-1638	602	110'± silty clay overlying unit
					160	1380	2034		
	9	21	24 N	2 E	3030	-1220	-1874	654	85'± silty clay overlying unit
					136	2148	2850		
	10	18	23 N	2 W	4296	-2012	-2714	702	
					343	1450	2138		
	11	31	23 N	3 E	3159	-1107	-1795	688	Top 150'± of unit appears sl silty
					397	1480	2123		
	12	17	23 N	3 E	3000	-1083	-1726	643	75'± silty clay overlying unit
					232	1180	1824		
	13	24	23 N	3 E	3907	-948	-1592	644	70'± silty clay overlying unit
					145	1774	2554		
	14	2	21 N	1 W	5909	-1629	-2409	780	
					235	1450	1945		
TATE	1	28	4 S	7 W	3165	-1215	-1710	495	Top 80'± of unit is sl silty
					222	1775	2460		
	2	20	4 S	9 W	3533	-1553	-2238	685	Top 145'± of unit is sl silty
					290	1480	2140		
	3	26	5 S	8 W	3364	-1190	-1850	660	Top 200'± of unit is sl silty
					271	1405	1905		
	4	15	5 S	7 W	4840	-1134	-1634	500	Top 80'± of unit is sl silty
					292	1295	1780		
	5	20	5 S	6 W	2911	-1003	-1488	485	Good shale section
					239	1818	2371		
	6	9	6 S	9 W	3586	-1579	-2132	553	Top 125'± of unit is sl silty

APPENDIX A		BASIC DATA FOR: PORTERS CREEK CLAY							PAGE: 12
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI TUNICA	1	21	4 S	11 W	200 5938	2195 -1995	2880 -2680	685	Top 215'± of unit is sl silty
	2	36	6 S	12 W	205 ---	2145 -1940	2814 -2609	669	Top 165'± of unit is sl silty
WEBSTER	1	4	21 N	9 E	312 10532	200 +112	840 528	640	Top 115'± of unit is sl silty
	2	8	20 N	10 E	460 1686	280 +180	884 -424	604	2-curve electrical log only
	3	1	19 N	10 E	420 2241	144 +276	750 -330	506	2-curve log; MGS has samples
WINSTON	1	3	14 N	12 E	513 2723	525 -12	1030 -517	505	
	2	9	13 N	14 E	486 4018	270 +216	795 -309	525	Top 300'± of unit progressively silty upwards
YALOBUSHA	1	29	11 S	3 W	520 2116	716 -196	1182 -662	466	Top 100'± of unit sl silty
	2	29	11 S	4 W	328 2176	702 -374	1196 -868	494	Appears somewhat silty at intervals throughout
	3	28	11 S	5 W	285 2276	816 -531	1345 -1060	529	Top 100'± of unit appears sl silty
	4	1	11 S	6 W	243 2134	837 -594	1374 -1131	537	Top 100'± of unit is silty
	5	18	11 S	6 W	339 2864	1145 -806	1680 -1341	535	Top 115'± of unit is silty
	6	30	11 S	6 W	311 2529	1126 -815	1660 -1349	534	Top 155'± of unit is progressively silty upwards
	7	18	25 N	4 E	284 2618	1155 -871	1760 -1476	605	Top 185'± of unit is progressively silty upwards
	8	30	25 N	4 E	380 3896	1150 -770	1775 -1395	625	Top 130'± of unit appears sl silty
	9	26	25 N	4 E	400 2704	1227 -827	1755 -1355	528	Top 220'± of unit is progressively silty upwards
	10	7	25 N	5 E	436 2597	1148 -712	1656 -1220	508	Top 77'± of unit is silty
	11	30	25 N	6 E	278 2497	787 -509	1326 -1048	539	Top 158'± of unit is progressively silty upwards

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STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI YALOBUSHA (cont'd.)	12	33	25 N	7 E	415 2841	605 -190	1160 -745	555	Top 150'± of unit is sl silty
	13	21	24 N	7 E	255 3188	495 -240	1045 -790	550	Top 100'± of unit is sl silty
	14	25	24 N	6 E	205 2960	562 -357	1140 -935	578	Top 150'± of unit is sl silty
	15	21	24 N	6 E	264 3212	705 -441	1275 -1011	570	Top 85'± of unit v sl silty
	16	6	24 N	5 E	389 2480	1085 -696	1672 -1283	587	Top 110'± of unit sl silty
	17	9	24 N	4 E	319 2701	1177 -858	1765 -1446	588	Top 110'± of unit sl silty
	18	34	24 N	4 E	385 2675	1192 -807	1820 -1435	628	Top 138'± of unit sl silty
	19	2	23 N	5 E	338 2615	994 -656	1562 -1224	568	Top 106'± of unit sl silty
SHARKEY PLATFORM AREA (Humphreys, Issaquena, Sharkey & Washington Counties)									
HUMPHREYS	1	13	14 N	4 W	115 5008	2771 -2656	3495 -3380	724	Top 165'± of unit appears sl silty
	2	15	14 N	4 W	110 5652	2650 -2540	3365 -3255	715	Top 100'± of unit appears sl silty
	3	23	14 N	4 W	109 4516	2582 -2473	3403 -3294	821	Top 100'± of unit appears sl silty
	4	24	14 N	4 W	120 5496	2694 -2574	3420 -3300	726	Top 65'± of unit appears sl silty
	5	5	13 N	3 W	105 4900	3203 -3098	3976 -3871	773	Top 90'± of unit appears sl silty
	6	4	13 N	4 W	98 5057	2872 -2774	3609 -3511	737	Top 100'± of unit appears sl silty
ISSAQUENA	1	6	13 N	7 W	110 4010	2880 -2770	3424 -3314	544	15'± marl? bed 284' above base of unit
	2	8	13 N	8 W	108 4010	2947 -2839	3429 -3321	482	Top 50'± of unit appears sl silty

APPENDIX A		BASIC DATA FOR: PORTERS CREEK CLAY								PAGE: 14
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS	
MISSISSIPPI ISSAQUENA (cont'd.)	3	26	13 N	8 W	110 4000	2680 -2570	3200 -3090	520	Top 70'± of unit appears v sl silty	
	4	27	13 N	9 W	117 5852	2670 -2553	3157 -3040	487	Excellent clay-shale section	
	5	3	13 N	9 W	120 6020	2638 -2518	3130 -3010	492	Excellent clay-shale section	
	6	11	12 N	8 W	110 3213	2600 -2490	3070 -2960	470	Top 50'± of unit appears sl silty	
	7	14	12 N	8 W	111 4008	2776 -2665	3264 -3153	488	Top 95'± of unit appears sl silty	
	8	37	12 N	8 W	101 4013	2760 -2659	3220 -3119	460	Top 70'± of unit appears sl silty	
	9	1	12 N	9 W	118 8086	2562 -2444	3020 -2902	458	Top 70'± of unit appears sl silty	
	10	18	12 N	7 E	102 4016	2823 -2721	3340 -3238	517	Top 100'± of unit appears sl silty 15'± marl? bed 240' above base of unit	
	11	9	11 N	8 W	105 8173	2635 -2530	3088 -2983	453	Top 50'± of unit appears sl silty	
	12	24	11 N	8 W	105 3543	2760 -2655	3190 -3085	430	Top 100'± of unit appears silty	
	13	24	11 N	9 W	106 3411	2680 -2574	3090 -2984	410	Top 70'± of unit appears silty	
	14	14	10 N	8 W	105 5422	3100 -2995	3565 -3460	465	Top 130'± of unit appears sl silty	
	15	25	10 N	8 W	110 6247	3252 -3142	3702 -3592	450	Top 100'± of unit appears sl silty	
	16	22	10 N	8 W	99 4325	3080 -2981	3492 -3393	412	Top 70'± of unit appears sl silty	
	17	9	10 N	8 W	101 4309	2994 -2893	3410 -3309	416	Top 75'± of unit appears sl silty	
	18	19	10 N	8 W	102 4088	3030 -2928	3448 -3346	418	Top 80'± of unit appears sl silty	
	19	1	9 N	8 W	102 4502	3587 -3485	4007 -3905	420	Top 65'± of unit appears sl silty	
	20	17	9 N	8 W	81 3827	3220 -3139	3639 -3558	419	Top 80'± of unit appears sl silty	

APPENDIX A		BASIC DATA FOR: PORTERS CREEK CLAY							PAGE: 15
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI ISSAQUENA (cont'd.)	21	1	9 N	9 W	108 4510	3070 -2962	3470 -3362	400	Top 70'± of unit appears sl silty
	22	10	9 N	9 W	107 5514	2896 -2789	3298 -3191	402	Top 145'± of unit appears sl silty
SHARKEY	1	31	14 N	5 W	111 3884	2880 -2769	3607 -3496	727	Top 90'± of unit appears sl silty
	2	9	14 N	6 W	109 3765	2759 -2650	3460 -3351	701	Top 65'± of unit appears sl silty
	3	15	14 N	6 W	107 3738	2775 -2668	3513 -3406	738	Top 75'± of unit appears sl silty
	4	17	14 N	6 W	116 3538	2758 -2642	3413 -3297	655	Top 145'± of unit appears sl silty
	5	34	14 N	6 W	106 4008	2836 -2730	3582 -3476	746	Top 150'± of unit appears sl silty
	6	12	14 N	7 W	120 4419	2829 -2709	3500 -3380	671	Top 90'± of unit appears sl silty; bot- tom 30'± of unit appears limy in part
	7	24	14 N	7 W	116 3746	2820 -2704	3499 -3383	679	Top 75'± of unit appears sl silty
	8	10	13 N	5 W	107 4496	3040 -2933	3820 -3713	780	Top 190'± of unit appears sl silty
	9	19	13 N	5 W	104 4392	3045 -2941	3835 -3731	790	Top 90'± of unit appears v sl silty
	10	4	13 N	6 W	111 4024	2930 -2819	3634 -3523	704	Top 135'± of unit appears sl silty; sl limy 35-45' above base of unit
	11	6	13 N	6 W	116 4202	2950 -2834	3597 -3481	647	Top 170'± of unit appears sl silty
	12	9	13 N	6 W	115 4509	3010 -2895	3640 -3525	630	Top 190'± of unit appears sl silty
	13	22	13 N	6 W	107 4515	3006 -2899	3622 -3515	616	Top 60'± of unit appears v sl silty
	14	25	13 N	7 W	111 4020	3030 -2919	3603 -3492	573	Top 60'± of unit appears v sl silty
	15	10	12 N	6 W	104 4098	3089 -2985	3696 -3592	607	Top 100'± of unit appears v sl silty
	16	27	12 N	7 W	100 4014	2894 -2794	3414 -3314	520	Top 50'± of unit appears silty

APPENDIX A

BASIC DATA FOR:

PORTERS CREEK CLAY

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STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI SHARKEY (cont'd.)	17	19	11 N	7 W	105 4024	2858 -2753	3325 -3220	467	Top 90'± of unit appears sl silty
	18	23	11 N	7 W	98 3904	2808 -2710	3277 -3179	469	Top 110'± of unit appears sl silty
	19	1	10 N	7 W	97 3904	2830 -2733	3343 -3246	513	Top 90'± of unit appears v sl silty
	20	4	10 N	7 W	95 4024	3005 -2910	3442 -3347	437	Appears limy 40'± and 70'± above base of unit
	21	7	10 N	7 W	106 3809	3194 -3088	3613 -3507	419	Top 65'± of unit appears sl silty
	22	12	10 N	7 W	97 4060	2945 -2848	3408 -3311	463	Top 40'± of unit appears sl silty
	23	27	10 N	7 W	97 4368	3438 -3341	3887 -3790	449	Top 70'± of unit appears sl silty
	1	29	16 N	6 W	114 4338	3098 -2984	3769 -3655	671	Top 50'± of unit appears sl silty
	2	24	16 N	7 W	119 4020	3194 -3075	not reached	753+	Schl. TD = 3947' in Porters Creek; Top 100'± of unit appears sl silty
WASHINGTON	3	19	16 N	7 W	112 5078	2880 -2768	3575 -3463	695	Top 135'± of unit appears sl silty
	4	23	16 N	8 W	124 4253	2830 -2706	3443 -3319	613	Top 95'± of unit appears sl silty
	5	35	16 N	8 W	120 3744	2718 -2598	3312 -3192	594	Top 90'± of unit appears sl silty
	6	29	15 N	5 W	109 4315	2818 -2709	3571 -3462	753	Top 90'± of unit appears sl silty
	7	28	15 N	6 W	112 3908	2800 -2688	3500 -3388	700	Top 100'± of unit appears sl silty
	8	30	15 N	6 W	120 4481	2775 -2655	3482 -3362	707	Top 135'± of unit appears sl silty
	9	14	15 N	7 W	113 7593	2740 -2627	3448 -3335	708	Top 80'± of unit appears sl silty
	10	2	15 N	8 W	120 3790	2762 -2642	3376 -3256	614	Top 50'± of unit appears sl silty
	11	18	15 N	8 W	112 3605	2619 -2507	3210 -3098	591	Top 80'± of unit appears sl silty

APPENDIX A		BASIC DATA FOR: PORTERS CREEK CLAY								PAGE: 1
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS	
TENNESSEE DYER	1	25	6 S	1 W	260 3232	1680 -1420	2045 -1785	365	Sl silty near top; sl marly near bottom	
FAYETTE	1	13	18 S	4 E	620 2019	600 +20	835 -215	235	Sample log	
	2	16	18 S	4 E	405 1767	430 -25	675 -270	245	Appears silty in middle & upper parts	
	3	10	16 S	2 E	430 2126	875 -445	1086 -656	211		
	4	13	18 S	1 W	433 1703	1125 -692	1450 -1017	325	Sl silty and/or marly in places	
	5	9	15 S	1 E	350 2288	1042 -692	1290 -940	248	V sl silty in a few places	
	6	14	15 S	2 E	369 1600	859 -490	1196 -827	337	Top 100'± of unit appears sl silty	
	7	13	14 S	1 W	318 2582	1233 -915	1547 -1229	314	Sl silty in upper & lower parts of unit	
HAYWOOD	1	3	14 S	3 E	445 2181				Casing set through unit	
HENRY	1	20	4 S	13 E	566 4873	264 -302	386? -180?	122?	Tops by E. N. Wilson (KGS)	
LAKE	1	17	3 S	1 E	293 2263	1600 -1307	1825 -1532	225	All solid shale	
	2	23	3 S	1 E	289 2590	1797 -1508	2002 -1713	205	All solid shale	
LAUDERDALE	1	5	9 S	2 E	329 2815	1465 -1136	1765 -1436	300	Top 120'± silty; marly or silty at intervals	
	2	6	11 S	4 W	437 3183	1947 -1510	2347 -1910	400	Top 50'± appears sl silty	
MADISON	1	11	11 S	8 E	--- 1289	220 ---	435 ---	215	Sandy and/or marly breaks in unit	
SHELEY	1	14	15 S	5 W	250? 2865	1653 -1403	1910 -1660	257	High marl development	
	2	21	18 S	5 W	390 3010	1603 -1213	2038 -1648	435		
	3	19	14 S	7 W	390 3390	2075 -1685	2518 -2128	433	Good shale throughout unit	
WEAKLEY	1	S	1 S	11 E	390 1143	617 -227	817 -427	200	Silty through about 50% of unit	

APPENDIX A

BASIC DATA FOR:

YAZOO CLAY

PAGE: 1

STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI CLAIBORNE	1	51	13 N	3 E	321 9906	728 -407	1230 -909	502	Marly at intervals
	2	38	12 N	4 E	189 6542	737 -548	1210 -1021	473	Marly at intervals
	3	9	12 N	3 E	244 6014	726 -482	1212 -968	486	Marly at intervals especially top 150'
	4	8	11 N	1 E	203 6504	829 -626	1244 -1041	415	Marly at intervals
	5	15	11 N	2 E	246 6515	888 -642	1334 -1088	446	Marly at intervals
	6	66	11 N	2 E	169 9903	879 -710	1290 -1121	411	Marly at intervals
	7	25	11 N	3 E	145 4911	776 -631	1272 -1127	496	Appears to be sl marly at intervals
	8	40	11 N	3 E	190 6086	860 -670	1314 -1124	454	Marly at intervals
	9	4	10 N	3 E	157 10127	962 -805	1370 -1213	408	Appears to be sl marly at intervals
COPIAH	1	27	12 N	5 E	263 10245	868 -605	1280 -1017	412	Pachuta marl is weakly developed 20' above base of unit. Marly at intervals
	2	24	1 N	1 W	413 10009	1040 -627	1398 -985	358?	Top of unit, picked just below casing seat, is questionable
	3	15	1 N	3 W	367 10305	1006 -639	1459 -1092	453	Unit sl marly at intervals
	4	2	10 N	5 E	307 7004	946 -639	1377 -1070	431	Unit sl marly at intervals
	5	6	10 N	6 E	338 10327	1042 -704	1420 -1082	378	Unit sl marly throughout; 95' water sand at top of unit
	6	9	9 N	5 E	315 10404	1203 -888	1625 -1310	422	Unit sl marly throughout
	7	6	9 N	6 E	487 6005	1285 -798	1652 -1165	367	Unit sl marly throughout
	8	6	9 N	7 E	383 15209	1330 -947	1693 -1310	363	Unit sl marly throughout
	9	26	9 N	7 E	339 10505	1372 -1033	1753 -1414	381	Unit sl marly at intervals

APPENDIX A		BASIC DATA FOR: YAZOO CLAY								PAGE: 2
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS	
MISSISSIPPI COPIAH (cont'd.)	10	35	9 N	8 E	475 3409	1557 -1082	1915 -1440	358	Unit sl marly throughout but especially at base where Pachuta develops	
HINDS	1	33	8 N	3 W	245 18488	195 +50	686 -441	491	Marly throughout	
	2	29	6 N	3 W	271 9002	281 -10	766 -495	485	Marly throughout	
	3	12	6 N	4 W	240 9000	214 +26	708 -468	494	Appears to be sl marly at intervals	
	4	9	5 N	4 W	203 9503	315 -112	774 -571	459	Appears to be sl marly at intervals	
	5	3	5 N	3 W	310 13005	343 -33	820 -510	477	Appears to be sl marly at intervals	
	6	7	5 N	1 W	365 6150	245 +120	643 -278	398	Appears to be sl marly in upper and lower parts	
	7	29	4 N	3 W	299 9056	480 -181	948 -649	468	Appears to be sl marly at intervals	
	8	3	14 N	5 E	129 12502	291 -162	765 -636	474	Marly at intervals	
	9	15	3 N	4 W	260 10000	570 -310	970 -710	400	Appears to be sl marly throughout	
	10	17	4 N	1 W	340 1072	340 0	774 -434	434	Appears to be sl marly throughout	
RANKIN	1	16	5 N	3 E	468 1666	213 +255	614 -146	401	Appears v marly in upper & lower thirds	
	2	15	4 N	5 E	434 8004	170 +264	525 -91	355	Very marly in upper & lower thirds; Pachuta marl is well-developed	
	3	19	3 N	5 E	477 8903	447 +30	780 -303	333	Very marly in upper & lower thirds; Pachuta marl is well-developed	
SIMPSON	1	13	2 N	1 E	404 9560	643 -239	1043 -639	400	Bottom 60'± appears v limy	
	2	24	2 N	1 E	486 9663	770 -284	1173 -687	403	Bottom 60'± appears v limy	
	3	8	2 N	4 E	420 2391	464 -44	740 -320	276	D'Lo Dome; base picked on Pachuta marl	
	4	14	2 N	5 E	505 13334	620 -115	890 -385	270	Base picked on Pachuta marl; Bottom 110'± appears v limy	

APPENDIX A		BASIC DATA FOR: YAZOO CLAY							PAGE: 3
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI SIMPSON (cont'd.)	5	15	2 N	6 E	465 8805	470 -5	766 -301	296	Base picked on Pachuta marl; bottom of unit is v limy
	6	17	1 N	4 E	288 9579	664 -376	962 -674	298	Base picked on Pachuta marl; few limy breaks throughout
WARREN	1	36	18 N	4 E	312 6631	458 -146	935 -623	477	Appears marly throughout
	2	11	18 N	5 E	360 10267	387 -27	893 -533	506	Appears marly throughout
	3	26	18 N	5 E	362 9003	452 -90	973 -611	521	Appears marly throughout
	4	22	7 N	4 W	151 8593	186 -35	651 -500	465+?	Appears marly throughout; surface casing may be set in the Yazoo
	5	28	17 N	5 E	320 12569	372 -52	899 -579	527	Appears marly throughout
	6	3	16 N	4 E	328 8262	417 -89	903 -575	486	Appears sl marly throughout
	7	6	16 N	5 E	182 10952	276 -94	792 -610	516	Appears marly throughout
	8	1	16 N	5 E	248 8880	290 -42	810 -562	520	Appears marly throughout
	9	1	14 N	3 E	205 11726	512 -307	950 -745	438	Appears sl marly at intervals
	10	40	14 N	3 E	286 9515	618 -332	1080 -794	462	Appears sl marly at intervals
	11	17	14 N	1 E	86 7010	353 -267	932 -846	579	Appears sl marly throughout; upper part may be, in part, Forest Hill
	12	23	14 N	1 E	92 4435	460 -368	980 -888	520	Appears sl marly at intervals

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APPENDIX A		BASIC DATA FOR: LOWER OTTAWA (MIDDLE ORLOVICIAN)							PAGE: 1
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI ALCORN	1	14	2 S	7 E	424 2670		1600 -1176		1927-28 data poor. No geophysical logs
CHICKASAW	1	33	14 S	2 E	412 11020		10464 -10052		Induction-electrical log; sample logs
	2	8	13 S	5 E	339 7496		4380 -4041		Electrical log & sample log to TD
	3	24	14 S	4 E	304 7029		6490 -6186		Electrical log & sample log to TD
ITAWAMBA	1	7	10 S	10 E	362 3538		3095 -2733		Sch. E. L. to 1794; Knox in samples @ 3095
	2	8	10 S	9 E	382 3373		2805 -2423		Sch. E. L. 1485-3370
LEE	1	28	11 S	5 E	315 4271		3855 -3540		Sch. E. L. & sample log to TD
	2	16	9 S	7 E	411 3200		2615 -2204		1927-28 data poor. No geophysical logs
MONROE	1	2	12 S	9 E	342 3795		3060 -2718		1929-32 well - fair samples - no E. L.
	2	28	12 S	6 E	312 4489		4120 -3808		Sch. E. L. & sample log to TD
	3	30	13 S	6 E	317 4995		4561 -4244		Sch. E. L. & sample log to TD
	4	18	13 S	7 E	301 4731		4540 -4239		Sch. E. L. & sample log to TD
	5	16	14 S	17 W	279 5055		4397 -4118		Sch. E. L. & sample log to TD
	6	1	14 S	19 W	235 5138		4838 -4603		Sch. E. L. & sample log to TD
	7	25	14 S	6 E	243 6121		5398 -5155		Sch. E. L. & sample log to TD
	8	22	15 S	6 E	292 10911		7195 -6903		Sch. E. L. 115-10911
	9	18	15 S	18 W	232 7210		6818 -6586		Sch. E. L. & sample log to TD

APPENDIX A

BASIC DATA FOR:

LOWER OTTAWA (MIDDLE ORDOVICIAN)

PAGE: 2

STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI PONTOTOC	1	36	8 S	2 E	403 2710		2520 -2117		Sch. E. L. & sample logs to TD
	2	3	9 S	2 E	412 5738		2860 -2448		Sch. E. L. & sample logs to TD
	3	15	9 S	3 E	484 2960		2770 -2286		Sch. E. L. & sample logs to TD
	4	29	9 S	3 E	470 4505		3176 -2706		Sch. E. L. & sample logs to TD
	5	13	10 S	3 E	427 4508		3640 -3213		Sch. E. L. & sample logs to TD
	6	1	11 S	4 E	367 4021		3610 -3243		Sch. E. L. & sample logs to TD
	7	26	11 S	3 E	510 7421		3930 -3420		Sch. E. L. & sample logs to TD
	8	21	11 S	1 E	352 5904		5598 -5246		Sch. E. L. & sample logs to TD
PRENTISS	1	31	4 S	9 E	500 3008		1864 -1364		Sch. DIL - FDC - CNL - GR to TD
	2	7	5 S	6 E	547 2614		1840 -1293		Sch. E. L. 1162-2613
	3	9	6 S	9 E	505 2311		1738 -1233		Sch. E. L. & sample logs 570' to TD
	4	8	7 S	9 E	440 2128 ¹ / ₂				No E. L. - samples poor; in Knox at TD
TIPPAH	1	12	2 S	3 E	457 5302		1255 -798		Sch. E. L. & sample logs to TD; Ottawa truncated to basal 85'
	2	34	2 S	3 E	514 4216		above -720		Sch. E. L. & sample logs to TD; all Ottawa & some of Knox truncated
	3	14	4 S	2 E	400 2340		1600 -1200		Sch. E. L. & G. R. logs; samples poor; over 300' Ottawa appears to be present
TISHOMINGO	1	23	3 S	10 E	613 2117		1775 -1162		Sample log; few hundred feet dense Ottawa
	2	9	4 S	11 E	495 1902		1616 -1121		Sample log; few hundred feet dense Ottawa
	3	21	4 S	11 E	540 1845		1763 -1223		Sample log; few hundred feet dense Ottawa

APPENDIX A

BASIC DATA FOR:

LOWER OTTAWA (MIDDLE ORDOVICIAN)

PAGE: 3

STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
MISSISSIPPI TISHOMINGO (cont'd)	4	18	5 S	11 E	499 2472		1555 -1056		Sample log; few hundred feet dense Ottawa
	5	1	7 S	9 E	389 3510		2020 -1631		Sch. E. L.
	6	18	7 S	10 E	387 2222		2076 -1689		Birdwell E. L. & G. R. & sample logs surface to 2222' TD
UNION	1	15	6 S	5 E	472 2510		1957 -1485		Sch. E. L. & sample log to TD; very thick dense Ottawa limestone
	2	36	7 S	3 E	417 2759		2268 -1851		Sch. E. L. & sample log to TD; Middle Ottawa indicates reefing tendency
	3	20	7 S	5 E	367 5010		1888 -1521		Sch. E. L. & sample log to TD; Ottawa section 400'+, mostly v dense
	4	3	8 S	1 E	400 3479		2694 -2294		Sch. E. L. & sample log to TD; Ottawa section 400'+, mostly v dense
ALABAMA BLOUNT	1	8	13 S	2 W	513 4352		1524 -1011		Sch. E. L.; McGlamery sample descriptions
COLBERT	1	10	4 S	15 W	515 1679		1639 -1124	1050-1675 625 (MO)	Sulphur water in Knox 1675-1679
	2	31	5 S	13 W	665 2163		1949 -1284		Data incomplete
CULLMAN	1	36	8 S	4 W	665 2085		2035 -1370		Data incomplete; mineral water @ 2035-85 in Knox
	2	26	9 S	2 W	916 7995		2410 -1494		Data incomplete; numerous geophysical logs
	3	19	10 S	4 W	866 3988		2583 -1717		Gamma Ray-Neutron log; data incomplete
	4	25	10 S	5 W	866 3688		2705 -1839		Gamma Ray-Neutron log; data incomplete
FAYETTE	1	11	14 S	12 W	498 4167		4125 -3627		DIL log - no sample information
FRANKLIN	1	26	8 S	12 W	968 2999		2780 -1812		Picked from McGl. sample descriptions
	2	35	8 S	15 W	692 4000		2584 -1892		DIFL-CN-CDN - sample information
	3	22	7 S	11 W	700 2560		2290 -1590		Driller's log

APPENDIX A		BASIC DATA FOR: LOWER OTTAWA (MIDDLE ORDOVICIAN)							PAGE: 4
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS
ALABAMA					727		2765		
FRANKLIN (cont'd)	4	26	8 S	14 W	-----		-2038		Geol. Surv. Ala.
	5	13	6 S	14 W	598 2147		1988 -1390		Sch. E. L. corr./w sample log L & H #1 Thorn
JACKSON	1	35	1 S	7 E	670 2485		1880 -1210		DIL - sample information
	2	27	2 S	7 E	620 3935		1885 -1265		DIL - correlation
LAMAR	1	6	14 S	15 W	378 4425		3969 -3591		McGl. sample descriptions
	2	18	14 S	14 W	540 5185		4370 -3830		Sch. E. L.
LAUDERDALE	1	21	1 S	10 W	525 1055		1035 -510		
	2	8	2 S	12 W	585 2010		1350 -765		
	3	4	1 S	10 W	554 2035		1043 -489		
	4	9	1 S	10 W	579 1537		1110 -531		E. log
LAWRENCE	1	17	5 S	8 W	620 4500		1693 -1073		LBF sample descriptions
	2	29	6 S	8 W	616 -----		1911 -1295		Geol. Surv. Ala.
LIMESTONE	1	10	2 S	3 W	867 -----		1050 -183		Geol. Surv. Ala.
MADISON	1	2	6 S	2 E	640		1670 -1030		
	2	8	1 S	1 E	730		1153 -423		
	3	24	5 S	2 E	596		1635 -1039		
	4	17	3 S	2 E	670		1245 -575		
MARION	1	27	11 S	14 W	403 4710		2985 -2582		Sample log

APPENDIX A		BASIC DATA FOR: LOWER OTTAWA (MIDDLE ORDOVICIAN)								PAGE: 5
STATE & COUNTY	NO.	Sec.	Twp.	Rge.	ELEV. & T.D.	TOP OF UNIT	BASE OF UNIT	THICKNESS IMPERMEABLE	REMARKS	
ALABAMA					465		2820			
MARION (cont'd)	2	7	11 S	13 W	3510		-2355		Sample log	
	3	15	12 S	12 W	590 4000		3490 -2900		Sch. E. L. & sample log	
	4	12	9 S	15 W	500 4446		2598 -2098		Geol. Surv. Ala.	
MORGAN	1	1	8 S	4 W	600 1827		1680 -1080		McGl. sample descriptions	
	2	7	8 S	4 W	614 1780		1780 -1166		McGl. sample descriptions	
WALKER	1	12	13 S	10 W	600 4182		3640 -3040		McGl. sample descriptions	
	2	14	14 S	9 W	498 4350		4040 -3542		Geol. Surv. Ala.	
	3	6	13 S	6 W	578 3455		3020 -2442		McGl. sample descriptions	
WINSTON	1	30	9 S	10 W	950 3128		2945 -1995		McGl. sample descriptions	
	2	6	10 S	10 W	885 3610		3100 -2215		Driller's log	
	3	20	10 S	10 W	888 3604		3216 -2328		Radioactive log; McGl. sample descriptions	

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