The Mississippi Geological Survey
A Centennial

EUGENE A. SMITH
EPHRAIM N. LOWE
WILLIAM C. MORSE
FREDERIC F. MELLEN
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FREDERIC F. MELLEN and WILLIAM S. PARKS
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BULLETIN 100

MISSISSIPPI GEOLOGICAL, ECONOMIC AND
TOPOGRAPHICAL SURVEY

FREDERIC FRANCIS MELLEN
DIRECTOR AND STATE GEOLOGIST

JACKSON, MISSISSIPPI
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LETTER OF TRANSMITTAL

Office of the Mississippi Geological, Economic and Topographical Survey

Jackson, Mississippi

September 4, 1963

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

Gentlemen:

The Survey has in its archives many manuscripts and items of worth which have not found their way into the growing sphere of published knowledge.

Among these items are two reports of value, not only because of their intrinsic worth, but also because of the outstanding men who wrote them while employed by the Geological Survey of the State of Mississippi.

Perhaps no State has had as distinguished and talented an array of geologists as has Mississippi; and few states, if any, can measure up to the economic production of the Mississippi Geological Survey when years of existence, manpower and appropriations are taken into account. The results of geological research in Mississippi have been remarkable.

These geological researches have resulted in the publication in the Bulletin series of 99 reports. The next ensuing publication would be Bulletin 100. It is appropriate, perhaps, that the hundredth Bulletin be a centennial volume, honoring our distinguished predecessors, reviewing the accomplishments of the Survey since its original organization by the Mississippi Legislature in 1850 and outlining, briefly, the projected work of the Survey in the years ahead.

The reports of Dr. E. A. Smith and Dr. E. N. Lowe, now published posthumously, give insights into the early work of the Survey. Dr. W. C. Morse's memorial to E. N. Lowe, and Prof. F. E. Vestal's memorial to W. C. Morse summarize the two longest periods of the Survey's history, each 24 years; for, in fact, the Survey was life itself for these two gentlemen and they, in their time, were looked upon and thought upon as being the embodiment of the Survey during their respective and respected tenures.

In keeping with our policies of concentrating on Economic Geology, contrasted to Academic Geology, we have been reviewing the work of the Survey, as reflected in the 99 Bulletins, and as reflected in the statistics on mineral production contained in the U. S. Bureau of Mines

Minerals Yearbook, in the compilation of which we collaborate. This analytical examination lends itself, in many instances, to graphical presentation. This we have attempted to do, and have been rewarded and pleased by what we see in the maps and graphs that have been produced.

One of the far reaching and beneficial effects of the minerals producing industries is in the employment of people, principally male, the type of industry most needed in the State of Mississippi. The Survey requested the Mississippi Employment Security Commission to prepare a chapter on this and through the enthusiastic cooperation of Director John E. Aldridge and other members of his Staff, Mr. William T. Hankins prepared the excellent summary article on *Employment In The Mining Industry In Mississippi.*

In order better to collate the 11,781 pages of geological and related data contained in the 99 bulletins (averaging 121 pages) Mr. Parks has set about the preparation of a comprehensive index of these materials. This work is not only of inestimable value to him, as a staff geologist becoming better acquainted with the past works of the Survey, but should be of great use to all researchers who want to find—in the shortest space of time—where, within these Bulletins, specific information may be found. In short, the availability of the index will help other geological researchers in their quest for economic data.

Finally, the law under which the Survey now functions, Senate Bill 2012, Laws of 1958, is included for the purpose of acquainting the Public with the duties, responsibilities and authorities of our Agency.

It is recommended that this compilation of works be printed as Bulletin 100, *The Mississippi Geological Survey, A Centennial.*

Respectfully yours,

Frederic F. Mellen
Director and State Geologist

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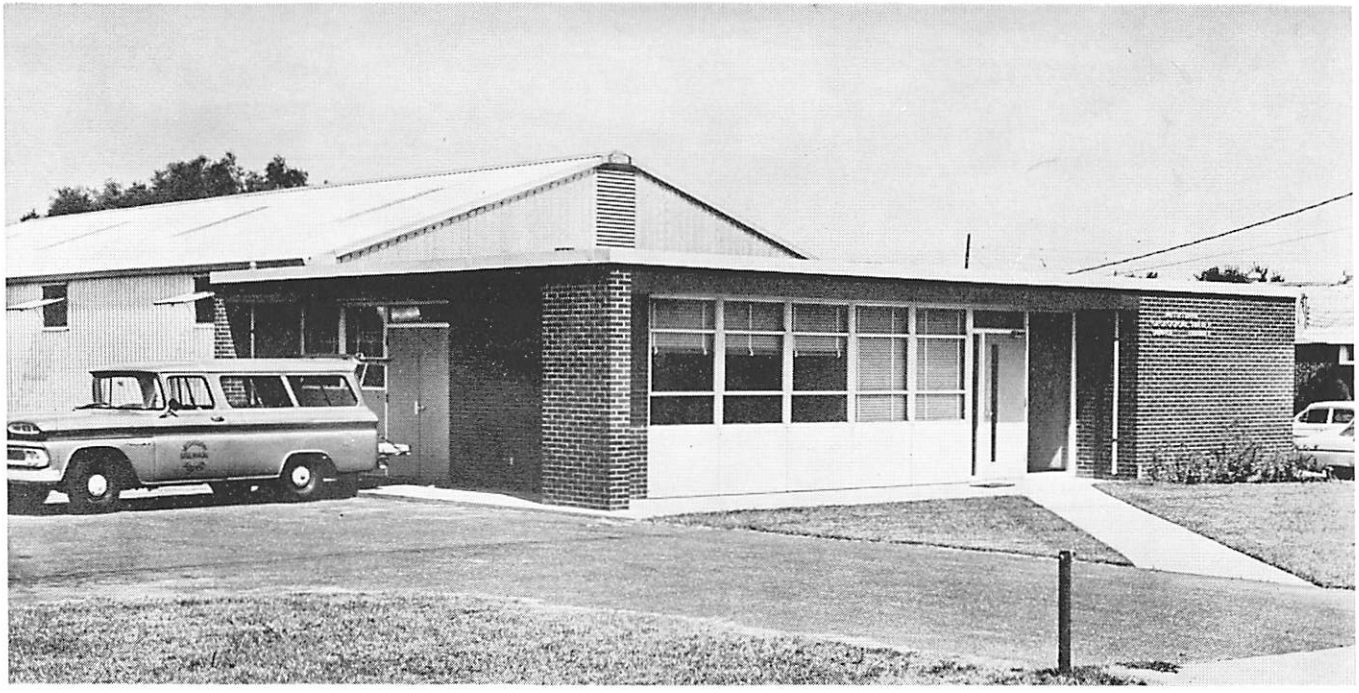

Frontispiece—Mississippi Geological Survey's Sample Library, 2525 North West Street, Jackson, Mississippi, the present headquarters of the Mississippi Geological Survey. Photo by Perry Nations, August, 1962.

REPORT OF A GEOLOGICAL RECONNAISSANCE OF PARTS OF THE COUNTIES OF YAZOO, ISSAQUENA, WASHINGTON, HOLMES, BOLIVAR, TALLAHATCHIE, AND COAHOMA, MISSISSIPPI, DURING THE MONTHS OF OCTOBER AND NOVEMBER, 1870

EUGENE A. SMITH

Assistant State Geologist

ABSTRACT

A geological reconnaissance of the lower Bluff Region and the Alluvial Plain of the Mississippi River and its tributaries was made during the fall months October and November of 1870. The bedrock strata, underlying the loess and stratified drift, are in angular unconformity to the overlying sediments. Throughout Yazoo County strata of Jackson age are exposed and can be identified by the same species of fossils and characteristics as are found on Moodys Branch and in the environs of Jackson. No characteristic Claiborne nor Buhrstone (Tallahatta) exposures were found through Holmes County, even into Carroll County. The physical aspects of the Alluvial Plain are described in detail, including depositional and physiographic features, soil types and their utilization, natural vegetation, water supplies, and culture. A number of chemical analyses of soils and measured sections of sediments are contained in the report. F. F. M.

The object of an excursion in the fall of 1870 was the examination of the geological relations of as much of the Yazoo Bottom as could be visited before the setting in of the winter rains.

A short trip through parts of the Lignitic, Cretaceous, Claiborne and Jackson groups, was undertaken first in order that I might see for myself the position of the strata of those parts and obtain some little experience in observation.

The Yazoo Bluff: Yazoo City was the point at which I entered the Valley. The Loess Bluff from Vicksburg as far north as Township 19 presents in its upper portions very much the same characters. The underlying strata, however, vary. At Yazoo City, the stratified drift below the loess is underlaid by massive blue clays, chiefly, of the Jackson age. In these clays were found many vertebrae of *Zeuglodon*, other Jackson fossils, and crystals of gypsum, some very large and well-defined.

The hills below Yazoo City as far as Satartia had already been examined and I did not spend much time on them. Above Yazoo City the strata of the Jackson group may be observed in the Bluff as far north as Section 5, Township 13, Range 1 East,

Holmes County. At that point, Mr. Wallace's, there is a bluff called Shell Bluff, from the number of shells. I did not myself examine the locality, but from the description given me by Mr. Wallace I am satisfied that the strata exposed there are of the Jackson group.

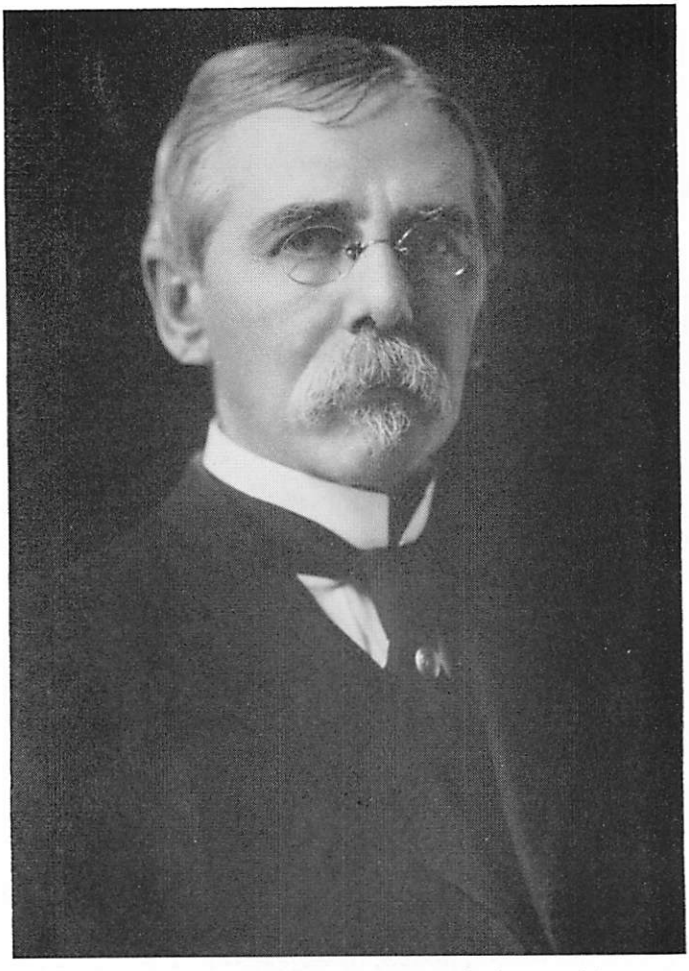

Figure 1.—Dr. Eugene A. Smith, Assistant State Geologist of Mississippi, later State Geologist of Alabama for 54 years.

At Mr. Purvis', about Section 25, Township 12, Range 1 West, Yazoo County, there is, in the bed of Mill Creek, a tributary of Piney Creek, an exposure of about 4 feet thickness of a greensand marl. This consists chiefly of comminuted shells and grains of

greensand and, from its appearance, is a fine marl. An analysis of it has not yet been made. At Purvis' store, Section 22, Township 13, Range 1 West, Yazoo County, are numerous deep ravines made by the tributaries of Tcheva Creek. The heads of these ravines show frequently very fine profiles of Jackson strata. One of these sections is given below:

Section, Ravine on Free Run Branch, Section 22, Township 13, Range 1 West, Yazoo County

Feet		No.
5	Loam and silt, forming surface.	7
2	Yellowish sand, with some perfect shells and many fragments.	6
2	Blue sand, with numerous well-preserved shells. *Rostellaria vellata, Cardium* & some univalves, not more particularly determined.	5
2	Sand of darker blue, in the upper portions of which the *Rostellaria* and the other univalves are found in the greatest profusion.	4
6-8	Alternating strata of blue sand and ledges of indurated blue sand. These strata become lighter in color and less fossiliferous in their lower portions.	3
8-10	Bluish micaceous sand, passing into brown, with streaks of yellowish ferruginous sand. The characteristic fossils, *Rostellaria,* etc., are well-preserved.	2
	Talus to bottom of the profile.	1

The bed of the branch below this bluff is full of fragments of indurated yellowish sand, full of shells, similar to the ledge in No. 6. In this section no trace could be observed of lignitiferous strata like those in the lower parts of the bluff at Moody's Branch. I have no doubt, however, that such strata do underlie the materials given above for, on the Eastern side of the high ridge upon which the store is situated, and at a level considerably lower than the bottom of the section above given, several outcrops of lignite were observed, forming the bed of Free Run Branch.

Several sections similar to the above may be seen in the neighborhood of the store on the western side of the ridge, while east of the ridge I found no outcrop of Jackson strata but only lignite, as mentioned above, very low down in the ravine. This fact is very easily explained by the circumstance that on the western side of the ridge the exposed faces are near the top of

the ridge, while on the east the only exposures noticed were near the level of the branch.

In all the little streams flowing down these ravines, the deposition of calcareous tufa was very abundant. Large masses of this matter, stalactites, etc., occur wherever the progress of the water has been checked, so that it trickles over an exposed surface and is subjected thus to rapid evaporation. The formation of this matter is constantly going on, and farmers in the neighborhood say that a rock of this sort which is soft enough to be cut with the knife, will, in the course of a month or two, become very hard.

It is no uncommon thing to find masses of this tufa made up of alternating layers, ½-inch or more in thickness, of a crystalline nature, and yellow spongy masses, resembling very much the rootlets of mosses.

Very fine impressions of the ordinary forest leaves are of frequent occurrence in these rocks.

In Section 1, Township 13, Range 1 West, Holmes County, there is a bluff with an exposure of lignitic strata as follows:

Section of Lignitic Strata on Still Spring Branch, Section 1, Township 13, Range 1 West, Holmes County

Feet		No.
1	Yellow loam, forming surface.	5
10	Whitish calcareous silt with brown spots, and calcareous concretions in the lower part, passing into a brown sandy loam (loess).	4
1	Stratified pebbles and sand with numerous black lumps apparently of lignitic character. Stratified drift.	3
7	Stratified pebbles and sand. Stratified drift.	2
	Yellowish laminated clay, containing leaf impressions; the cleavage surfaces coated with hydrated ferric oxide. The clay becomes more sandy lower down and passes into a grayish sand, with impressions of leaves, the surfaces of the leaves being coated with hydrated ferric oxide. This clay forms the bed of the branch.	1

About Section 35, Township 14, Range 1 West, Holmes County, there is a deep gully washed in the head of a ravine where there is a fine exposure of loess and stratified drift. The bluff forming the head of the gully is semicircular and has a diameter of about 200 yards. The space fronting the bluff is made into an amphitheater by a small, very steep ridge formed of stratified drift detritus, jutting out from each side and leaving a narrow pass between them. The perpendicular bluff in some places is 40-50 feet high, then comes a talus quite as high. The perpendicular face consists of 25-30 feet of loess with the surface stratum of yellow loam and 15-20 feet of stratified drift, red sand and pebbles.

The calcareous silt is washed nearly smooth, while the drift below it is furrowed into the semblance of rounded pillars, supporting it.

On the talus, there are some trees more than a foot in diameter, and the middle of the amphitheater is full of still larger trees. Below is a sketch of the bluff.

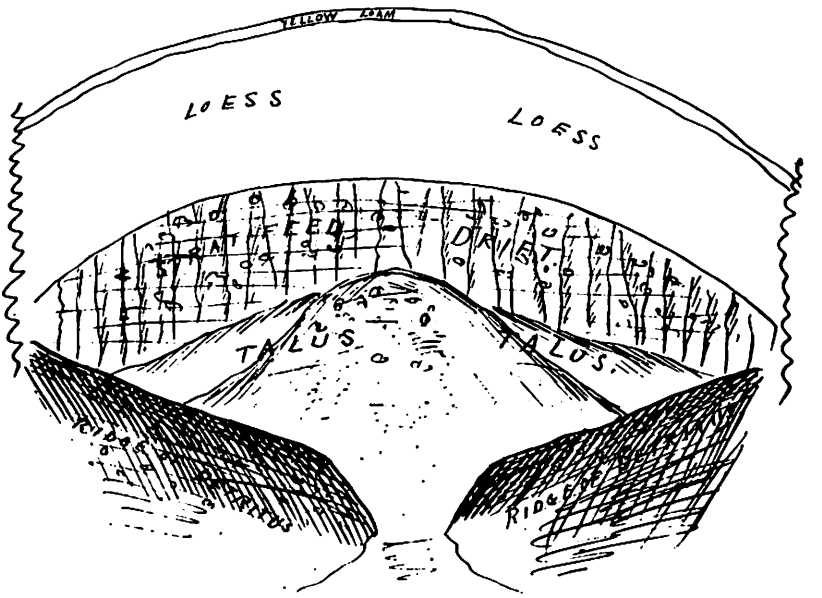

Figure 2.—Yellow Bluff, Section 35, Township 11, Range 1 West, Holmes County.

From Mr. Wallace's, Section 5, Township 13, Range 1 East, Holmes County, northward as far as the northern part of Town-

ship 18, Ranges 1 and 2 East, Carroll County, I have not seen any outcrop of strata other than Loess, Drift and Lignite. A diligent search did not enable me to find any trace of Claiborne or Buhrstone strata.

A very good section of lignitic strata occurs on Rankin's Branch, Section 36, Township 15, Range 1 East, Holmes County, which is repeated with slight modifications in several localities in the neighborhood.

Lignitic Strata, Rankin's Branch, Holmes County

Feet		No.
25	Loam and silt of loess formation.	5
4	Stratified drift, pebbles and sand.	4
3	Gray lignitic clay with black streaks.	3
2	Lignite.	2
1	Light-gray, soft clay as far as seen in the branch.	1

The same strata appear in bluffs on the branch for a distance of a mile or more.

The stratum of lignite is deposited upon an undulating surface and is sometimes a foot above and again entirely below the level of the water in the branch.

About one mile east of this locality, is a hillside covered with huge blocks of a conglomerate of rounded pebbles, cemented together with ferruginous matter. Hard siliceous sandstone, often like flint and resembling completely that near Kosciusko, is likewise of frequent occurrence in the neighborhood. In Sections 11 and 12, Township 15, Range 1 East, Holmes County, where a ravine ends in the Fannegusha Creek bottom, immense masses of these sandstones are piled together in the greatest confusion, almost filling up the ravine in its lower portion. This stone can hardly be utilized as it is extremely hard, and the hammer makes very little impression upon it. Occasionally a block, tolerably soft, may be seen.

North of this I noticed several outcrops of lignitic clay but no lignite.

As far north as the upper part of Township 18 the Yazoo Bluff retains very much the same character as regards the loess and stratified drift. The former is represented everywhere by a

brown or buff-colored calcareous silt sometimes 25 feet thick; the latter, by pebbles, sand and clay.

The Yazoo Bottom:

The soil of the Yazoo Bottom at the foot of the Bluff is a rich, dark, sandy loam which has in a great degree been formed by the washings from the loess hills.

Below Satartia are several plantations called "prairies," as the Roach Place, Ball Ground, etc., but no difference between the physical aspect of these soils and of those of other tracts, could be observed. Chemical analyses of none of them has, as yet, been made.

I have ascertained the localities of several other "prairies" in the Botton: viz., Gov. Humphrey's, Township 19, Range 1 West, Sunflower County; Shell Bluff, Township 18, Range 1 West, Sunflower County; Roe's Bank, Township 17, Range 1 West, Sunflower County; Maj. Walton's, Township 22, Range 1 West, Tallahatchie County; Bell Prairie, Township 13, Range 2 West, Yazoo County; Ricks Place, Township 14, Range 2 West, Yazoo County; Martin's, Township 18, Range 2 West, Sunflower County.

Several of these, Shell Bluff, Roe's Bank and Martin's, I visited. The two former are on the bank of the Yazoo, the latter on Bear Creek and northwest of the Yazoo. In the immediate neighborhood of each were numerous shell mounds with fragments of Indian pottery.

From Maj. Morgan at Shell Bluff, where there are several very large shell mounds, on one of which his house is built, I learned that when the place was first occupied by the whites, no large trees were growing upon it, but many small sassafras trees. With regard to this place, he says that it has none of the characteristics of a prairie proper, but was so called simply from the absence of large trees.

From what I could see and learn from inquiry with regard to Roe's Bank, Ball Ground and Roach's, the same conclusion would be justified. They were old Indian clearings. The Ball Ground was used by the Indians for their ball play. The presence of the shell heaps on the banks of the river, where these prairie spots occur, is likewise very suggestive.

Of the true prairie soils, the result of the disintegration of the calcareous Port Hudson strata, such as were observed by Dr. Hilgard in the Tensas Bottom, I have not seen any well authenticated instance.

There is, in the Mississippi or Yazoo Bottom, west of the Yazoo River, a great uniformity in the soil and vegetation, and a description of a few localities would give a tolerably fair idea of the whole country, so far as my observation goes. South of Rolling Fork, the soil forming the banks of Deer Creek and Steele's Bayou is a dark-gray loam, very productive. The loamy soil forms a strip some 200 yards wide, on both sides of these streams. Honey locust is everywhere to be seen; pecan, water and willow oaks, and sweetgum, common. Back of the loamy land, which is not overflowed except when there is unusually high water, and lower, is a stiff dark clay traversed by cracks and mottled with spots of ferruginous matter. This clay upon drying breaks up into little angular fragments, giving rise to the so-called "buckshot soil." It is exceedingly fertile, and there is no change in its character for 10 feet or more so that the farmers say it will never wear out.

The growth is sweetgum, pecan, water and willow oaks and hackberry in about equal quantities. An undergrowth of very dense cane covers most of this land. Farther down towards the swamp the soil is still the dark-gray buckshot clay, but the undergrowth of cane ceases, and cypress sets in, and soon becomes the prevailing tree in the open swamp. This swamp is never cultivated for it is under water most of the time and filled with innumerable bogs. A strip of buckshot land several hundred yards wide back of the loam is under cultivation; it is subject to yearly overflow in its lower parts at least. Farmers say that the cotton on this land is much more liable to injury from frost than that on the higher land near the banks of the creek.

Below is given an analysis of the "buckshot" clay from the "back land" of lower Deer Creek. The soil is from one of the plantations of J. D. Hill, Esq.

No. 390. Deer Creek virgin "buckshot" soil, Issaquena County. *Depth:* 12 inches. *Vegetation:* Sweetgum, hackberry, honey locust, pecan, willow and water oaks. Undergrowth of cane.

Insoluble matter	51.013
Silica, soluble in $NaO.CO_2$	20.704
Potash	1.104
Soda	.325
Lime	1.329
Magnesia	1.115
Brown oxide manganese	.119
Peroxide of iron	5.818
Alumina	10.539
Phosphoric acid	.304
Sulphuric acid	.024
Volatile matter	7.369
	100.383

This analysis needs no comment.

In the southern portion of the Bottom, I have not seen any very satisfactory exposures of strata. At Omega, one of the Hill Plantations, so named from the owner, J. D. Hill, on Deer Creek, there is an old well about 15 feet deep which I examined. Below the loam and "buckshot" clay which reached to a depth of about 10 feet, came a soft greasy-smooth-feeling blue mud or clay. In this I found a fragment of wood.

On the bank of Black Bayou near where it empties into Deer Creek, at Reality, another Hill Plantation, is a low bluff composed of the following strata:

Section on Black Bayou, Issaquena County

Feet		No.
18 in.	Yellowish sandy loam, very little clay, forming surface.	5
3 ft. 6 in.	Darker more clayey strata, with yellowish or reddish spots, alternating with sandier strata.	4
1 ft. 6 in.	Light-gray sand with very little clay, but with spots of ferruginous matter.	3
2	Dark-gray, stiff clay traversed with cracks and mottled with ferruginous dots, crumbling on exposed surface into fragments, "buckshot."	2
	Below this to the water's edge the bank was covered with detritus, but digging into it showed a smooth blue clay, like that found at the bottom of the well at Omega.	1

On Steele's Bayou, 4 miles west of this place, is a bank which shows substantially the same succession of strata. The road from Deer Creek to Steele's Bayou in this neighborhood is

along the banks of Black Bayou which connects the two. Some 6 miles northward another road crosses the swamp between the two places. This road is partly along the bank of Houston Bayou, and partly through the open swamp. The latter part of the road has been mended or floored with rails and passage over it is anything but smooth. The western bank of Deer Creek, from the upper part of Township 10, Range 7 West to the lower part of Township 9, Range 6 West, is occupied by the Hill Plantation. The eastern bank in this locality is not yet cleared. These places are from 1½ to 2 miles wide. On the highest parts of the bank the soil is a sandy loam. Below this, and coming to the surface farther towards the swamp, is the dark-gray clay which forms the "buckshot." Sometimes the sandy ridge is not on the immediate bank of the creek, but some distance back from it, and in some cases there is a soil of "buckshot" clay between the creek and the loam mass.

The water in all the country described above is very much the same, being very hard and containing chiefly the carbonates of iron, lime and magnesia. Mr. Blessing, who has driven many wells on Deer Creek, or Silver Creek, says that he finds water usually in a bed of sand and pebbles, which underlies the blue mud mentioned above. This bed of pebbles is sometimes very hard and resists the driving almost like a rock. He says that water always rises in the tubes to within 30 feet of the surface, and he knows of a few instances in which it has risen into or stood permanently in the barrel of the pump, 2 feet above the surface of the ground.

In 1867 the whole country described above was under water, and the marks on the trees are very plain yet. On the banks of Steele's Bayou, this water mark is some 8 feet above the ground, diminishing in height as we approach the Mississippi.

Between Lake Providence and Skipworth's Landing, the soil on the east bank of the Mississippi River is generally a dark, sandy loam, very fertile. The strip of land cultivated is a mile or two wide. The immediate banks of the river are very sandy and covered with a growth almost exclusively of cottonwood.

The water in this region is strongly impregnated like that mentioned before. In one shallow well, however, the water was remarkably free from that strong mineral taste though it was hard. This well was only a few hundred yards from the river.

On General Wade Hampton's Walnut Grove Plantation, Section 4, Township 13, Range 9 West, Issaquena County, there is only one well out of 14 or 15 that is comparatively free from mineral taste. In a well dug on this place some years ago, a fragment of wood was struck at the depth of about 30 feet.

Near the foot of Lake Washington, a tube was driven down some time since, and at the depth of 45 feet a hard substance was encountered which resisted the driving. The tube was drawn out and another attempt was made to reach water a short distance away, but with the same result. A stream of inflammable gas issued from the tube, which, at the time of my visit, had been burning some 3 months. An analysis of this gas, given below, shows it to be nearly pure marsh gas; the small percentage of carbonic acid being in favor of the supposition that it does not proceed from strata in which vegetable matter is in its first stages of decomposition.

Analysis of gas from Burning Well on General Wade Hampton's Walnut Grove Plantation, Section 4, Township 13, Range 9 West, Issaquena County:

CH_4 =	74.30%
N =	19.00%
H =	3.20%
CO_2 =	3.50%
	100.00%

The pebble bed in this part of the bottom is reached at the average depth of 30 feet, but at the mouth of a small bayou which empties into Lake Washington opposite General Wade Hampton's Wildwood Plantation, Section 7, Township 14, Range 9 West, Washington County, the pebbles strew the beach of the lake. These pebbles are worn and rounded and are evidently of the drift.

Between Lake Washington and Big Deer Creek, as that portion of the creek above Rolling Fork is called, the land is very low and not under cultivation except here and there a small patch on the bank of Mound Bayou. The same alternation of loam, buckshot clay and cypress swamp occurs here as was the case farther south. Above Rolling Fork the land on both sides of Deer Creek is under cultivation and, as the banks are higher, there is a comparatively wide strip of land on each side which is above the overflow. The country has been cultivated for a

longer time and has altogether a more civilized air than the Little Deer Creek country.

Rolling Fork is a branch of the creek which flows almost directly eastward into the Sunflower River. The land between Deer Creek and the Sunflower is very low and, at most seasons, impassable. Not a house or other vestige of man is to be seen for miles in the swamp. The banks of the Sunflower are not high and very little land is under cultivation. Some years ago there were several prosperous farms on the river but they have been under water so much that they are now almost all abandoned.

The soil of the high ridge or bank of the Sunflower at this place is a light-gray, sandy loam with yellowish and orange streaks. The growth is sweetgum, maple, willow oak, elm and hackberry. The loam is underlaid at a depth of from 4-5 feet by "buckshot" clay and the water has washed away a portion of the loam from above this clay so that there is a part of hammock 15-20 feet wide between the loam ridge and the immediate bank of the river. This hammock-like depression is very frequently seen on the banks of streams in the bottom.

Below is given an analysis of the soil from the loam ridge on the bank of the river at Buck's Ferry in Issaquena County, depth about 12 inches.

No. 394. Sunflower River Frontland Soil, Issaquena County

Insoluble matter	71.164
Silica soluble in $NaO.CO_2$	13.506
Potash	.401
Soda	.191
Lime	.406
Magnesia	.196
Brown oxide manganese	.011
Peroxide of iron	3.845
Alumina	6.889
Phosphoric acid	.165
Sulphuric acid	.016
Volatile matter	2.748
	100.038

This soil, from the analysis, ought to be both productive and durable and such is the testimony given by the few farmers in

the neighborhood. If, by a better system of protection against high water, this land could be kept above overflow it would be some of the best farming country in the Bottom.

Between Sunflower and Silver Creek there is an uninhabited swamp some 15 miles wide. Along the banks of Straight Bayou, which connects the two streams, there is a somewhat peculiar vegetation, the large trees being almost exclusively swamp chestnut oak and sweetgum. A very dense undergrowth of cane occurs also a short distance from the bayou. The road passes sometimes along the sloping bank of the bayou between the cane and the bed of the bayou and, when such is the case, the road is perfectly dry and but for the immense roots of the sweetgum which lie half above ground would be very smooth. As soon, however, as we pass from the bank up on the level land where the cane is abundant the road is full of mudholes. The soil through all this swamp is much lighter colored than that of any of the swamps in the Deer Creek region and it is considerably more sandy and, to all appearances, very much less fertile.

A good portion of the soil of Silver Creek is of the same character, the growth of swamp chestnut oak and sweetgum being characteristic. The people speak of this as "white land," which is not held in very high estimation.

The surface soil on Silver Creek is underlaid by a stratum of compact, yellowish, sandy clay with streaks of ferruginous matter similar to that on the banks of Straight Bayou. The highest land is some 40-50 yards from the water's edge and the surface soil of the depression, or hammock thus formed, is a light-colored, gray clay which crumbles on exposure into angular fragments like "buckshot." It is also traversed by cracks and mottled with ferruginous dots. In the wells on this creek the strata passed through vary very much. At Mr. Montgomery's, Section 23, Township 14, Range 4 West, Yazoo County, below the surface soil is the compact clay mentioned above; below that dark buckshot clay, then blue clay. A few miles farther south on Mr. D. LeLoris' place no blue clay has been struck in digging wells, but water was obtained in a sandy stratum at a moderate depth.

Between Silver Creek and Wolf Lake there is a road (Township 12, Range 4 West) which passes through an open swamp,

the surface of which is formed of dark-colored buckshot clay. The road crosses Panther Creek or a tributary of it near Section 13, Township 12, Range 4 West. The banks of this creek appear to be very low and there is no strip of loam over the buckshot clay. Just at the water's edge and below the buckshot clay comes a stratum of bluish stickey clay full of calcareous concretions. These concretions are very numerous farther north but I have noticed none farther south than the latitude of Yazoo City.

At the junction of Tokeba Bayou and Wolf Lake on the plantation of Col. William Battaille the average depth of the wells is 27 feet. The strata passed are surface soil, 2 feet; yellowish, compact clay, 6-8 feet, like that of Silver Creek; then "buckshot" clay, 8-10 feet; and below that a blue clay, the upper portions of which are full of calcareous concretions. Below this blue clay is a bed of white sand, sometimes coarse-grained, in which very good water is found. The water from one of these wells 26½ feet deep seems to be pure freestone water which does not curdle with soap. There is much complaint among the farmers of this vicinity with regard to the inefficiency of the levees to protect their lands. The general impression seems to be that there has been more serious damage to the crops from overflow *since* high levees were built than *before*.

At Yazoo City very near where a small bayou runs into the river the blue clay which formed the lower part of the banks of the bayou was full of calcareous concretions like those seen on Panther Creek.

On the bank of Tchula Lake near the town of Tchula there is sort of hammock where the ridge of sandy loam was some distance from the water's edge and a level space 20-30 yards between it and the lake. This level space is buckshot clay similar to that on the Sunflower River mentioned above. The soil of the ridge was a yellowish loam resembling in every respect the Sunflower River Frontland soil.

Honey Island is cut off from the mainland by the Yazoo River on the west and Tchula Lake, an old channel of the River, on the east. At the northern end of the island and in the bank of a bayou which connects Tchula Lake with the Yazoo River is a very characteristic section of strata:

Section of Bank of Bayou, Honey Island

Feet		No.
3	Top sandy clay with yellowish ferruginous dots.	9
4	Grayish joint clay mottled with ferruginous coloring matter.	8
4	Lighter colored and sandier stratum with yellowish ferruginous streaks.	7
6	Dark-gray, stiff clay with ferruginous streaks crumbling on exposed surface to "buckshot."	6
4 in.	Gray sand tinged yellow in places with hydrated ferric oxide.	5
2	Dark-gray, stiff clay similar to No. 6,	4
2	Gray sand full of ferruginous concretions (tubes and plates) in its lower portions.	3
2½	Ledge of blue clay with ferruginous concretions, interstratified with streaks of bluish sand, the stratification lines being strongly ferrugious. The exposed surfaces are covered with white efflorescence.	2
	Talus to bed of bayou.	1

Below stratum No. 2 issue numerous springs strongly impregnated with iron, and the runs of these springs are filled with a moss-like mass of hydrated ferric oxide. Strata No's. 4 & 6 seem to be identical in the nature of the clay composing them.

No's. 7 & 9 are composed of a yellowish sandy loam similar to the Frontland soils of Sunflower River and Tchula Lake.

On the bank of the Yazoo River a short distance from where the above section was taken the succession of the strata is very much the same as that given above. The first stratum of grayish joint clay (corresponding to No. 6 of the above section) is full of calcareous concretions which are of a dull gray color and very soft when imbedded in the moist clay but which became white and hard upon drying. Below the buckshot clay with calcareous concretions is a stratum with ferruginous concretions similar to those of the section given. From the blue clay stratum issue likewise numerous springs strongly impregnated with iron.

Three miles west of the Yazoo River on Bear Creek, lower part of Township 18, Range 2 West, Sunflower County on the

plantation of Mr. Martin, there occur several so-called prairie spots where shell mounds with fragments of Indian pottery are frequent. Mr. Martin says that on these prairie spots the cotton is more subject to *blight* than elsewhere and he says that this blighting occurs oftener on *old* land than on *new*. Maj. Fleet Mercer, whose occupation as a land surveyor has made him thoroughly acquainted with nearly every part of the Yazoo bottom, told me some time since that cotton on the prairie spots on the west side of the Yazoo was more liable to rust than on the other land. This testimony would seem to confirm the supposition that the prairie spots in this part of the bottom are nothing more than Indian clearings.

In the wells dug on Bear Creek strata of yellowish sandy clay, dark-gray clay and blue clay are struck. In the latter stratum 22 feet below the surface a log was struck which, on being exposed to the air for some time, dried and crumbled up like rotten wood.

There is in the low-grounds in this vicinity a whitish clay called "jug-metal"; it is very stiff and tenacious and is impermeable by water. When worked up at the proper time it produces tolerably well.

Between the Yazoo and Sunflower at this place, a distance of about 18 miles, the road goes for 7 or 8 miles along the banks of Bear Creek then strikes through an open swamp resembling that between the Sunflower and Silver Creek described above. The color of the soil, the growth of sweetgum and swamp chestnut oak are the same in both cases.

Between Mr. Martin's and the Ferry (Garvin's) some 15 miles, there is not a house nor a clearing nor anything suggesting civilization.

West of the Sunflower the road follows the bank of Indian Bayou where the land is high and the plantations join each other for 8-10 miles then through an open swamp for 9 miles to the Bogue Falaya. The soil of the Indian Bayou is a fair specimen of "white" land soil which is very common on the banks of the bayous which run into the Sunflower River. It occurs also on Silver Creek as stated above. The soil is of grayish color somewhat sandy, the subsoil a whitish close-textured clay with reddish ferruginous spots.

No. 376. Indian Bayou Frontland Soil, Sunflower County. *Depth* 5 inches. *Vegetation:* Sweetgum, swamp chestnut oak, hickory, holly, water and willow oaks, dogwood, some ash and maple and an undergrowth of cane.

Insoluble matter	87.898
Silica, soluble in $NaO.CO_2$	4.036
Potash	.226
Soda	.116
Lime	.153
Magnesia	.256
Brown oxide manganese	.048
Peroxide of iron	1.848
Alumina	2.565
Phosphoric acid	.162
Sulphuric acid	.042
Volatile matter	3.013
	100.363

No. 377. Indian Bayou Frontland Subsoil, Sunflower County. *Depth* 5-18 inches. *Vegetation:* Same as above.

Insoluble matter	87.898
Silica, soluble in $NaO.CO_2$	3.816
Potash	.305
Soda	.079
Lime	.147
Magnesia	.392
Brown oxide manganese	.050
Peroxide of iron	2.312
Alumina	2.998
Phosphoric acid	.283
Sulphuric acid	-----
Volatile matter	1.499
	99.779

These analyses indicate a soil of only moderate fertility and it is a well-known fact that the "white" land is not much esteemed by the farmers.

The water on Indian Bayou is obtained at depths varying from 30-80 feet, the shallowest well being fresh from mineral taste and quite soft. In one of these tubes the water stands permanently in the barrel of the pump some 2 feet above the ground.

After crossing Bogue Falaya there is a narrow swamp and then come the cultivated land of Deer Creek again. Here as in the neighborhood of Rolling Fork both sides of the creek are

under cultivation; the improvements, however, are much superior to those lower down the creek. It is no uncommon thing to see fine mansions, handsome bridges and beautiful lawns.

Between Deer Creek and Greenville there is a fine road which, 3-6 miles from Greenville, passes along the bank of Fish Lake. Here the road has been thrown up and a ditch 2-3 feet in depth dug on each side. The "buckshot" clay, very strongly mottled with hydrated ferric oxide, is thrown up from this ditch and where it has been exposed for a short time it is covered with a brown ferruginous coating. Occasionally isolated patches of sand are cut through. A short distance from Deer Creek the loam land ceases and there is then dark-gray buckshot clay to within a few miles of Greenville where the loam of the Mississippi River bank is encountered.

A short distance above Greenville on the Levee road there are some wells in which pure sand like that of the Mississippi River underlies directly the surface soil. At Capt. Hailes', Section 35, Township 20, Range 8 West, below the loam 2-3 feet thick comes 3 feet of sand like freshly deposited river sand and then 20 feet or more of dark-gray clay, "buckshot." Beneath this is said to be a red clay in which water is reached. Water rises in such wells to within a few feet of the surface.

In Section 11, Township 20, Range 8 West there is a so-called "prairie" spot. My informant, Capt. Hailes, says that it has the name from its barrenness for sand comes to the surface overlaid only by a thin stratum of clay. At first there was a growth of wild rye, prickly pear (not cactus), and wild verbena on the place. It is high land and was apparently a sand bar over which the river has made no deposits except the thin stratum of surface clay, which he calls "buckshot." At a depth of 12 feet very pure good water may be had.

At the head of Lake Bolivar which is an old channel of the river there is a part of the levee, 150-200 yards long, which is constantly sinking and as fast as the dirt is piled up on the levee it squeezes out at the base. The sides of the levee are full of immense cracks and slides. Much labor has been expended on this portion of the levee but with very discouraging results. The river is caving some half mile above this part of the levee and will in a year or two reach Lake Bolivar again unless a barrier can be constructed.

Lake Beulah is another old channel of the river cut off within a few years. The banks of this lake present very much the same appearance as those of the Yazoo at the head of Honey Island. Below the surface loam of 6-8 feet thickness comes heavy, dark-gray, "buckshot" clay full of calcareous concretions. The driven wells in Beulah are from 50-90 feet deep and the water at all depths essentially the same in character: very clear and sparkling when first drawn but soon becoming turbid by the precipitation of the carbonates of iron, lime and magnesia held in solution by free carbonic acid.

At Mr. Robertson's, Section 9, Township 26, Range 6 West, Bolivar County, is a driven well 33 feet deep, very strongly impregnated; so much so as to be almost unfit for washing purposes since it stains with iron rust. From this place to Friar's Point there is very little to be seen along the road which is upon or by the side of the levee. Very few plantations are seen. Indeed the road along the river from Greenville to Friar's Point is very monotonous. Not even the ordinary transitions from the highland loam to "buckshot" clay and swamp are to be seen often since the road is along the levee most of the way.

To obtain a fair idea of the topography of this part of the bottom it would be necessary to go on horseback with a trustworthy guide, then by following the banks of bayous and crossing swamps impassable by a wagon more of the country could be seen which would give an insight into the more particular details of the swamp geology.

About 3 miles southeast of Friar's Point on Col. Brown's land there is a spring which gushes up in the bed of Sunflower Bayou. The stream from the spring is said to be very copious. At the time of my visit the water of the bayou was over the spring so that nothing could be seen except a strong discoloration (with hydrated ferric oxide) of the water of the bayou for a distance of 50 yards above and below the spring. From all accounts I gathered that the water emitted sulphuretted hydrogen, though this may be a mistake as I perceived no smell of that gas. In the bed of Saxon Bayou a few miles distant from this there is a similar spring.

Between Friar's Point and Jonestown, Section 13, Township 28, Range 3 West, Coahoma County the road is through a swamp.

One of Gov. Alcorn's plantations is on the bank of Swan Lake, Section, Township and Range as above.

Near the house there is a Dogwood Ridge, which cultivated, yields very fair crops and a short distance back of the ridge is a slight depression in which there is a clay resembling "buckshot" clay in every respect except in color, it being of a light gray.

No. 395. Dogwood Ridge Soil. Gov. Alcorn's, Coahoma County. *Depth:* 24 inches. *Vegetation:* Dogwood, sweetgum, holly, ash, sassafras and prickly pear. A light-yellow, sandy loam very much like a good upland loam. Down as far as 2 feet there is no change in the strata.

Insoluble matter	83.886
Silica, soluble in $NaO.CO_2$	7.022
Potash	.392
Soda	.086
Lime	.259
Magnesia	.596
Brown ox. manganese	.086
Peroxide of iron	2.691
Alumina	3.593
Phosphoric acid	.142
Sulphuric acid	.010
Volatile matter	2.007
	100.770

No. 396. Light-gray "Buckshot" Clay. J. S. Alcorn's. *Depth:* 8 inches. *Vegetation:* Same as above.

Insoluble matter	75.513
Silica, soluble in $NaO.CO_2$	10.895
Potash	0.606
Soda	.146
Lime	.386
Magnesia	.972
Brown ox. manganese	.133
Peroxide of iron	2.804
Alumina	4.457
Phosphoric acid	.278
Sulphuric acid	.007
Volatile matter	4.401
	100.598

The Dogwood Ridges are inferior in fertility to some of the River Frontlands.

The clay above mentioned is of frequent occurrence on Silver Creek, etc., and does not equal in fertility the darker colored "buckshot" clay though a very fine soil.

The driven wells in this locality yield water similar to that found throughout the bottom, the difference in the water being apparently in quantity only. One well on the Dogwood Ridge spoken of above, 35 feet deep, yielded water without mineral taste and quite soft. A qualitative analysis shows the same general composition for this as for the water from a well 119 feet deep at Mr. Jones' house. The analysis of this latter water may perhaps be taken as a fair specimen of the average composition of water in the bottom.

The specific gravity is 1.00034. Percentage of solid matter in the water is 18.72 grains in the gallon. The solid matter is as follows:

Analysis of water from a driven well 119 feet deep, Gov. Alcorn's Plantation, Coahoma County

$FeO.CO_2$		4.877
$CaO.CO_2$	dissolved in free carbonic acid	19.575
$MgO.CO_2$		
		17.672
SiO_2		17.482
$CaO.SO_3$		.610
Na.Cl		1.744
NaO, HO	$2CO_2$	12.852
KO, HO	$2CO_2$	9.969
CaO united with organic acid		14.665
MgO united with organic acid		.560
		100.008

Between Jonestown and Cold Water the road goes along the banks of Moore's Bayou. This road is one of the great emigrant roads and people are passing at all times during the dry season. On Moore's Bayou there is a good deal of the "white land," mentioned above, timbered with sweetgum and swamp chestnut oak. In some places on this white land I noticed a few ordinary white

oaks and some hickory, a strange sight in the bottom and seen, I believe, only on the "white" lands.

At the junction of Moore's Bayou and Cold Water there is a good deal of very high land, some of it sand, though the crops are magnificent.

In crossing the bottom in this latitude one sees less of the white land than is the case below this. There are likewise no such side swamps as lie on both sides of the Sunflower lower down. In the low swamp some of the mud is almost jet black.

From the junction of Moore's Bayou to the mouth of Cold Water the banks of the latter river are high and one plantation joins another to within 4 miles of the mouth then there comes a stretch of low country.

On the eastern side of the Tallahatchie there is here a swamp 12-15 miles wide timbered with sweetgum, swamp chestnut oak, a few white oaks, holly and an undergrowth of cane. The soil is a light yellowish, sandy loam similar to the Silver Creek soils. On the banks of the Yockeney in this swamp are several places where the beach near the water's edge is covered with calcareous concretions like those found in other parts in the "buckshot" and blue clays.

GENERAL GEOLOGICAL RELATIONS OF THE STRATA OF THE YAZOO BOTTOM

It has generally been assumed that the formations underlying the Mississippi bottom were exclusively of alluvial character though Gen'l. Humphreys (Report on the Mississippi River) and Dr. Hilgard (Am. Journal of Science, January, 1869) have expressed the opinion that the present channel of the Mississippi has been cut into older formations.

The facts enumerated above go to show that the latter opinion is correct, and my observations have led me to the conclusion that the true river deposits of any considerable thickness are mostly confined to narrow strips of land lying on both sides of the Mississippi and of the bayous and creeks that form a network of streams throughout the bottom and to ancient river channels since filled up.

The accompanying diagram of a section through these bayous and the land intervening between them will give a fair idea of the general topography of the bottom.

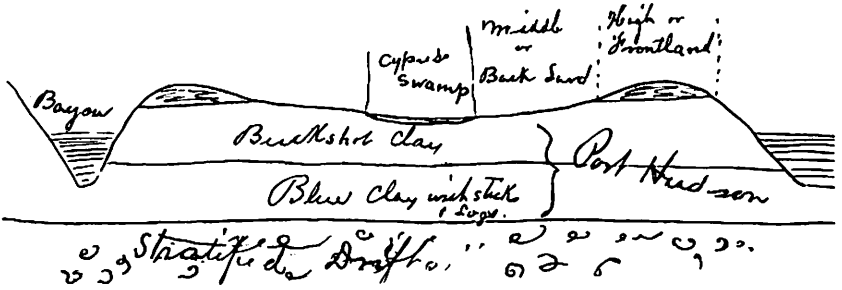

Figure 3.—Section in Mississippi Bottom, Showing Arrangement of Deposits.

The high or frontlands on the immediate banks of the streams are, at present, rarely overflowed. They constitute a sort of natural levee thrown up by the streams during high water. The soil is generally a sandy loam varying in color from nearly black to yellow and nearly white and of various degrees of fertility. The growth varies also with the character of the soil as may better be seen below in the remarks upon the soils.

From the "front-land" there is a gradual slope towards the swamp. The soil undergoes a transition from the sandy loam into the tenacious clays of the middle or "back-land." The latter region is often under water during the wet season. The clays of the "back-land," doubtless belong for the greater part to the Port Hudson age as the great abundance of calcareous and ferruginous concretions found in them indicate. These concretions are unlike any found in the true river deposits. The great thickness of continuous clay deposits also points to the conclusion that they belong to an ancient formation.

These clays are generally of a dark-gray color, sometimes nearly black, again light-gray traversed by cracks and full of streaks and dots of ferruginous matter. They are very sticky and tenacious and when exposed to the atmosphere become covered with dull red coating of hydrated ferric oxide and upon drying, crumble into small angular fragments, giving rise to what is known in the bottom as "buckshot" soil.

As we go from the "back-land" to the cypress swamp there is frequently very little change in the nature of the clay and

it is difficult, if not impossible, to distinguish between the "buckshot" clays of the older formation and that of the recent swamp except where the concretions above-mentioned come to our aid. The clays of both formations are usually dark-gray traversed with cracks and full of ferruginous matter: both crumble into "buckshot," both support a similar vegetation except when the presence of more or less standing water affects it.

One of the most characteristic sections of Port Hudson strata observed has been given above. (Section on bank of Tchula Lake at the head of Honey Island.) The three uppermost strata represent probably the alluvium while those below belong to the Port Hudson age.

The section on Black Bayou given above is essentially the same and on the banks of the Yazoo River, head of Honey Island, on Lake Beulah, Bolivar County, strata are exposed which correspond very closely with that on Tchula Lake. Indeed there is a great uniformity in the succession of the strata throughout the Bottom as they are laid bare on the banks of streams and in digging wells, departures from this general character being mostly local.

Below the buckshot clays is generally a stratum of blue clay containing logs and sticks, leaves and other vegetable remains. I have frequently seen outcrops of the blue mud very low down on the banks of bayous but have never observed any stump stratum like that at Port Hudson as described by Dr. Hilgard. Log sticks, however, have frequently been struck in digging wells so that I have no doubt but that this blue clay is the equivalent of the Port Hudson stump stratum.

Very few wells are dug now in the Bottom, iron tubes driven into the ground having almost entirely superseded them. The information to be obtained from the record of wells is, therefore, very scanty.

The composition of the gas from the well on Gen'l. Hampton's place likewise speaks for its origin in an ancient formation.

Below the blue clay with vegetable remains there is a stratum of pebbles and sand of the Drift formation.

The pebble bed is very often reached in digging wells, the depth varying very greatly. As before mentioned the pebbles are at the surface at the mouth of a small bayou emptying into Lake Washington while in some driven wells they are not reached at a depth of 120 feet.

Wells, etc.:

Throughout the Bottom water is obtained either from shallow dug wells, by means of iron tubes driven into the ground or the inhabitants sometimes prefer to use the water from the bayous.

During the summer when the water in the bayous is low it is often of a greenish tint and very hard. Steele's Bayou and the upper parts of Deer Creek show this green tint very plainly.

In the case of the wells the water always rises to within 30 feet of the surface and, where as is frequently the case, the tubes are driven down 60-80 feet the water may always be drawn by a pump. I have observed some instances in which the water stood permanently in the tube 2 feet above the surface.

The analysis given above of water from Gov. Alcorn's may be considered as showing an average composition.

Soils:

The soils of the Yazoo Bottom may be conveniently arranged into 5 classes which differ materially from each other in fertility as well as in general physical properties:

First, a light-colored sandy clay of close texture with a few yellow spots. The growth upon this soil is chiefly swamp chestnut oak and sweetgum with some ash, maple and willow oak. This is the soil of the white lands mentioned above and it occurs chiefly on Silver Creek and on the bayous on both sides of the Sunflower River which flow into that stream. Soil and subsoil of Indian Bayou, analyses of which are given above, are representative of this class of soil.

Second, a dark-gray sandy loam forming the Frontlands of many of the creeks and bayous of the Bottom. The growth is honey locust, hackberry and sweetgum chiefly. The Dogwood Ridge soil of Gen'l. Alcorn's plantation, analysis given above, is a specimen of a variety of this class though a typical dark-

colored Frontland soil has not yet been analyzed. The front-lands of the Mississippi in most places belong to this class.

Third, a light-gray sandy loam with yellowish and orange streaks. This loam is sometimes of a light-yellow color. It forms the front-land of Sunflower River and Tchula Lake and occurs frequently elsewhere. The growth is sweetgum, maple, water and willow oak, elm and hackberry. The analysis given above of a Sunflower River Frontland soil may be taken as representing the average constitution of this class.

Fourth, a light-gray tenacious clay traversed by cracks, streaked with ferruginous coloring matter and crumbling upon exposure to the weather into angular fragments, "buckshot." This clay is lighter in color and less fertile than the dark-gray "buckshot" clay which has made Deer Creek so celebrated. The analysis of the clay from Gov. Alcorn's represents its composition.

Fifth, a stiff dark-gray clay sometimes nearly black traversed in all directions by cracks and full of streaks and dots of ferruginous matter. This is the "buckshot" clay, *par excellence,* and forms the most fertile soil in the Bottom. It belongs probably, together with the preceeding, to the Port Hudson formation and forms the soil of the backlands lying between the water courses.

The territory of which it forms the surface soil is generally subject to overflow though there is usually a strip from ½ - ¾ mile wide on the banks of streams under cultivation. The growth is sweetgum, overcup oak, willow and water oaks, hackberry, pecan; near the banks of the streams are undergrowth of cane but in the low swamps no cane but an open cypress glade.

The Deer Creek buckshot soil, the analysis of which has been given above, is one of the best of these soils.

In comparing the analysis of these soils with the estimation in which they are held by farmers one cannot but be struck with the close correspondence between the fertility as indicated by the chemical analysis and as ascertained by actual experience.

DISCUSSION

In a memorandum on tenure of members of the Association of American State Geologists released by A. A. S. G. Historian George F. Hanson in July, 1963 it was pointed out that Dr. E. A. Smith had a tenure of 54 years (1873-1927) as State Geologist of Alabama. Prior to this remarkable period of service, incidentally, the longest of any State Geologist, he served Mississippi from December 1866 until 1871 as Assistant Geologist, as recorded in Lowe's "History of the Mississippi Geological Survey." On December 14, 1954, Dr. Stewart J. Lloyd, Chemist, Geologist and Scientist of the University of Alabama, a colleague of his, presented an inspiring address "Eugene Allen Smith, Alabama's Great Geologist" at the 1954 Alabama Dinner of the Newcomen Society of England, held at Mountain Brook Club, at Birmingham. This pamphlet was printed under copyright to Dr. Lloyd. The publications of the Geological Survey of Alabama are a lasting record and tribute to Dr. Smith's energies and abilities.

Had Dr. Smith remained in Mississippi we can only assume that he would have succeeded to the position of State Geologist and the Survey would have had almost a continuous period of service through the Civil War unto the present. Our loss, in this respect, was Alabama's gain: the deficit has been overcome only through the dedication, determination and drive on the parts of Crider, Lowe, Morse, and their staffs and successors. For, although Mississippi did not have a Survey from 1872 to 1906 (34 years), by dedicated application of her geological scientists and publication of their works she has for the first time, approached Alabama in the value of produced minerals (Bur. Mines, 1962 Production: Alabama $219,837,000 (rank 20th); Mississippi $209,428,000 (rank 21st).

The Smith manuscript, originally in the Survey's files, recently was offered for sale by a gentleman in Chicago to the Department of Archives and History. When he was advised that the Department had no funds for the purpose, the manuscript was given to that Department. The Survey asked that it be returned to its files but was told that the Department of Archives and History had no legal authority to return or otherwise dispose of such items; but the Department obligingly furnished a facsimile reproduction of the Smith manuscript to the Survey. Dr. Smith's handwriting, for the most part, was unusually clear and legible,

and our transcription is accurate. We do not know that the manuscript was completely intact, but it does seem to be essentially complete.

Dr. Smith's "Geological Reconnaissance" is the first report of his to be published by the Survey. It is written in a free and clear style, scientifically accurate but not to the point of being pedantic. In Yazoo and Holmes Counties, we can recognize the geological outcrops and features which he described for us over 90 years ago. In the vast expanse of the lower "Delta," Dr. Smith has ably described the early development of plantations along the natural levees of the streams ("frontlands", as he calls them), has described the variations and types of alluvial sediments and soils in their virgin states, and has, in clear and readable language, described the beginnings of the cultural development of one of the world's richest agricultural areas immediately after the Civil War.

The Smith Report, therefore, contributes background information to the historian, to the botanist, to the agronomist, to the engineer, as well as to the students of the earth sciences, geography and geology.

The Mississippi "Delta," since it is completely an alluvial plain, has only alluvial geology as so well described by Dr. Smith. Information on the alluvial forms and sequences is clear and meaningful, and has not subsequently been so well described. Data on driven and dug water wells, on the "buckshot" and "white land," on the "blue mud" and on the buried sand and gravel bars is faithfully portrayed.

A number of persons have read Dr. Smith's report and are heartily in accord with the decision that it be published. From the standpoint of economic geology, the notes and references to the shallow waters, the character of the soils, the "blue muds" and the sands and gravels are sufficient justification. These notes bring to light information on the nature and distribution of these alluvial materials nowhere else so well described. The Survey has in preparation a proposal for an economic geological study of the mineral resources of the "Delta" and, most certainly, the Smith report will provide leads and clues to important industrial mineral substances which are believed to be present in the vast alluvial sediments of northwestern Mississippi.

August 26, 1963 Frederic F. Mellen

HISTORY OF THE MISSISSIPPI GEOLOGICAL SURVEY (1850 - 1906)

EPHRAIM N. LOWE

ABSTRACT

The Mississippi Geological Survey was authorized by an act of the Mississippi Legislature in 1850. Three early reports on the Geology and Agriculture of the State were prepared by B. L. C. Wailes, Ludwig Hafner (Harper), and Eugene W. Hilgard, and these were published and distributed by the Survey. After the Civil War the Survey gradually became a casualty of the economics of Reconstruction and educational politics. The basic outlines of Mississippi Geology contained in the three reports served the State until demand for new geologic information brought about the re-establishment of the Survey in 1906 by act of the Legislature. F. F. M.

On the organization of the University of Mississippi in 1848 the first faculty consisted of four members, one of whom was a professor of Chemistry and Natural Philosophy. John N. Millington, then filling a chair at William and Mary College, Virginia, was elected to fill this chair. Dr. Millington was an Englishman by birth, a former pupil and associate of Faraday, and at the time of his election was seventy years old.

We know little of the extent of geological teaching at the University at this time, but it must have commanded some attention, for on March 5, 1850, the Legislature of the State passed an act authorizing an Agricultural and Geological Survey of the State, the Survey to be conducted from the University, with Dr. Millington to be Chief Geologist, to which position he was elected in June, 1850.

Dr. Millington's age prevented his taking the field, and an assistant was appointed on July 15, 1851. Oscar M. Lieber of South Carolina, was appointed to that position, but resigned on January 14, 1852, after having made some reconnaissance trips on horseback over parts of the State, of which no record was left, except a small sketch map of the State, with four geological divisions suggested in broken lines, consisting of: the Alluvium of the Delta, the Tertiary uplands of the central part of the State, the Cretaceous limestone, and the Paleozoic region, with two divisions, Millstone Grit, and Carboniferous Limestone. Mr. Lieber was later State Geologist of South Carolina, to which

department reference may be made for further account of his work.

In January, 1852, Professor B. L. C. Wailes, then of the faculty of Jefferson College, at Washington, Adams County, was appointed Assistant Professor of Geology and Assistant State Geologist, succeeding Lieber. Wailes had come into Mississippi at an earlier day as a surveyor of land for the United States Goverment, and had located at Washington.

Figure 4.—Col. B. L. C. Wailes, never State Geologist, but the distinguished author of the First Report on the Agriculture and Geology of Mississippi.

In 1852 the original act creating the Geological Survey was amended so as practically to make the Survey a complete Natural History Survey, and space was allotted in the State Library at Jackson for the care and display of the collections made by the Survey.

Professor Wailes had already made rather extensive collections of rocks and fossils in the southwestern part of the State and had some familiarity with that region, and upon his appointment he set to work assiduously to cover the rest of the State. During 1852 and 1853 he was much in the field, making examinations of the southern and northeastern parts of the State and collecting from these sections, especially Tertiary shells from the marl beds at Jackson, which were submitted by him to Conrad for identification. Mammalian bones from the loess of the Mississippi River bluffs were submitted to Leidy for description. From the date of his appointment until the completion of his report in 1854, he traveled more than seven thousand miles, and his collections amounted to several thousand specimens. Speaking of his survey, Professor Wailes says: "The discovery of mines of copper, lead, or the precious metals, or even of the true coal fields, was obviously not to be expected. It was therefore mainly in reference to its influence and bearing upon the agricultural prosperity of the State, that it was undertaken." Hence with this idea in view considerable attention was given to the marls and soils. Few analyses, however were made, owing to the illness and final resignation of Dr. Millington; but some study of the fauna and flora of the State was begun, and lists and notes were made.

In 1853, owing to ill health, Dr. Millington resigned his work at the University, and with it his position as head of the State Geological Survey. The same year John C. Keeney, A.M., was elected to fill the chair of Chemistry, Agriculture, and Geology at the University of Mississippi in place of Dr. Millington, but he does not appear to have had any active connection with the Geological Survey.

In the meantime Professor Wailes had prosecuted the work of the Survey and had prepared his report. Although Dr. Millington was officially the State Geologist, he disclaimed the honor, and requested that the name of Professor Wailes should appear in the report as the chief geologist, saying, "But it has always

appeared to me that the person who travels and personally examines the geological and mineralogical formations of a country, ought to be considered the principal officer."

On the completion of Professor Wailes' "Report on the Agriculture and Geology of Mississippi" in 1854, the State Legislature passed an act authorizing the printing of the Report in an edition of 2,000 copies, 1,000 of which were to be sold by the Secretary of State, the rest to be distributed free, as designated in the act.

This first geological report on Mississippi is worthy of some description, especially since it is now a very rare book. It is a volume of 371 pages, printed on good paper in large type easily read, and was in substantial cloth binding. Seventeen plates, said to have been lithographed from his own drawings, and a frontispiece of an old English map of Mississippi of date 1764, by Emon Bowen, embellish the volume. The last four plates present excellent illustrations of 38 common and characteristic fossil shells of the Jackson formation, determinations of which had been made by Conrad, then at the zenith of his reputation.

The first 116 pages of the Report are taken up with the introduction and a Historical Outline of events in Provincial Mississippi, ending with the transfer of the forts at Natchez and Walnut Hills (Vicksburg), by Governor Gayoso to the American representatives on March 30, 1798.

Nine pages are devoted to Land Titles; seventy-eight pages to Agriculture; eighty-nine pages to Geology; twelve pages to Meteorology; forty-seven pages to the living Fauna and Flora of the State, and fifteen pages of Appendix devoted mostly to copies of Legislative Acts and Messages of the Governor.

The Historical Outline is very interesting and important as an historical document; the agricultural section is of no practical value today, and the geological is important today chiefly because of the four excellent plates accompanying it. That part devoted to the fauna and flora of the State is too general to be of present value, except for lists of species the determination of which, in some instances, are not certain, because not accompanied by specimens for verification. It should be said of the Wailes Report, however, that it was intended to be mainly preliminary and general, and had Professor Wailes remained in the work later

reports would undoubtedly have gone more fully into the study of the geological structure of the State.

Keeney who had succeeded Dr. Millington, served but one year and was followed in February, 1854, by Lewis Harper, at that time a teacher of Natural Science in an academy at Greenville, Alabama. Professor Wailes' conduct of the Survey had seemed to meet with general approval throughout the State, and naturally he expected to be elevated to the full professorship and official head of the Survey, which up to that time had been an adjunct to the chair of Geology at the State University. When he was passed over he felt that his work was not receiving proper official recognition, and immediately resigned. Unfortunately we have no further records of the life of Professor Wailes.

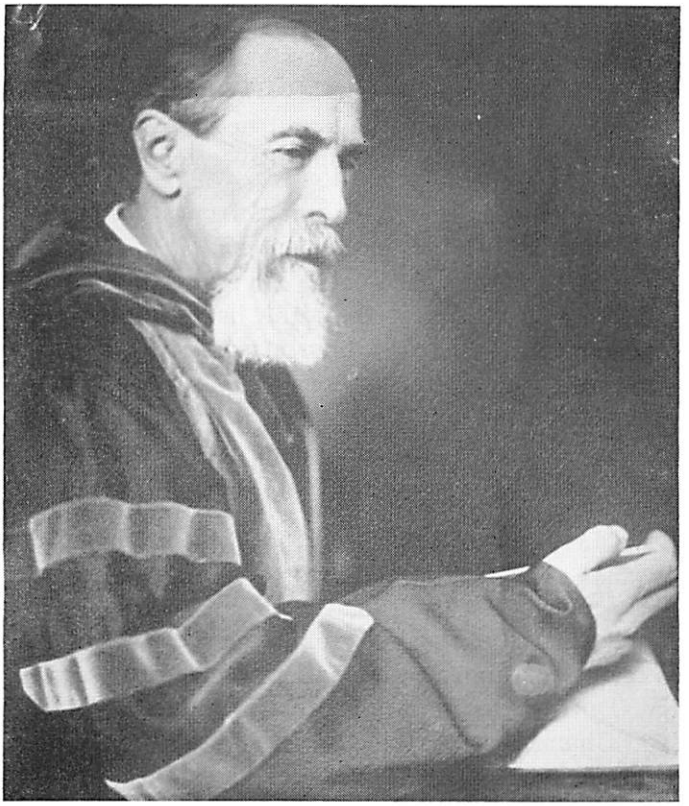

Figure 5.—Dr. Eugene W. Hilgard, twice officially State Geologist, World-renowned as the "Father of Agricultural Geology."

From February 1854, until September 1855, work of the Geological Survey was suspended, although Professor Harper bore the title of Professor of Geology and Agriculture, and of State Geologist. In order to promote the work of the Survey the board of Trustees of the University relieved Harper of a portion of his duties as instructor, and directed him to take the field personally. A competent assistant was obtained in the person of Dr. Eugene W. Hilgard, then a young man lately returned from Europe, where he had taken his Ph.D. at one of the German Universities.

Dr. Hilgard was well equipped for his work. Arriving at Oxford about the middle of September he and Harper took the field early in October with a camp outfit, an ambulance and a negro serving as driver and cook. The itinerary took them through the northeastern prairies to their eastern boundaries, thence southward across the successive Tertiary outcrops as far as Leakesville, in southeastern Mississippi. Thence, owing to the lateness of the season, they returned to Oxford by way of Fort Adams, and up the Mississippi River to Memphis.

Professor Harper was a German, from Hamburg, his real name being Ludwig Hafner, which on coming to this Country, he had anglicized. He seems not to have had much training in scientific work, and almost from the beginning of their intercourse he and Dr. Hilgard, a man of splendid scientific attainments, were in frequent disagreement. With the advent of Hilgard on the scene, the field work of the Survey progressed rapidly. At first Harper and Hilgard made joint trips throughout parts of the State, but later worked separately in disconnected areas.

In the Legislative session of 1855-1856 the Governor recommended that the Geological Survey be disconnected from the University, ostensibly in order that better work would be promoted in both institutions; but probably largely because Professor Harper had made himself unpopular with the University administration. During a temporary absence in New York of Dr. F. A. P. Barnard, Chancellor of the University, Harper published an unwarranted attack upon the Chancellor, which drew upon him the Chancellor's rebuke in a scathing arraignment of his official ability and his personal character.

Whatever else may be said of Harper, he seemed at the time to have been not without political influence, for it was through his efforts that the Legislature, in January, 1857 passed an act to provide for the printing of his Geological and Agricultural Report. By the provisions of this act the Geological Survey was made a separate department of state work under the direction of the Governor, with office and laboratory located in Jackson, and (odd incongruity) occupying space in the State Penitentiary! Under this act, the State Geologist was to be named by the Governor, and the appointment was given to Harper. However, his "sentence" was of short duration, for the publication of his Report during 1857 caused such dissatisfaction in the State that he was obliged to resign his office toward the end of the year.

Harper's only report, known as a preliminary report on the Geology and Agriculture of Mississippi is a volume of 350 pages of print, a geological map of the State, some small county maps, and a number of crude cuts, mostly of geological sections. While this report contains some valuable records of observations, it has also some grave inaccuracies and inconsistencies. These defects may in some measure be accounted for by the "unfavorable circumstances" under which it was prepared; these "circumstances", however, Professor Harper seems to have brought upon himself. His hostility to the University administration had caused the complete severance of his connection with the University, and his report was prepared while he was in retirement at the little village of College Hill, about five miles north of the University, separated, as he states, "not only from the geological and paleontological specimens, but also from any library." Dr. Hilgard spoke later of the Report as being "a literary, linguistic, and scientific curiosity." The subsequent history of Lewis Harper is not known.

Eugene Woldemar Hilgard was born in Zweibrucken, Bavaria, on January 5, 1833. His parents were Theodore Erasmus and Margarette Hilgard, his father being a lawyer, holding the position of Chief Justice of the Court of Appeals of the province. In 1836, for political reasons, the Hilgards came to America and settled near Belleville, Illinois. After study in this Country, Eugene returned to Germany in 1849 and entered the University of Heidelberg, later changing to the University of Zurich, and then to the Royal Mining School at Freiburg, Saxony. He later

returned to Heidelberg, where in 1853 he received the degree of Ph.D. *summus cum laude,* at the early age of twenty.

In 1855 Dr. Hilgard returned to Washington and fitted up a chemical laboratory in the Smithsonian Institution, serving as chemist of the Institution. There he was engaged when he met Dr. F. A. P. Barnard, who was then Professor of Physics at the University of Mississippi, and who had been commissioned while on a trip north to secure the services of a competent assistant geologist for the Geological Survey. Dr. Barnard tendered him the position, and it was accepted, Dr. Hilgard entering upon his duties as Assistant Geologist with energy and enthusiasm, making extended trips throughout the State in different directions. Much valuable and very accurate field work was done by Dr. Hilgard during the period of two years in which he was Assistant Geologist on the Harper Survey, and much of the most accurate data contained in Harper's Report was taken directly from Hilgard's field notes.

As stated above, in 1857 Harper resigned, and for a short time the work of the Survey was suspended, Dr. Hilgard meantime returning to the Smithsonian Institution. But his work on the Survey was recognized as being so able and satisfactory that on the revival of the Survey early in 1858 he was called back to take charge of it as State Geologist. One of the first of his official acts was to remove the Survey from the penitentiary, in Jackson, back to the State University.

In April, 1858, Hilgard again took the field with his usual outfit—an ambulance with two mules and a negro driver—and studied carefully the Cretaceous and Tertiary outcrops, including a detailed examination of the Jackson and Vicksburg fossiliferous horizons. During 1859 he traversed with greater detail and care the counties of east Mississippi from Columbus to Pascagoula, thence along the coast to Pearl River, and up the Pearl to Columbia, thence west to the Mississippi Bluffs and north along the east border of the loess region northward to Vicksburg and Jackson.

The results of Hilgard's work were embodied in a "Report on the Geology and Agriculture of Mississippi", which was submitted to the Legislature when it convened in December, 1859. Although this report was not yet completed, a special committee

of the Legislature approved it, and the Legislature appropriated a fund of $3,500 for the printing of the report in an edition of 5,000 copies. This sum was inadequate, and in order to get the report published, Dr. Hilgard proposed to pay personally $250, and the public printer $250, in order to bring the amount within the $4,000 bid of the public printer. The report was then completed as rapidly as possible, was submitted to the state printer and put through the press under the supervision of Professor W. D. Moore, of the University, while the author hurried to Spain to wed Miss J. Alexandrina Bello, a daughter of Colonel Bello, of the Spanish army at Madrid. This lady he had met and wooed while visiting Spain to regain his (health) in 1853. On his return from Europe in November, 1860 with his bride, he found his report in print. While the report was printed in Jackson, Mississippi, the whole edition was sent to St. Louis for binding; and there it remained until after the end of the Civil War, which broke out immediately after the report was shipped north, and it was not until 1865 that measures were taken for its recovery.

During the distressing interval between 1861 and 1865 the support of the Geological Survey was not entirely withdrawn. It is a splendid tribute to the work of Dr. Hilgard that at the called session of the Legislature in August, 1861, instead of ignoring this work, as would have been natural under the terrible stress of the hour, an act was passed suspending the appropriation for the support of the Geological Survey "until the close of the war, and for twelve months thereafter; except the sum of twelve hundred and fifty dollars per annum, which shall be applied to the payment of the salary of the State Geologist, and the purchase of such chemicals as may be necessary to carry on the analysis of soils, minerals, and mineral waters, and to enable him to preserve the apparatus, analyses, and other property of the State connected with said survey."

Dr. Hilgard remained at the University, which had been suspended during the War, and he, with Dr. A. J. Quinche, also of the University faculty, was instrumental in saving the University buildings from being destroyed when General Grant's army entered Oxford in 1862. "General A. J. Smith, in command of the van of Grant's army, at first intended to burn the buildings, because they had, as he said, been used for 'war purposes.' This purpose was abandoned, however, upon the personal suggestion

of Dr. Hilgard, 'that occupation as a hospital was hardly a war measure, and that possibly the United States army might have a similar use for the buildings in the near future', assuring him that all sick and wounded of both armies would receive impartial attention, which stipulation was strictly adhered to, the University buildings having been used alternately as a hospital by both Confederate and Union forces as one or the other occupied the territory around Oxford."

The Confederate authorities appointed Dr. Hilgard as an agent of the "Nitre Bureau", the purpose of which was to locate nitre deposits within the Confederate States which could be made available for the manufacture of explosives. At the siege of Vicksburg he was ordered to erect calcium lights on the bluffs above the City for the illumination of Federal gunboats when attempting to run the gauntlet of the Confederate batteries. The difficulty of securing the necessary materials delayed the completion of the arrangements to prevent the expected illumination when the fleet finally passed and the Federal forces reached the City.

After the close of the war the work of the Geological Survey was resumed in 1866. Dr. George Little, Professor of Natural Sciences at Oakland College near Rodney, Mississippi, was appointed in July, 1866, as assistant geologist to Hilgard. "In view of the difficulties and insecurity besetting the office of State Geologist under the regime then existing" in the State, Dr. Hilgard, in October, 1866, resigned from the State Geological Survey and accepted permanently the chair of Chemistry at the University. Dr. Little, upon Hilgard's recommendation, being appointed State Geologist. Little was an Alabamian by birth, and had only recently returned from Europe where he had taken the degree of Ph.D. from Gottingen University. Dr. Eugene A. Smith, also an Alabamian, and also recently from Europe, with a Ph.D. degree from Heidelberg University, was appointed Assistant Geologist in December, 1866, which position he held until 1871, when he resigned to accept a position at the University of Alabama. During his connection with the Mississippi Survey he made numerous traverses of the State, taking valuable notes, but unfortunately none of these were published. His later work is fully embodied in the Reports of the Alabama Geological Survey. The Mississippi Geological Survey under Little issued no publications, owing chiefly to lack of sufficient funds. Dr. Little in October,

1870, accepted the professorship of Geology and Natural History in the University.

With the organization of a School of Agriculture and Mechanic Arts at the University in 1871, Dr. Hilgard was elected to the chair of Economic and Agricultural Chemistry and Special Geology and Agriculture, the position carrying with it the office of State Geologist, Dr. Little holding the professorship of General Geology and Natural History. Mr. R. H. Loughridge, of Texas, succeeded Dr. Smith as Assistant Geologist on the Survey, and prosecuted the work of analyzing marls and soils, preparatory to the issuing of a second report which Hilgard had in contemplation when he resigned in 1872 to accept a position at the University of Michigan as Professor of Geology and Natural History. Publication of the results of this later period of the Survey work was not provided for, and they were never published, except such parts as related to the soils of the State which were issued by Hilgard in the Tenth Census Report.*

The Hilgard collection of soils, marls, rocks, fossils, etc., were left at the State University, where it still remains.

Hilgard's administration of the State Geological Survey marks its most brilliant period of geological investigation. In spite of previous surveys, the State was practically still virgin territory for the geologist. Hilgard rose to the occasion and his Report and his interpretations of the stratigraphy of the State stand practically intact today as to its main outlines. The accuracy of his observations and the correctness of his interpretations have in nearly all instances stood the test of later study made under more favorable conditions than existed in his day.

Dr. Hilgard was a man of broad culture and scientific training, and his investigations covered not only the stratigraphy of the state, but also a careful and detailed study of the agriculture, soils, forests, and native flora, especially in their relation to the soils. Large collections of rocks, soils, minerals and fossils were made and displayed in the University Museum.

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*See "Report on the Cotton Production of the State of Mississippi, with a discussion of the General Agricultural features of the State," by Eugene W. Hilgard, Ph.D., 1884.

In 1875 Dr. Hilgard went to the University of California, as Professor of Agriculture and Director of the Agricultural Experiment Station, which he founded in 1875. All the rest of his life was spent in this work. He died in Berkeley, California on January 8, 1916, three days after his eighty-third birthday.

Dr. Little became State Geologist of Georgia in 1874, but later returned to the University of Mississippi, where he held the chair of Natural History and Geology from 1882 to 1889. His later years were spent at the University of Alabama, in Tuscaloosa, where he died in February, 1925, at the age of 84.

Robert Hills Loughridge, who had held the position of Assistant Geologist on the Georgia Geological Survey under Dr. Little, was appointed to the assistantship on the Mississippi Geological Survey when Dr. Smith resigned in 1871. He was the son of President Robert McGill Loughridge and Olivia D. Hills, and was born October 9, 1843, at the Kewetate Mission, Creek Nation, Indian Territory, of which his father had charge. His early education was received at the Mission Station under the careful direction of his parents. He was a soldier in the Confederate Army during the Civil War, and was seriously wounded at the Battle of Shiloh. After the war he removed to Texas, where he attended school at La Grange for one year. In 1868 he entered the University of Mississippi, which at that time was under the administration of Dr. John N. Waddell, his former preceptor at La Grange College. In 1871 he received the degree of B.S. from the University, and after graduation was appointed Adjunct Professor of Chemistry, which position he held until 1874, having in the meantime enrolled for the graduate degree of Ph.D. This was conferred upon him in 1877 while engaged in the work of the Georgia Survey under Dr. Little.

During his connection with the University of Mississippi a strong friendship sprang up between Loughridge and Hilgard, which lasted throughout their lives. When Dr. Hilgard resumed charge of the Mississippi Geological Survey in 1871, and after the resignation of Dr. Eugene A. Smith to take the professorship of Geology at the University of Alabama, Hilgard secured the appointment of young Loughridge to the place of assistant on the Survey, where he remained until 1874, when he was called to the Georgia Geological Survey during Dr. Little's administra-

tion, from which place, at the invitation of Dr. Hilgard in 1878, he went to California to assist in the preparation of the Tenth Census Report, on Cotton Production of the State of Mississippi.

From 1872 until 1906 the State was without a Geological Survey, although various investigators, both local and from the United States Geological Survey, from time to time published papers on different phases of the State's geology. The earlier ones by the United States Geological Survey were mostly reports of fossils collected at the different horizons. T. O. Mabry, of the State University, wrote an extended article on "The Brown Loam", (1903), and W. N. Logan, of Agricultural and Mechanical College, wrote a bulletin on "The Geology of Oktibbeha County", (1904), and in collaboration with W. R. Perkins, issued a bulletin on "The Underground Waters of Mississippi", (1905). A fuller report, "Summary of the Underground Water Resources of Mississippi", by A. F. Crider and L. C. Johnson, was issued the next year, (1906), by the United States Geological Survey.

In 1903, Colonel R. H. Henry, the World's Fair Commissioner for Mississippi, effected a cooperation with the United States Geological Survey, by which, in order to give adequate representation to the State's mineral resources at the Chicago World's Fair, a geologist was sent into the State to study its geology. A. F. Crider was assigned to the work, and in 1906 his "Geology and Mineral Resources of Mississippi" was issued as United States Geological Survey Bulletin No. 283.

Figure 6.—Dr. Albert F. Crider, first of the modern State Geologists of Mississippi, who served from 1906 to 1909.

MEMORIAL TO EPHRAIM NOBLE LOWE*

(1864 - 1933)

WILLIAM C. MORSE

In the passing of Ephraim Noble Lowe, the University of Mississippi lost a teacher; the community, a friend; the Geological Survey, a director; Mississippi, a citizen; Pennsylvania, a wanderer; the Quakers, a son; the South, a gentleman; the North, a grandson; Nature, a nobleman—though Heaven gained a soul. Genial, gentle, generous, he was ever the delight of his friends. It is said of him that he belonged to the Old School; rather, he belonged to the Rare School, the one whose members are so few.

His work can never be dissociated from the man. In fact, his greatest work was the development of the man, the gentleman, the life—the gentle, quiet life that left its benevolent influence on student and colleague, on all who came in contact with it. His next greatest work, perhaps, was the directorate of the State Geological Survey from 1909 to his death in 1933, for truly none other than a genial, gentle, generous soul could have kept courageously on to the end on such pitiful appropriational support. Of the quarter of a century, he writes, that "Except for the years 1920-1921, the Geological Survey has always been handicapped by inadequate financial support."[1]

Notwithstanding these meager appropriations, he was able, as director, to issue 17 bulletins (including two on Forestry and one on Plants), a special report on Archeology, and, in cooperation with the United States Geological Survey, a report on the Ground Water Resources. He directed, in addition, the publication of a number of shorter papers, press reports, and administrative reports—two of the last including (1) a History of the Survey and (2) Petroleum Possibilities. Besides all of these reports, he was able to issue, in cooperation with the United States Department of Agriculture, 40 detailed county soil reports and maps, and, in cooperation with the United States Geological Survey, 30-odd topographic sheets or advanced proofs thereof. In a few

*Reprinted from Bull. American Assoc. Petr. Geol., Vol. 18, No. 3, (March 1934) pp. 428-31, with permission of the Association.

[1]National Research Council Bull. 88 (1932), p. 62.

instances, however, some of these reports were possible only because of his fine enlistment of cooperation of others—one report being based entirely on a private survey costing thousands of dollars, and another, partly on the laboratory identification of material studied in a great eastern school of technology. These are the visible fruits of his directorship. Less conspicuous but no less real, were his untiring efforts to stimulate within the state the utilization and conservation of the soil resources, the development of the oil and gas industry, the hydro-electric potentialities, the clay industry, and others.

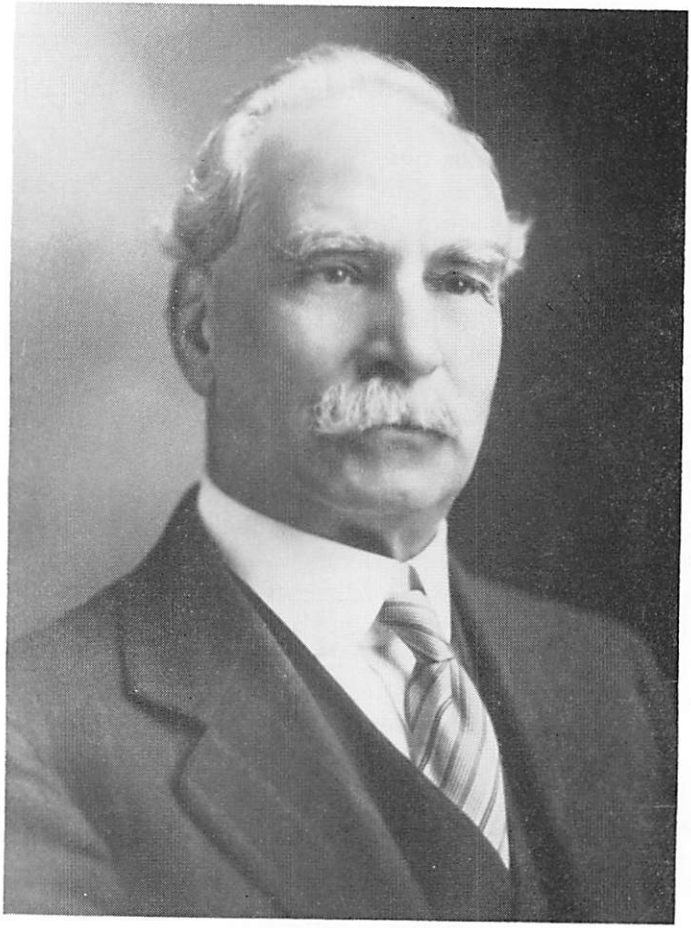

Figure 7.—Ephraim N. Lowe, M.D., State Geologist of Mississippi from 1909 to 1933.

Like so many of the earliest geologists and paleontologists, Dr. Lowe was trained in the School of Medicine. Accordingly, he belongs to that fine school of naturalists manifest by the variety of his efforts and by the range of his publications. While lack of space prohibits the listing of the 30 or more titles of his published reports, a few of the more important should be mentioned. His "Geology, Geography, Soils, and Mineral Resources of Mississippi," first published as Bulletin 12 (1915), and later revised as Bulletin 14 (1919), and finally as Bulletin 20 (1925), is an excellent summation of all existing geologic knowledge of the state at the time of the respective editions. His "Plants of Mississippi," published as Bulletin 17 (1921), reveals the breadth of his interest and perhaps his most pretentious effort. His contribution to the Coastal Plain stratigraphy of Mississippi in the form of a report on the Midway and Wilcox, which appeared as Bulletin 25 the year of his death (1933) is, perhaps, his most scientific work. His Biblical story, "The Tishbite," published by The Stratford Company of Boston (1923), manifests his literary skill.

Ephraim Noble Lowe was born near Utica, Hinds County, Mississippi, May 5, 1864, the son of Edmund F. Lowe (1823-1902), the son of Daniel Lowe (1800-1845), the son of Daniel Lowe (....., ... Mississippi, ...), the son of John Lowe (North Carolina, 1726 - Georgia, 1800), a soldier in the War of Independence. John Lowe was, according to the record furnished, a descendant of the Quakers under Penn in Pennsylvania, a branch of the Quakers from Plymouth, Massachusetts, a branch of the Quakers from England. Thence the name seems to extend to Belgium (as Lewes) and to Germany (as Löwe). Ephraim's mother, Emily Minerva Peyton (1833-1873), the second wife of his father, was a descendant of the Peytons, also of England.

Ephraim entered the University of Mississippi in 1879, and was graduated in 1884, as a Bachelor of Philosophy. He was a member of the Sigma Chi fraternity. He pursued one year of post-graduate work in geology and biology *in absentia* during 1880. He attended Tulane University, which granted him the degree of Doctor of Medicine in 1892.

He engaged in private geologic and biologic work in Colorado from 1887 to 1889, and practiced medicine in Mississippi from 1892 to 1893. In 1893 he returned to Colorado, where he remained until 1902, practicing medicine and indulging his biologic and

geologic yearnings. Save for a vivid little Christmas story of duty and a dangerous mountain pass, little is recorded of this period of his life, but, no doubt, his soul was attuned to Nature as he roamed the wide expanses of the Rockies from Mexico to Montana, for he dearly loved God's great outdoors. In 1902, he returned to Mississippi on the occasion of the death of his father.

In 1904, he was appointed assistant in biology and geology at the University of Mississippi, serving as such from 1904 to 1906 and attending the University of Chicago during the summers of 1904, 1905 and 1906. He then became acting professor of geology from 1906 to 1908, and professor of geology and assistant State geologist from 1908 to 1909. He next served as director of the Mississippi Geological Survey at Jackson from 1909 to 1924, when the Survey was returned to the University. From 1924 he served as both director and professor of geology until his death on September 12, 1933.

Dr. Lowe was active in a number of scientific societies, civic organizations, and the church. He was a member of the Association of American State Geologists, The American Association of Petroleum Geologists, the Torrey Botanical Club, the National Drainage Congress (State vice-president, 1922), the Southern Water Power Association, the Southern Forestry Congress, the American Association of Soil Survey Workers, the National Economic League, the American Geographical Society, the American Association for the Advancement of Science, the Rotary Club, the Knights of Pythias, and the Methodist Episcopal Church, South.

On November 28, 1895, Dr. Lowe married Sarah M. Yeager of Wauseon, Ohio. To this union two children, Marguerite Emily (Mrs. Paul Warren Bucks), and Edmund Peyton, were born. Mrs. Lowe died on March 21, 1898. On May 14, 1903, Dr. Lowe married Laura Edna Haley of Utica, Mississippi, to whom was born a daughter, Edna May, now deceased. He is survived by Mrs. Lowe and the two children. The body was laid to rest in Old Bear Creek Cemetery, near Utica, the home of the Lowes for several generations.

As in the beginning, so in the end: the World is poorer in the passing of a man; Heaven is richer in the gaining of a soul.

AN ADDRESS

RECOGNITION DINNER HONORING DR. WILLIAM C. MORSE, AND MR. FRANKLIN E. VESTAL, SENIOR GEOLOGIST ALUMNI BUILDING, UNIVERSITY OF MISSISSIPPI

MAY 9, 1958

FREDERIC F. MELLEN
Consulting Geologist

Within the last two years there have passed by me, with great celerity, many milestones of human experience. As these markers flash by I am increasingly impressed with the insignificance of the individual, with the inability of Man to control the passage of time, and with the importance of each one of us developing habits of application to our respective jobs, devotion to our Society, and appreciation of the contributions of other individuals who have toiled for the enrichment of the life of Mankind.

Tonight, we are here to honor two outstanding geological scientists on the eve of their so-called retirement from service to Mississippi, to the South, and to the Nation. It has been my great pleasure to have known Professor Franklin E. Vestal and Dr. William C. Morse for nearly forty years. They both began their professional lives in Mississippi at Agricultural and Mechical College, where, in the instruction of Mississippi students, they laid the ground-work for much of the geological development of the State. Each in his own capacities, and as a team, has made timely and frequent contributions to the geological knowledge of Mississippi.

In the nearly twenty-four years of the present Directorship of the Mississippi Geological Survey detailed mineral surveys have been completed on a great many of the counties of the State, and numerous special and general geological bulletins have been issued. During this period, in large part because of the administration of the Geological Survey, the annual value of the State's mineral production increased from less than $4,000,000 to over $132,000,000, or about 35 times. In oil production we rank 9th in the Nation. In other fields we are showing distinct, though less spectacular, advancement.

Figure 8.—State Geologist Dr. William C. Morse, in his 84th year; Senior Geologist Franklin E. Vestal; University of Mississippi Chancellor Dr. John D. Williams, photographed at the testimonial banquet May 9, 1958, honoring the two geologists on their retirement from the Mississippi Geological Survey. University News Bureau photo.

I have been asked to comment briefly upon the outlook for further economic growth of our minerals.

Our water supply, our greatest mineral resource of all time, to which we do not assign a dollar value, must be protected as much as possible from surface and subsurface pollution. In my opinion, Mississippi is probably the best watered area of its size on the face of the Earth. In time, quality-of-water studies will locate solutions suitable for commercial extraction of chemicals.

Development of non-fuels, iron ores, cement, agricultural lime, bleaching and bonding clays, raw clays and clay products of all types, sand and gravel, light-weight concrete aggregate and other items can be expected to continue in varying degrees.

The ultimate extraction of aluminum from our aluminous clays and bauxites may come about in a few decades. Perhaps in shorter time we will see the manufacture of rock wool for insulation, the development of our thick lignite deposits for pigments and chemicals, and the development of our salt domes for salt and chemical derivatives. Many varied industries can be established upon the raw materials we now know, and their development will be expedited by the widespread availability of natural gas, fuel oil and electricity as sources of power.

In thinking against the probably foreseeable time when oil and natural gas will decline as important fuels, studies of outcrop and well samples for uranium salts might reveal sources of that important mineral. The extensive literature on uranium exploration and exploitation that is appearing in other parts of the Nation and the World is giving clues as to where we might expect concentrations of uranium salts. In our own State there are Gamma Ray-Neutron logs which show strata of exceptional radioactivity, but the importance of these, if any, must await long and careful study before realization.

In the production of oil and gas we can consider that only the surface has been scratched. In 1930 a 5,000-foot well was a deep one, as was a 10,000-foot well in 1940, but, as 1960 approaches 15,000- and 20,000-foot wells are commonplace. Deeper and more widespread drilling, even when dry holes result, add to the accumulation of subsurface structural and stratigraphic geological knowledge when properly studied and evaluated. Such information, when intelligently used in conjunction with other geological and geophysical information, inevitably leads to discovery of new oil and gas deposits.

Only a relatively small percentage of Mississippi's 50,000 feet, more or less, of sedimentary rocks crops out at the surface. Most of our stratigraphic succession of rocks is known only from subsurface drilling which, in addition to revealing new formations, reveals the complex structure of the tectonic framework of the State.

If the Earth were compared morphologically with a tremendous animal, Mississippi might be likened to a portion of the chest of that great beast, because it is divided in three major structural basins separated by three elongated basin rims sep-

arating the Paleozoic, the Mesozoic and the Tertiary basins from one another. The basin rims may be likened to the ribs and the basins to the soft fleshy depressions between the ribs. Our three basins, the Black Warrior Basin, the Mississippi Interior Salt Basin, and the Miocene Basin, together with their rim areas, have not been explored equally for oil and gas. Even the most developed areas of the Interior Salt Basin fall far short, perhaps, of their ultimate economic development. Great structures remain to be found or to be defined better, and stratigraphic traps will, in time, be worked out in all parts of Mississippi.

Nowhere in Mississippi has "Basement" rock been penetrated. At the present time, it cannot be said that any County of our Commonwealth has been "condemned" as having no prospects for oil or gas. Indeed, to the contrary, Mississippi has a good chance of ultimately producing oil and gas in paying quantities from a greater percentage of its Counties than any State in the Nation. Complex structure and diverse stratigraphy produce anomalous conditions which, until proved otherwise by drilling, can easily harbor those two elusive and fugacious resources, petroleum and natural gas.

To Dr. Morse and Professor Vestal, both of whom have always been perfectionists in their presentation of scientific truths, I want to commend the meticulous work of Lord Tennyson for his intimate understanding of nature and power of expression. He, too, realized the transitory nature of geologic history and the illimitable scope of earth's processes.

There rolls the deep where grew the tree.
O earth, what changes hast thou seen!
There where the long street roars, hath been
The stillness of the central sea.
The hills are shadows, and they flow
From form to form, and nothing stands;
They melt like mist, the solid lands,
Like clouds they shape themselves and go.

[In Memoriam A. H. H., CXXII, 1-8]

MEMORIAL TO WILLIAM CLIFFORD MORSE

(1874 - 1962)

FRANKLIN E. VESTAL[1]

Dr. William Clifford Morse, widely known geologist, died March 2, 1962, in his eighty-eighth year.

William Clifford Morse was born on a farm near Starr, Hocking County, Ohio, October 28, 1874, the son of James and Jennie Brown Morse. The family name was a familiar one in the County; William's great-grandfather had come there from Warren, Litchfield County, Connecticut, in 1818, bringing with him his wife and children and his mother. The last leg of their journey was by ox cart. Upon arriving in the promised land, they found it necessary literally to carve their new home out of the wilderness. Their first completed dwelling was of round logs.

James Morse served in the federal army in the Civil War. He returned from the war to a rather poor hill farm, where William Clifford was born. The mother's people migrated to Hocking County from Clarion County, Pennsylvania. Both parents were of that God-fearing, sturdy, self-reliant pioneer stock which conquered the wilderness. The son spent his boyhood on the Hocking County farm, receiving from it and from his strong-willed father and devoted mother a training which was of great value to him through a long life. Difficulties did not discourage either of them; on the contrary, they were a challenge. This mental attitude was reflected many years later in one of Doctor Morse's remarks: "Whenever I hear anybody say a thing can't be done, right away I want to go ahead and do it."

William attended the public schools of his neighborhood and a school referred to as a "normal" school, and he later was a student at Ohio University, Athens, Ohio, for a year. Also, during these early years he studied telegraphy and was telegraph operator at Wellston, Ohio, for a few years. In 1896 he married Miss Martha Rarick and some time later moved to Columbus, where he enrolled in Ohio State University (1902). That he was an outstanding student was attested by his rapid progress. Following his receiving the A.B. degree (1906) he was awarded a fellow-

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Figure 9.—State Geologist William C. Morse in May, 1948. At this time he was serving, also, half-time as Chairman of the Department of Geology at the University.

ship in Zoology, and in 1907-1908 he was a fellow and assistant in the Department of Geology. He was granted the A.M. in 1908. During the next 5 years he was Instructor in Geology at his Alma Mater; in the summer of 1911 he was University Scholar in Geology at The University of Chicago and was in residence at Chicago for the 1913-1914 session. Late in 1914 he went to Washington University in St. Louis as Instructor in Geology. He was promoted to Assistant Professor July 1, 1916, a position which he held until his resignation April 25, 1918, to accept the chairmanship of the Department of Geology of Mississippi Agricultural and Mechanical College (now Mississippi State University). He was identified with Mississippi Geology for the remainder of his life.

During the 1926-1927 session Doctor Morse was in residence at Massachusetts Institute of Technology, where he received the Ph.D. in 1927. In 1930-1931 he was visiting professor at the University of North Carolina. In 1934 he was appointed Director of the Mississippi State Geological Survey and Chairman of the Department of Geology of the University of Mississippi at Oxford, Mississippi. He held the position of Director of the Survey and State Geologist until his retirement June 30, 1958. During the summer of 1937 he was Honorary Fellow at Ohio State.

Doctor Morse was an earnest and forceful teacher. Emphasizing fundamentals, he insisted that his students master them. Always ready to help them overcome real difficulties, he impressed upon them the necessity of thinking for themselves. Many of them chose geology as a profession, and he followed their careers with unflagging interest and showed great satisfaction with their accomplishments.

Doctor Morse's record of field work is impressive. He was assistant geologist for the geological surveys of Ohio and Kentucky and for the Ohio Academy of Science during the summers 1907 through 1910, and geologist for the State Highway Department of Ohio, 1912-1913. He was engaged in oil and gas exploration for the Illinois Geological Survey through the second half of 1914 and the summer of 1915; he made a survey of oil structures in Kansas, Illinois, and Missouri during the summers of 1916 and 1917 and was consulting geologist for several oil companies in Ohio, Illinois, Missouri, Oklahoma, Texas, Louisiana, and Mississippi from 1914 to 1934. The summers of 1919-1921 were devoted to work for the Kentucky and Mississippi geological surveys, and

in 1926 he completed his field study of the Paleozoic rocks of Mississippi for the Mississippi Geological Survey, a study which served as the subject of his doctor's dissertation.

However, Doctor Morse did not permit his obligations as teacher, consulting geologist, and Director of the State survey to cancel his study of geologic literature and the urge to see for himself the geological features of the North American continent. During several summers from 1922 to 1937 inclusive, he traveled widely in the United States and Canada, especially east of the Mississippi River, and later made two trips to Mexico. These travels afforded him opportunity to indulge his passion for collecting fossils and mineral and rock specimens; he accumulated a large collection, which he exhibited and used freely in his teaching and research. He was equally interested in assembling geological literature; his private library was one of the most extensive among the libraries of men of his profession.

During the 24 years of Doctor Morse's directorship, the Mississippi State Geological Survey made greater progress toward the acquisition of complete data on the State's geology and mineral resources than it had made through the previous 84 years of its existence. By cosponsoring federal works projects preceding and during World War II the Survey was able to overcome for a few years the handicap of insufficient funds which had plagued it since its beginning. Competent geologists were employed; a county-unit system of field exploration and sampling was inaugurated with the co-operation of the counties; and a ceramics laboratory was equipped and put in operation under the direction of a trained ceramic engineer. Sixteen counties were explored, and a comprehensive report on each was published as a bulletin by the State Survey. Before Doctor Morse's retirement in 1958 nine additional county surveys had been completed and bulletins published. At the time of his retirement the State Survey had published 85 bulletins, of which 60 were issued during his administration. He himself was the author of 11.

The fruits of the work of the State Survey under Doctor Morse's directorship were abundant. The Tinsley dome, from which flowed the first oil produced in Mississippi on a commercial scale, was discovered and described by a Survey geologist, as was the Cranfield dome soon afterward. These discoveries

launched a period of intensive exploration by oil companies which to date has raised Mississippi to ninth place in the United States in the production of oil and gas. This record could with fairness be considered a monument to Doctor Morse's early belief in the state's petroleum potentialities and his enthusiastic promotion of the search for petroleum. Other mineral industries of Mississippi—brick making, Portland cement manufacture, clay mining and processing, rock quarrying, and others—all owe much to him and his staff.

Early in the 1950's Doctor Morse introduced the helicopter as an instrument for use in the work of the Mississippi Geological Survey. Perhaps he was among the first to use this machine for geological exploration.

Doctor Morse had the great good fortune to receive instruction from some of the foremost geologists of America: Prosser, Chamberlin, Salisbury, Weller, Shimer, and Lindgren, and others of their contemporaries. From them he learned the true scientific attitude, without which research is futile, its results unreliable—the importance of painstaking study and absolute accuracy. Throughout his life his studies of geology and related sciences, whether in the field, in the laboratory, or in the library, were distinguished by meticulous care, attention to detail, and unremitting effort to be correct.

Doctor Morse had been deeply impressed by the great leaders under whom he had received his training. Naturally, the science of geology as interpreted and expounded by them served as the basis of his teaching. He was essentially conservative: always ready to hear anything new, but never the first to accept it unreservedly, especially if it questioned or opposed the views of the distinguished men of the science. He followed the reasoning which led to the announced conclusion in each and every case and evaluated it himself. In every case he asked for the evidence; to him speculation and hypotheses were idle unless they were logical outgrowths of logical interpretation of tangible things.

Doctor Morse was one of the transition-period group of scientists—from the period of broad scientific attainments to that of hair-splitting specialization. And he was of the old school. He was interested in every branch of science, although Geology was his specialty. To him the larger features, the general prin-

ciples, were the important things, and he discounted research that to his mind had little or no bearing on them. He had little patience with minutiae that seemed to him to lead to nothing of consequence—"research" that accumulated data which had no particular significance. In a word, he was more a "lumper" than a "splitter." He certainly was not one of those "specialists" who cannot see the forest for the trees.

He was, first of all, a field man. Although he would have been the last to ignore or underrate the work of other geologists, his guiding principle was, "See for yourself, whenever possible." He constantly impressed upon his students the importance of field observations. Several local field trips were required as part of all courses in Geology, and in 1922 he initiated extended summer field trips for advanced students at Mississippi A. & M., thus giving them the opportunity to get at least a glimpse of the topography and geology of a large part of the United States, particularly of central and eastern regions with which so much published geological literature is concerned.

Perhaps Doctor Morse's most outstanding characteristic was his indefatigable industry. He quoted convincingly, "Rest is not quitting the busy career." "Business before pleasure" was for him a guiding principle; in fact, practicing his profession was his main pleasure, as is testified to by the record of his activities. The dates alone of his many publications point to almost constant activity in his chosen field.

Although essentially a "practical" man, Doctor Morse had a strong feeling for the wonder and beauty of Nature. He was even guilty of quoting poetry now and then in his classes, being especially fond of the passage from Tennyson beginning

> "The hills are shadows, and they flow
> From form to form, and nothing stands."

And albeit he was not lacking in self-confidence, he recognized his limitations. At the beginning of a textbook manuscript on which he was working he had placed the lines from Shakespeare: "In Nature's infinite book of secrecy a little I can read."

Doctor Morse prized association with other scientists. He was a Fellow of Sigma Xi, of the Ohio Academy of Science, the American Association for the Advancement of Science, and of

The Geological Society of America; member of the Paleontological Society, The American Association of Petroleum Geologists, The American Association of State Geologists, the Mississippi Geological Society, and the Mississippi Academy of Sciences. He is listed in several editions of American Men of Science.

The death in 1929 of his only child, Paul Franklin Morse, who had made a name for himself in Geology, was a blow from which Doctor Morse never completely recovered. Some years later he was further saddened by the death of his wife. In 1951 he married Miss Dorothea Bignell, who survives him. And as he had lived the first few years of his life on the farm, so he lived happily his last few years, within a few miles of the center of the full flowering of his scientific labors, of the church he loved and served, and of the homes of his many friends.

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EMPLOYMENT IN THE MINING INDUSTRY IN MISSISSIPPI

WILLIAM T. HANKINS*

ABSTRACT

Mississippi is not commonly thought of as being a mining state. Nevertheless, mining in Mississippi is a small but thriving industry. The production of petroleum and natural gas comprises the major part of the industry, but the State also has many open pits and quarries that produce "hard minerals" such as sand and gravel, limestone, and clay.

In 1939, there reportedly were only 800 people employed in the mining industry. Since then employment has shown steady over-all gains, and by 1962 there were 6,400 people employed. Annual wages totaled $644,000 in 1939 and $35,446,000 in 1962. In 1930, about one-third of the total employment was in natural gas production and two-thirds in other mines and quarries. By 1940, these proportions had reversed and in 1960 more than five-sixths of those employed were in petroleum and natural gas production.

Manufacturing industries that use or that possibly could use the State's raw mineral substances in their operation have also shown substantial gains in employment over the past decade.

Wages of workers in the mining industry have increased more than fifty-three times from 1939 to 1962 or seven times as fast as employment. The average worker in mining and related industries earns more than the average worker in the State.

Mississippi is not thought of commonly as a state in which there are many mines. Mississippi has no gold or copper mines and no commercial coal or iron mines, yet mining is a small but thriving industry in the State. This report concerns employment in the mining industries and in the manufacturing industries which process the products from the mines. Mention is also made of the wages accruing to the employees of the establishments which operate in these industries. From the standpoint of the number of employees, petroleum and natural gas products comprise the major part of mining in the State. The State also has a number of sand and gravel quarries or pits which furnish raw material for construction and plants which crush limestone for agricultural uses or for the manufacture of cement and which

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make brick and ceramic tile from clay as well as process clay for other industrial uses.

Even though bricks have been manufactured and sand and gravel has been mined in the State for a long time, the mining industry has experienced its most rapid growth in comparatively recent years. The discovery of natural gas in northeast Mississippi in 1926 and at Jackson in 1930 and the drilling of the first producing oil well in Yazoo County in 1939, when combined with the establishment of plants which manufacture glass bottles, turn limestone into cement and clay into ceramic tile, and make catalysts for industrial uses, caused employment in the industry to double and redouble.

According to the Bureau of Census, in 1930 only 800 people were employed in "Mining" (Standard Industrial Classification 13, petroleum and gas production, and 14, other mines—sand and gravel, etc.) in Mississippi. By 1940, employment had increased to over 1,900; by 1950, it was 3,600; and in 1960, it was more than 5,600. In 1930, about one-third of total employment was in oil and gas production and two-thirds in other mines and quarries. By 1940, the proportions were reversed and by 1960 more than five-sixths of those employed in this industry were in petroleum and gas production.

Table 1 shows the growth of employment in the industry from 1939 to 1962. Two sets of employment figures are shown in this table. The first, total employment, is an estimate prepared by the Mississippi Employment Security Commission in cooperation with the Bureau of Labor Statistics. The other, covered employment, is based on reports submitted by employers who pay unemployment taxes to the Employment Security Commission. The figures in the second column are smaller than those in the first inasmuch as employers who hire fewer than four people regularly are not covered by the Law. A part of the increase from 1957 to 1958 resulted from changes in industrial classification. The slight drop in employment since 1960 is a part of an industry-wide decline in the petroleum production industry.

Table 1.

Average Annual Total Employment, Annual Average Employment Covered by the Mississippi Employment Security Law, Total Wages in Employment Covered by the Law Mining, 1939 - 1962

Year	Total Employment*	Covered Employment	Total Annual Wage**
1939	800	691	$ 644,000
1940	1,900	1,534	2,007,000
1941	2,000	1,748	2,400,000
1942	1,700	1,689	2,581,000
1943	1,600	1,489	3,052,000
1944	2,000	1,907	4,801,000
1945	2,900	2,633	7,360,000
1946	2,900	2,630	7,253,000
1947	4,200	3,818	11,481,000
1948	3,600	3,327	10,977,000
1949	3,000	2,782	9,142,000
1950	2,600	2,407	7,996,000
1951	2,900	2,664	9,543,000
1952	2,800	2,768	10,659,000
1953	3,000	2,897	11,658,000
1954	3,100	2,998	12,576,000
1955	3,500	3,276	14,390,000
1956	4,000	3,737	16,756,000
1957	5,300	4,558	21,246,000
1958	5,600	5,424	27,524,000
1959	6,700	6,501	34,225,000
1960	6,700	6,464	34,829,000
1961	6,300	6,239	34,067,000
1962	6,400	6,224	35,446,000

What turn will employment in this industry take in the future? The next thirty years may or may not show the same percentage gain as the past thirty years has. The trend will depend on what new petroleum reserves are discovered and on the extent of the exploitation of the clays and other "hard minerals" which abound in the State.

Sources: *Payroll Progress in Miss., 1939-1959, Mississippi Employment Security Commission, 1963, and Mississippi Labor Market, a publication of the Mississippi Employment Security Commission, March, 1961, 1962, and 1963.

**Jobs, a publication of the Mississippi Employment Security Commission, Fourth Quarter, 1960, and Third Quarter, 1961 and 1962.

One of the manufacturing industries which processes the products of the State's mines is classed as "Petroleum Refining and Related Industries" (SIC 29). Employment in this industry, which is covered by the Employment Security Law, is shown in Table 2. The increase from an average of 73 in 1946 to 614 in 1962 is an eight-fold one. No comment about the trend of the future of this industry is needed other than to say that a large establishment on the Gulf Coast began refining oil in the late summer of 1963.* A sizeable increase in employment in this industry seems assured.

Table 2.

Average Employment Covered by the Mississippi Employment Security Law and Total Wages in Employment Covered by the Law

Petroleum Refining and Related Industries, 1946-1962

Year	Employment	Total Wages
1946	73	$ 181,033
1947	95	291,828
1948	122	429,869
1949	149	498,296
1950	148	517,909
1951	144	505,439
1952	264	1,002,870
1953	280	1,134,974
1954	289	1,195,611
1955	230	972,680
1956	264	1,022,327
1957	418	1,654,302
1958	443	2,277,995
1959	499	2,649,648
1960	511	2,806,223
1961	580	3,217,524
1962	614	3,446,129

Source: Jobs, a publication of the Mississippi Employment Security Commission, Fourth Quarter, 1960, and Third Quarters, 1962 and 1963.

The other manufacturing industry which processes products of the mines is classed as "Stone, Clay, and Glass Products"

*"Construction of the $125 million Standard Oil Co. of Kentucky refinery near Pascagoula proceeded ahead of schedule and will eventually provide employment for approximately 350 persons. Several units will go on stream in July 1963." The Mineral Industry of Mississippi in 1962, U. S. Bureau of Mines.

(SIC 32). Among the types of plants in this industry which operate in the State are those which make brick and tile, refractory brick, glass bottles, ceramic tile, cement, ready-mix concrete, and others which process clay for industrial uses. Table 3 traces the employment growth in this industry, both total and that covered by the Employment Security Law. Although the growth is not as great percentagewise as in petroleum refining, it has been steady and total employment has more than doubled since 1946. Some of the increase from 1957 to 1958 was caused by the reclassification of ready-mix concrete plants from another industry to this one. Because many of the products of this industry are used in the construction industry and the latter industry apparently will increase in the State, a continued employment increase seems to be foretold.

Table 3.

Average Annual Total Employment, Annual Average Employment Covered by the Mississippi Employment Security Law, Total Wages in Employment Covered by the Law Stone, Clay, and Glass Products, 1946-1962

Year	Total Employment*	Covered Employment**	Total Wages**
1946	INA	1,398	$ 2,754,764
1947	2,100	2,422	4,912,194
1948	2,200	2,415	5,349,134
1949	2,200	1,980	4,638,718
1950	2,300	2,262	5,567,109
1951	2,700	2,471	6,720,373
1952	2,800	2,611	7,557,155
1953	2,700	2,620	7,987,128
1954	2,700	2,673	8,705,169
1955	2,900	2,818	9,554,781
1956	3,500	3,190	11,516,065
1957	3,800	3,219	12,208,306
1958	4,100	3,968	14,943,319
1959	4,700	4,463	17,496,680
1960	4,700	4,494	18,275,854
1961	4,800	4,708	19,891,501
1962	4,900	4,777	20,803,939

Sources: *Payroll Progress in Mississippi, 1939-1959, Mississippi Employment Security Commission, 1963, and Mississippi Labor Market, a publication of the Mississippi Employment Security Commission, March, 1961, 1962, and 1963.

**Jobs, a publication of the Mississippi Employment Security Commission, Fourth Quarter, 1960, and Third Quarter, 1961, and 1962.

The total 1960 employment of 12,000 in mining and related employment seems small when compared with the State's total work force of more than 700,000. However, employment in these industries has more than doubled from 1950 to 1960. As a percent of the total work force, it has increased by nearly three times. Had it not been for the increased employment in the mining industry, some of the other industries in the State would have undoubtedly decreased employment-wise.

Although this report is primarily concerned with employment, it is appropriate to mention briefly the trends in the amounts of wages received by those working in mining and related industries. Tables, 1, 2, and 3 show the total annual wages paid in employment covered by the Employment Security Law in the three industries discussed. A few comparisons are in order. Covered employment in mining increased by more than seven times from 1939 to 1962, while wages increased more than fifty-three times or seven times as fast as employment. In "Petroleum Refining and Related Industries," the 1962 employment was more than eight times what it had been in 1946. Wages were more than nineteen times what they had been in 1946. In "Stone, Clay, and Glass Products," employment increased more than three times, while wages increased by more than seven times. Even though decrease in the purchasing power of the dollar has reduced the value of much of these increases, the fact remains that the worker is still able to purchase more with the wages he has earned.

The average worker in the three industries studied in this article earns more than the average worker in the State. Covered employment in the three industries amounted to 4.1 percent of total covered employment in the State, while total wages were 5.8 percent of all wages earned in covered employment in the State during the year 1962.

The amounts of wages shown in Tables 1, 2, and 3 do not include proprietors' income (profits). Table 4 shows the amounts of total civilian income received by persons for participation in production and a breakout showing the amount for participation in mining. These figures include profits as well as wages and salaries. Mining income as a percent of total income is also shown. From 1940 to 1962, income received from mining increased from a little less than one-half of one percent of total income to

more than one and one-half percent of the total income of the State. This, along with other figures quoted earlier in the report, will serve to show the growing importance of mining to Mississippi's economy.

Table 4.

Total Civilian Income Received by Persons for Participation in Production, the Amount Received from Mining and Mining Income as a Percentage of Total Income Mississippi, Selected Years

(Income Figures in Millions of Dollars)

Year	Total Income	Mining Income	Mining Percent of Total
1940	416	2	0.48
1946	969	9	0.93
1948	1,323	17	1.28
1950	1,254	12	0.96
1955	1,661	19	1.14
1958	1,799	31	1.72
1959	2,023	38	1.88
1960	2,033	37	1.82
1961	2,134	35	1.64
1962	2,263	35	1.55

Source: Personal Income by States Since 1929, U. S. Department of Commerce, 1956 and Survey of Current Business, a publication of the Department of Commerce—August issues of 1959-1963.

THE PRESENT COURSE OF THE MISSISSIPPI GEOLOGICAL SURVEY

FREDERIC F. MELLEN[1]

WILLIAM S. PARKS[2]

ABSTRACT

The Mississippi Geological Survey was created by act of the Mississippi Legislature in 1850 and is one of the oldest Geological Surveys in the Nation. During its history it has had a great many capable and renowned geological scientists and these men have been responsible for developing the background information upon which the present-day mineral economy of Mississippi is built.

Many of the Survey's publications have contributed directly to the establishment of successful mineral industries. These include those whose products are: sand and gravel, light-weight aggregate, oil and gas, brick and tile, agricultural lime, Portland cement, building stone, raw and processed clays and others. The geological research and publications of the results and the distribution of the 99 Bulletins heretofore published have been responsible, to a large extent, for the phenominal growth of the mineral economy of Mississippi, over 10,000 percent in the past 30 years, and now, for the eleventh consecutive year, showing an all-time high, well over $200 million, now placing Mississippi 21st State in the Nation.

The accomplishments of the Survey in the fields of fuels and nonfuels and water development are reviewed and a program of expanded activity is recommended.

Analytical studies of the Survey and its services, both objective and subjective in nature, have been conducted, and the results are presented in a number of maps, charts, tables, and in discussion.

The Mississippi Geological Survey concludes that greater appropriations for its research activities will pay handsome dividends to the State. It points with pride to the fact that appropriations to date, although totalling only $1,100,000 in the 58 years, 1906-1964, have played an important role in minerals development which in the same period have yielded a valuation of $2,400,000,000, or a ratio of $2,182 for each appropriated dollar. It is also concluded that additional appropriations, permitting accelerated geotechnic research, will aid in the continued phenominal growth in annual minerals production of Mississippi.

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INTRODUCTION

The Mississippi Geological Survey was created by an act of the Legislature in 1850 and is, therefore, one of the oldest State Geological Surveys in the Nation. It came into being 29 years before even the U. S. Geological Survey was created. By the outbreak of the Civil War it had prepared three voluminous reports on the Agriculture and Geology of the State of Mississippi: the first by Wailes, the second by Harper, and the third by Hilgard. Hilgard's report, although printed in Jackson in 1860 had been shipped to St. Louis for binding, and this was accomplished after the Civil War in 1865. These three books are not uncommon in private and public libraries, and the Mississippi Geological Survey still has for sale a few copies of the Hilgard Report, the outstanding one of the three, a book to which frequent reference is made by present-day geologists, agriculturalists, and laymen.

Mississippi was a wealthy State in the days prior to the Civil War, and her people derived their wealth chiefly from agriculture and commerce. They were progressive in their thinking, and established educational institutions to which they brought well-qualified and renowned educators from Europe and elsewhere. They also instituted through the Mississippi Geological Survey research into the relation of the geological bedrock formations to the soils which these sediments produced—soils which, in turn, yielded the products from which Mississippi's wealth was derived. In the work of Hilgard and his associates, prior to, during, and after the Civil War, agricultural geology took shape and assumed new importance: Mississippi's work, through Hilgard's genius, was, and still is, recognized World-wide.

In these early days of Mississippi the State Geologists worked closely with the people about the State and, notably, with the water well drillers from whom they secured a great deal of their information, information which has been, and is being, used continuously and increasingly, in development of geological knowledge of the State. In those days there were no wells drilled for oil or gas and it was exceedingly rare that any hole was dug, bored or drilled for any reason other than to supply water.

The Survey now presents its Bulletin 100, *The Mississippi Geological Survey, A Centennial.* In this volume there appears a posthumous title of Dr. E. N. Lowe covering the history of the

Survey from 1850 to 1906. After the Civil War the Survey became a casualty of Reconstruction, and by 1872, on Hilgard's resignation, the Survey ceased to exist for a period of 34 years. During this period 1872-1906, few geological publications appeared on Mississippi. Most of these were published by Mississippi Agricultural & Mechanical College (Mississippi State University) and by the U. S. Geological Survey.

In 1906 the Legislature recreated the Mississippi Geological Survey and the *ex-officio* 5-member Board selected Dr. A. F. Crider as Director and State Geologist. Crider served for 3 years and was succeeded by E. N. Lowe. Dr. Lowe served as Director of the Survey and State Geologist for 24 years (June 4, 1909, until September 12, 1933), and he, in turn, was succeeded by Dr. W. C. Morse who served as State Geologist for another 24 year period (September 1, 1934, until June 30, 1958). During the 52 years of the new Survey, 85 bulletins were published, 60 of which appeared in Dr. Morse's administration.

For some years, since the middle of World War II, to be exact, the activity of the Survey began to slow for various reasons. The facilities continued to grow, although Legislative support did not increase as rapidly as it should have.

In 1957 a bill was drafted to abolish the Survey. However, during the 1958 Legislative session after lengthy conferences between Members of the Legislature, Geology Department Heads of Millsaps, Mississippi State and the University, a number of Oil Company and consulting geologists, and some interested citizens, the author of the bill-to-abolish agreed to be an author of a bill-to-recreate. Thus came about the enactment of Senate Bill 2012, Laws of 1958, *An Act to Establish a Geological, Economic and Topographical Survey, etc.* The chief change in the Survey law was the abolition of a non-meeting *ex-officio* Board and the creation of a Board that would meet, a Board working more closely with the people of the State and more directly interested in the progress of the Survey, a staggered term Board composed of two professional geologists, a licensed practicing civil engineer and two businessmen. The Board receives a monthly report from the State Geologist, meets quarterly (or more often, as needed), is available for discussion of Survey business if necessary, and its members receive the munificent stipend of $20.00 per day when actually meeting. The Director and State

Geologist serves at the pleasure of this Board; and, without duress it may be said, the Board has been an outstanding, judicious and ethical governing body. The Survey's employees are selected by the Board, but the Director has the authority to discharge any employee. The Director is responsible to the Board, to the Survey Staff and to the Public. He is bound by the codes of Ethics of professional organizations to which he belongs, and he serves under the required oath of office and a fiduciary bond.

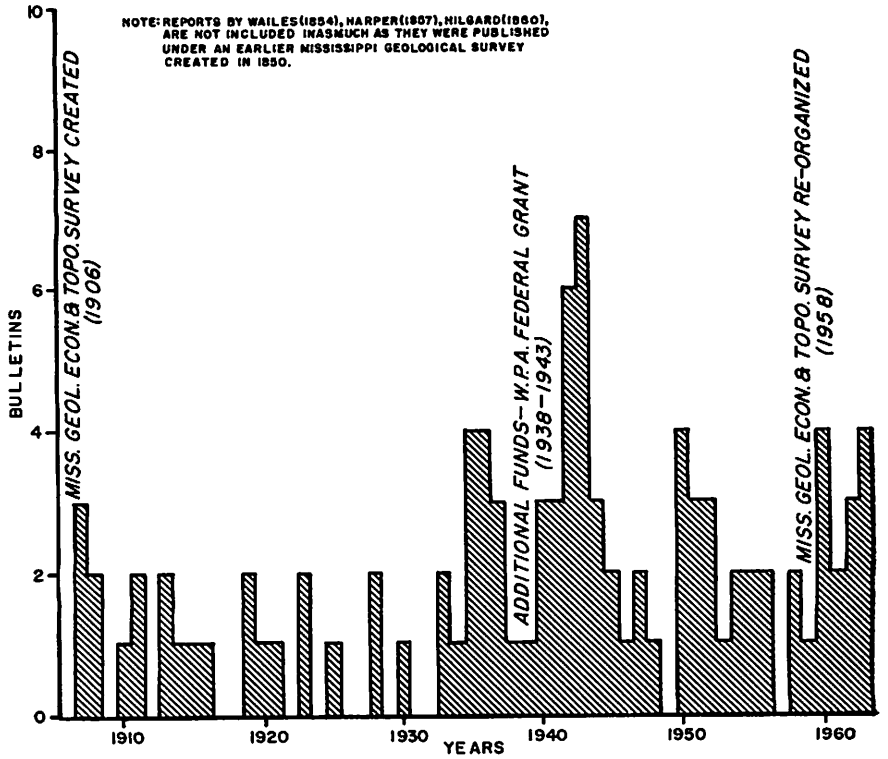

Figure 10.—Publication frequency of bulletins of the Mississippi Geological Economic & Topographical Survey.

In review, 37 bulletins were published under the present Geological Survey from 1907 to 1938. These reports included economic geological investigations on cement and Portland cement materials, brick clays and clay industry, lignite, pottery clays, structural materials, iron ores, marls and limestones, oil and gas prospecting, road-making materials, bauxite deposits, build-

ing stone, and bleaching clays. Up-to-date reports of this type are essential to the mineral industries.

Perhaps the golden era of geological research in Mississippi was between 1938 and 1943 when the Geological Survey had financial assistance provided by Federal grants through the Works Progress Administration. It was during this period that the Survey began a county-by-county mineral resources investigation. With the additional funds provided by the grants, the Survey was able to make detailed mineral resource investigations and to conduct the necessary testing of materials. A total of 15 counties were surveyed under this program. In addition, 5 other reports, 3 of regional and 2 of local aspect, were published during this period (Figure 10).

Since the closing of the WPA and thus the termination of Federal support, the Geological Survey has forged along on its limited State appropriations. From 1943 through 1958, the Survey published 28 bulletins of varied interest to the minerals industries. Ten of these are county reports, but only two of these included sections on testing of materials. This was the result of inadequate funds with which to provide the necessary personnel and to maintain facilities for a testing laboratory. The need for testing facilities is extremely important not only for work on county-type reports but also for the furtherance of the economic geological studies of particular mineral resources.

Since the reorganization of the Survey by the Legislature in 1958 the new Board has been of great assistance to the Director in efforts to obtain support for an accelerated minerals resource investigation program. Fourteen bulletins have been published under this Board, bringing the total number to 99. In addition to Bulletin 100, others are in various stages of preparation.

THE SURVEY'S ROLE IN OUR MINERAL ECONOMY

To illustrate the influence the Survey has had in the mineral economy in terms of tangible returns some of the highlights of the Survey's work in relationship to the establishment or advancement of the minerals industries in the State are reviewed. It must be remembered, however, that normally many months or even years may elapse from the publication of data to its initial utilization by industry.

Bulletin 22, "A Preliminary Report on Bentonite in Mississippi," Bulletin 22a, "A Supplementary Report on Bentonite in Mississippi," and Bulletin 29, "A Preliminary Report on Bleaching Clays of Mississippi," stimulated interest in Mississippi's bentonite and provided basic information that led to its development. At present there are three companies processing Mississippi bentonite, two operating mines in the Itawamba-Monroe County area and one operating mines in both Monroe and Smith Counties.

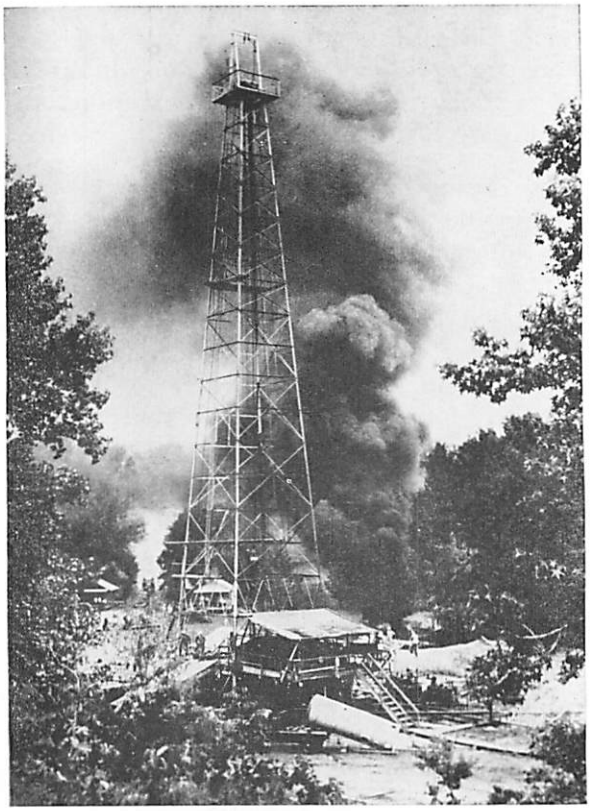

Figure 11.—Union Producing Company's No. 1 Green C. Woodruff, discovery well of Tinsley Field, Yazoo County, Mississippi's first commercial oil well, discovered as a direct result of the Mississippi Geological Survey's mineral resource investigation of Yazoo County. Photo by Union Producing Company, September 1939.

Bulletin 23, "Paleozoic Rocks," and Bulletin 26, "The Highland Church Sandstone," stressed the importance of an excellent building sandstone in Tishomingo County. A quarry has produced

this beautiful stone for many years, and the subsurface oil and gas possibilities pointed out in this report have become reality downdip in Mississippi's Black Warrior Basin.

Bulletin 36, "The Jackson Gas Field and the State Deep Test," gave a history of the Jackson Gas Field and basic data concerning this gas field. This report provided much of the information necessary for the later conversion of a portion of the field into an underground gas storage system.

Information through public release prior to the publication of Bulletin 39, "Yazoo County Mineral Resources," led to the drilling of the G. C. Woodruff No. 1, the discovery well of the Tinsley Field, the first commercial oil production in Mississippi (Figure 11). This discovery has had more profound and lasting effect upon the economy of the State than any other single accomplishment. Up until the discovery of Tinsley, Mississippi was virtually unexplored and untested so far as its oil and gas possibilities were concerned. The "oil boom" that followed the Tinsley discovery has led to the discovery of many other fields and the incentive for exploration has been continuous and expanding.

Bulletin 39, "Yazoo County Mineral Resources," and Bulletin 49, "Scott County Mineral Resources," gave essential data on the ceramic properties of the Yazoo clay. This basic work led to the later establishment of a lightweight aggregate plant in Hinds County using Yazoo clay as raw material.

Bulletin 42, "Tippah County Mineral Resources," and Bulletin 61, "Light-Weight Aggregate," supplied the basic data for the establishment of two plants in Tippah County producing a fired granular aggregate used extensively as an industrial absorbent.

Bulletin 43, "Warren County Mineral Resources," provided the basic data which eventually played an important part in the establishment of two cement plants, one in Warren County and one in Rankin County.

Bulletin 46, "Mississippi Agricultural Limestone," stressed the value of liming acid soils and provided information concerning limestones suitable for agricultural use. There are presently three quarries producing agricultural limestone in Mississippi,

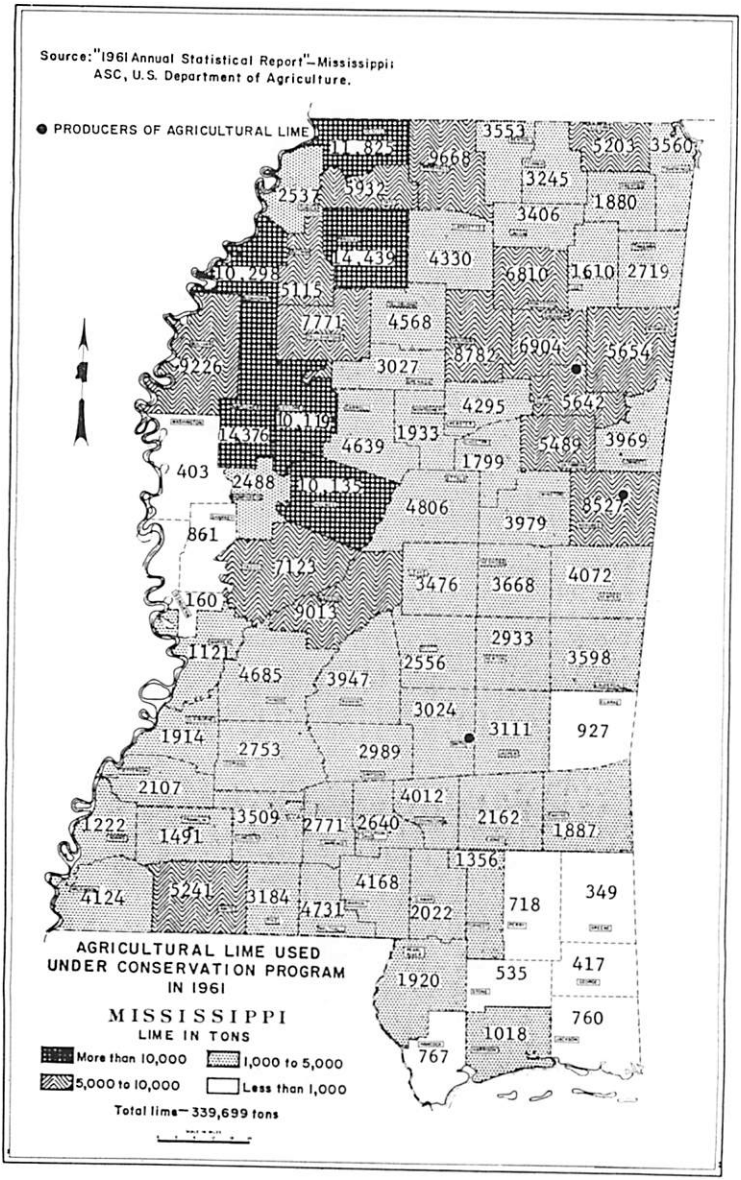

Figure 12.—Agricultural lime used in the Counties of Mississippi under the ASC Program in 1961.

each of which was established subsequently to Bulletin 46 (Figures 12 and 13).

Bulletin 79, "Lower Cretaceous Stratigraphy of Mississippi," dealt with potential deep oil and gas horizons in Mississippi which, at the time the report was published, were coming of great interest as drilling objectives. The publication of that report has been referred to by persons in the oil and gas industry as the "most timely report the Survey ever published." A period of intensive exploration and important discoveries followed immediately after the publication of Bulletin 79, and it was then in especially great demand by geologists.

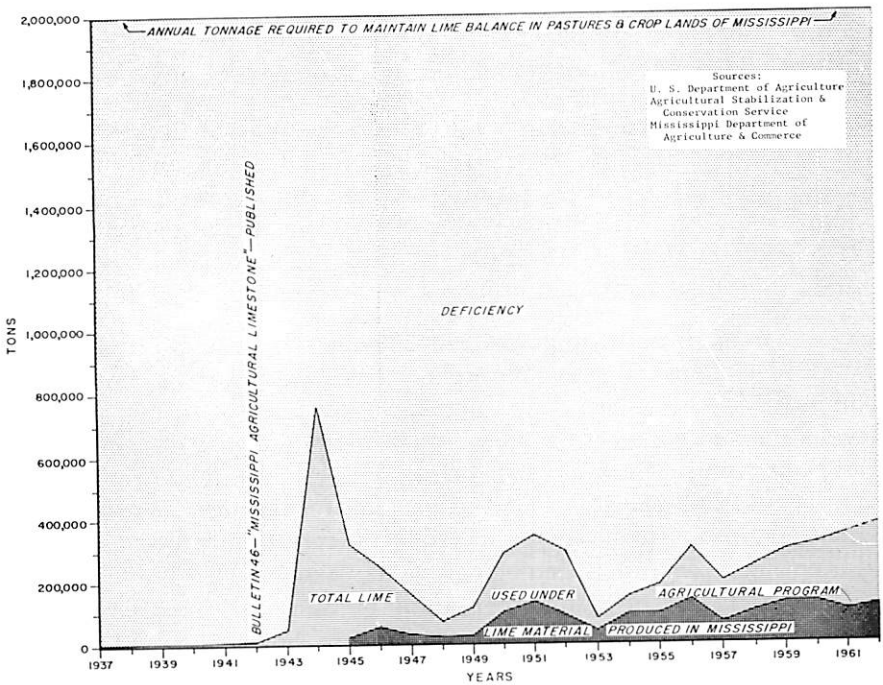

Figure 13.—The publication of Mississippi Geological Survey Bulletin 46, "Mississippi Agricultural Limestone" played a part in the increased usage of agricultural lime by farmers of Mississippi.

Other than oil and gas, Mississippi has large mineral deposits worthy of development, which, once they are developed, will be an enormous source of revenue. The most important of these are a variety of non-metallic rocks and minerals. Most of these

non-metallic substances are more or less commonplace materials such as clay, sand, limestone, etc. Their value is determined largely by the demand for products made from a particular material rather than a general demand for the raw material itself.

Geotechnic research is needed in order to determine the potential uses for which our great variety of non-metallic materials are best suited. With such basic information it will be possible to attract the attention of the various minerals industries or show need for the establishment of our own minerals industries. There are probably numerous cases where Mississippians are using mineral products made outside the State that could be manufactured profitably in the State at a lower cost to the local consumer. Such industries, when established within the State, would afford additional employment and additional revenue.

The water supplies of the State are one of its greatest industrial attractions. In the field of ground water and surface water studies the Survey was for years solely responsible. In an address to the Mississippi Water Well Contractors Association at Edgewater Park on November 16, 1963, the State Geologist outlined the Survey's role in ground water development as follows:

"We have a drilling rig and 500 feet of drill pipe, and a Widco electrical logger. We do not drill water wells, but frequently, when we are called upon, log, or attempt to log, water wells for you contractors. Our rig is for the purpose of sampling and obtaining other data for the study of mineral resources and for stratigraphical study of the various formations. We would like very much to have our rig running continually because we cannot get too much geological data. We have had excellent cooperation in the supplementation of our well records with contributions of logs of hundreds of core holes from oil companies, individuals, and the Ground Water Division of the U. S. Geological Survey.

"In the process of working up the geology and mineral resources of a county, we secure first all available data. These are placed on a map and from this can be determined where and how deep we need to drill with our rig. The more useful data that is contributed to us, the cheaper will be the cost of our survey work to the State and the more efficient our results will be.

"In the more than 100 bulletins of the Survey, totalling over 12,000 pages of text, a large percentage of the work deals with ground water, ground water geology and surface water. Forty-three bulletins contain information on water resources. Twenty-six of these contain sections on ground water resources in county or area studies. Eight deal exclusively with water resources of specific areas. One is devoted to surface waters of the State giving complete data on the drainage basins. These reports are replete with data on aquifer depths, thicknesses, hydrological characteristics, water analyses and other useful information. Twelve of the 43 bulletins discuss surface waters to varying degrees of completeness, and 3 of these contain detailed information on stream flow, run-off, etc.

"Ground-water and geology are inalienable. The Legislature wisely required the Mississippi Geological Survey to catalogue and map the geological features of the State. When properly recorded, these findings often assume unsuspected significances. Hilgard, for example, described the Jackson Dome as an uplift many years before it was known that anticlines were favorable for the entrapment of oil and gas; at the same time he described Mississippi bauxite long before bauxite was known to be the principal ore of aluminum. Accurate scientific recording is economically valuable in the hands of specialists. Two of our recent publications attracted the attention of the U. S. Geological Survey in a manner least expected when a staff geologist in Washington wrote us: 'In this report I found two references of great interest in connection with a compilation I have been making on the geologic processes that contribute to ground-surface movements. These are in the paper on Attala County which contains an explanation for the cave and sinkhole development, and the description of the unusual feature called *dessication sinking* at Clarksdale.'

"The Survey recently completed reports on Attala and Jasper Counties in which there were sections on ground water. We have had numerous fine comments on these reports and we believe that you will find them very useful in making your bids on water wells in those areas. Much of the data used was furnished by various water well contractors, some of our own equip-

ment, but the very great bulk was developed and donated to us by oil companies and independent oil operators—samples and electrical logs on core holes and on oil test wells.

"Electrical logging at its best has serious limitations. It is color blind and it can't tell the size of the sand grains. For these reasons, among others, the Mississippi Geological Survey is very much sample-conscious, for well samples will tell you a great deal about the formations that cannot be determined otherwise.

"We have, at our office at 2525 North West Street, Jackson, the 'Cross-roads of the South', one of the finest Well Sample Libraries in the Nation. In this we catalogue and store cuttings from oil test wells, core holes, water wells, prospect holes, and from our own test drilling. In this same building our files contain thousands of electrical logs, available for use by you or your representative, as are the cuttings and cores.

"In addition to these reference materials, the Mississippi Geological Survey Library, now at the Jackson address, is by far the most complete geological library in Mississippi. Our publications are exchanged with other geological surveys of 45 other states, many foreign countries, many academies of science, and others. We are a depository of the U. S. Bureau of Mines and the U. S. Geological Survey and have a complete set of the U. S. G. S. Bulletins, Professional Papers, Water Supply Papers, and other items. We subscribe to dozens of scientific and trade journals, and purchase reference books and materials in an effort to afford a satisfactory geological research library to the geologist, the engineer, the layman, and the contractor.

"The Survey, as you know by now, does not have any regulatory function. All of its duties outlined previously are research and fact-finding in nature. We are most anxious to serve you within our capacity and we are likewise desirous that you help us increase our capacities by furnishing us with samples—at 10-foot intervals—on your wells, and with your driller's logs and electrical logs when, and if, available. We regard these as open file data, unless otherwise requested.

"With new industry coming into the State new problems arise. Prime contractors often bring or attempt to bring their

sub-contractors with them. Insofar as these matters are concerned the Survey, of course, has no jurisdiction nor does it desire any. We like to see our own citizens prosper and in this connection we require all of our staff to be acquainted with Charles Fulgham's speech on 'Responsibility to Existing Industry,' in which he, as Executive Secretary of the Mississippi Manufacturing Association, covers this subject superbly. Although most State Officials do not call it by that name, practically all of us realize that the principal obligation that we have is to our existing industry—the taxpayers we already have, the industries already in business, such as the members of your own Association.

"Mr. Fulghum has pointed out that we, as Mississippians interested in the development of the State, might do well to look about us to see what industries we have that are suffering from competition outside the State and that need a helping hand. He points out that often we are more ready and willing to vote bond issues to bring a new industry into the State in direct competition with an already sick home industry than we are to visit our home industries, discuss their problems with them, and see if there is any reasonable or practical way the State and Local Governments can be of assistance. As an *ex-officio* member of the Agricultural and Industrial Board, I have the opportunity to observe this philosophy taking hold on the Board's members and staff. I believe that the State is getting away from the philosophy of getting new industry at any cost and is becoming more selective in its choice of new industries. What has been said in this regard about the industry also applies to the individual, for he, too, is a citizen-taxpayer: we recognize his rights and our obligation and the great truth in the saying 'A public office is a public trust.'

"We notice in the elections this past summer a great deal to do about the purchase of products from outside the State. This was a very serious matter with many Mississippi producers and a great deal of money entered certain campaigns, perhaps unnecessarily. Unfortunately, some of our loudest and most voluble advocates of Money-in-Mississippi do not practice what they preach. They buy their building stone from Crab Orchard, Tennessee, rather than from Tishomingo Stone Company; they buy crushed limestone and slag from Alabama when Miss-Lite aggregate, made from Yazoo clay in Hinds County would do the job

equally well. They buy Portland cement, gravel, sand, agricultural limestone from across our borders when our own producers have capacity and can produce competitively, often cheaper.

"The Mississippi Survey's information is public information and its reports are widely distributed as a service, but that is all. They are available to water well contractors, consulting geologists and engineers anywhere. The Survey does no commercial consulting, has no entangling alliances, and its only concern in carrying out the duties assigned to it by the Legislature is for the welfare of the State of Mississippi, its Industries, and its People.

"We believe that the Mississippi Water Well Contractors Association's members realize that the strong economy in Mississippi today has been, to an important degree, the direct result of the Mississippi Geological Survey's research investigations, and the publishing of their results. Our mineral industries have had you drill many water wells for them, in their oil fields, at their compressor stations, at their refineries, at their mines, plants and other installations. Besides being your customers directly, they have contributed greatly to the employment of Mississippians, to the increase in the *per capita* effective income, and to the most salubrious economic climate Mississippi has enjoyed since the Civil War.

"Industrialization and population growth bring on greater demands for water. The *per capita* use of water increases with *per capita* income. In regions where there are little or no ground water supplies, such as central Kentucky or Tennessee, the cities of any size must be located on rivers for their water supply. Away from perennial streams towns depending upon springs, cisterns or low volume shallow wells cannot grow to any apprecible size. Mississippi is unusually blessed with its water supply and indeed it is, in my opinion, the best watered area of its size on the face of the Earth. In many areas fresh waters extend to depths greater than 3,000 feet. We should be concerned with the proper plugging of our oil and gas test wells and with the possibility that salt waters might be injected into our fresh water reservoirs for disposal. This is a regulatory matter in the hands of the Oil and Gas Board, which is aware of the problems.

"I regret to say that I have observed many large towns and cities in our State that have been short-sighted in providing adequate water supplies for their people. Instead of locating and developing ground water fields, as the City of Memphis and the City of Clinton, Mississippi, have done so wisely, they are content to allow their people to drink and bath in the surface water impounded in artificial multipurpose lakes. Such waters are the run-off and concentrations of chemical wastes and biological filth, are susceptible to all types of surface pollution, including sudden atomic fall-out, or sudden failure of the impounding levees. Although filtration and water plant treatments now in use can handle most contaminants, neither the chemical qualities of the water nor their tastes can be much improved, but will tend to worsen as the age of the reservoir increases. I strongly believe and advocate, therefore, that all of our municipalities should consider dual water stystems—artesian water fields for human use, and surficial reservoirs and streams, when available, for industrial use. Pure water is necessary for health; it is essential for survival. Our ground water supplies are sufficient to supply all of the people of this State for many centuries yet to come, and I believe that no municipality would be unable to develop sufficient high-quality ground water capacity for human use far beyond the foreseeable future. It is that simple: a dual system would reserve the protected and safe ground water supplies for human use and surface water for large industrial use."

It is obvious, therefore, that the continuation of the exponential growth in mineral production must be supported by a parallel exponential increase in direct appropriation to the Mississippi Geological Survey for conduct of geologic research and investigation of the under-developed and non-developed mineral resources of the State.

In the development of mineral resources, the Survey works closely with Mississippi producers and the U. S. Bureau of Mines in preparing the data for Mississippi's contribution to the annual Minerals Yearbook.

The Survey assists in the collection of production data from the individual producers. It is very obvious that not all producers report their annual production and value of the production. The

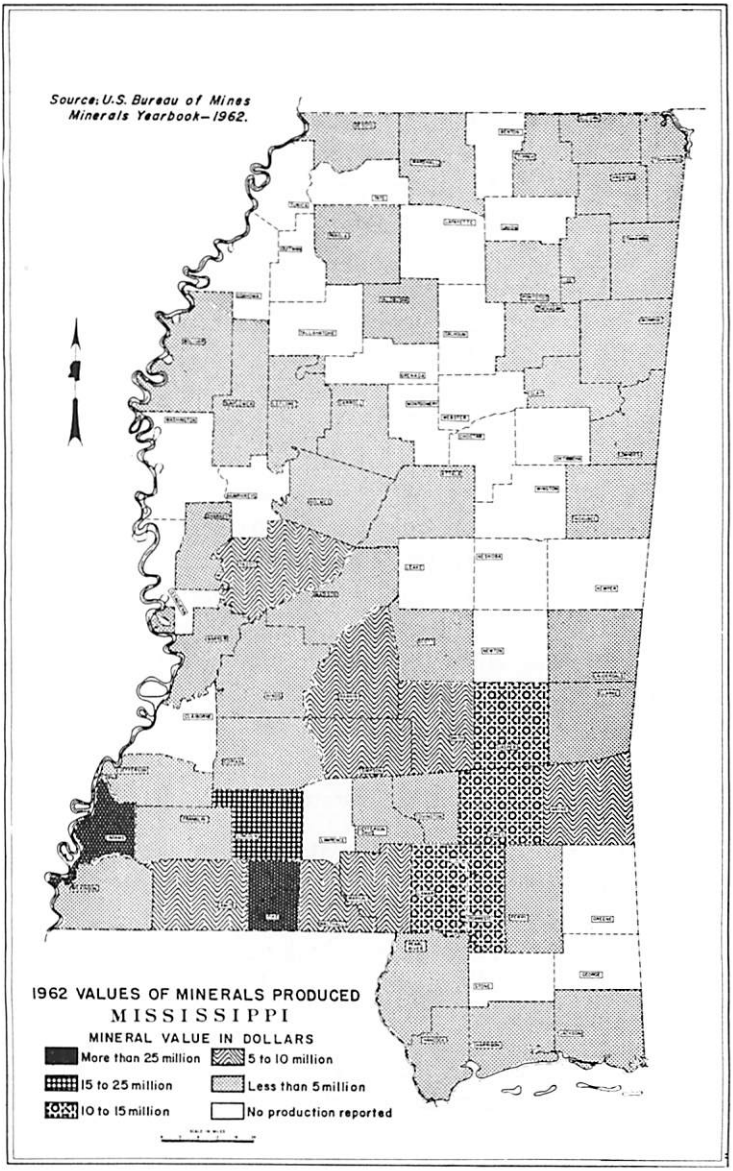

Figure 14.—Values of minerals produced in Mississippi in 1962 by Counties. It is obvious some of the counties in blank did not report their production.

map prepared from 1962 data (Figure 14) shows 26 of our 82 counties reporting no mineral production. This is known to be inaccurate as some of these 26 counties have large and successful mineral producing plants that should report their production and product value to the Bureau of Mines. The Survey is constantly encouraging such industry cooperation so as to increase the dependability of the data and, incidentally, to give a more realistic account of the State's position in the minerals field. County and community leaders can assist in developing better liaison between the government fact-gathering agencies and the mineral producers. Certainly, there are fewer than 26 non-productive counties in our State, and the data from the non-reporting industries might well raise Mississippi from 21st to 20th in the Nation, placing it ahead of Alabama for the first time.

The Survey is the designated cooperating agency with the U. S. Geological Survey in topographic mapping in Mississippi and it has the support of the Mississippi Economic Council, most State Departments and many organizations of the State. A program is now proposed that will complete the topographic coverage of Mississippi within a six-year period at a total cost to the State of $1,400,000. Nothing could be more conducive to a rapid economic development, including particularly mineral resource investigations, than adequate topographic maps of the entire State. In Hancock County there is a wonderful example of the pay-off of such maps. The site of the great NASA static testing project at Gainesville was selected in Washington, D. C. without previous announcements—without the necessity of ground inspections or surveys—because recent high quality topographic maps were available of the area, showing it to be suitable and desirable for the needs. Thus, Mississippi secured a new half billion dollar industry simply because these topographic maps had been made.

The Survey identifies rocks and minerals sent in by citizens of the State and in such a routine examination the first bentonite was discovered, leading, eventually, to the now flourishing bentonite producing industries of Mississippi, as mentioned previously.

For the second year, the Survey is supplying at nominal price an educational set of typical rocks and minerals of the State.

Also, for the second year, the Survey is conducting its Mississippi Geologic Research Paper Contest, supported by contributions from various corporations and others. The plan is to develop quality scientific writing and economic geological ideas from the minds of the hundreds of geologists now working in or with the geologic data of Mississippi. Bulletin 97, the result of the first contest, was highly acclaimed in a review in the Bulletin of the Houston Geological Society.

Again, for the second year, the staff is visting the science departments of the Mississippi High Schools presenting a program on "Mississippi Mineral Resources." Last year Survey geologists talked to nearly 3,000 science students in this program supported by the National Science Foundation and Mississippi Academy of Sciences.

The Survey staff and Board are outstanding, well-educated people, who have been repeatedly recognized for their abilities. In the 29th Biennial Report there was noted *Special recognition to the Survey*: "During the first half of the Twenty-ninth Biennium, a number of special honors came to the Survey. Governor Barnett appointed Board Chairman Henry N. Toler as Mississippi's official delegate to the Sixth World Petroleum Congress at Frankfurt, West Germany, which he attended June 19-26, 1963. Vice Chairman Don Echols was honored by election to President of the Mississippi Chapter of American Agronomy Society. Staff Geologist William H. Moore was elected Chairman, Geology and Civil Engineering Section, Mississippi Academy of Sciences, Inc., for the 1964 program. For the second straight year, the Survey's exhibit at the Mississippi Gem and Mineral Society's show at the State Fair Grounds won a Special Award.

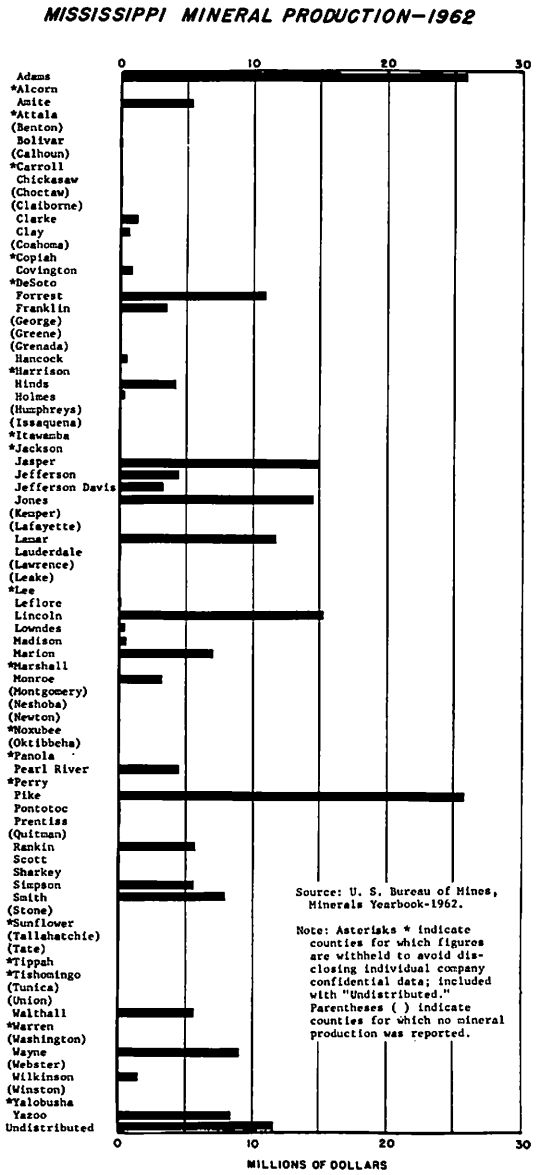

Figure 15.—Chart compiled from U. S. Bureau of Mines data showing distribution of values, by Counties, of Mississippi's 1962 mineral production.

MINERAL INDUSTRY GROWTH ON THE COUNTY LEVEL

The fabulous growth of the mineral industries in Mississippi is exemplified by the chart (Figure 15), which shows that 21 counties yielded a greater income from mineral production in 1962 than the entire State yielded 30 years earlier. Mississippi's 1932 yield was $2,718,919. Following, in order of rank, are the counties which, in 1962, exceeded that figure:

Rank	County	Value 1962 Mineral Production
1	Adams	$25,967,205
2	Pike	25,808,577
3	Lincoln	15,306,146
4	Jasper	14,940,163
5	Jones	14,557,694
6	Lamar	11,669,362
7	Forrest	10,921,476
8	Wayne	9,157,358
9	Yazoo	8,402,353
10	Smith	7,921,906
11	Marion	7,028,851
12	Rankin	5,740,904
13	Simpson	5,646,439
14	Walthall	5,562,381
15	Amite	5,380,497
16	Pearl River	4,520,904
17	Jefferson	4,429,803
18	Hinds	4,259,612
19	Franklin	3,526,108
20	Jefferson Davis	3,388,939
21	Monroe	3,329,669

COMPARISON OF APPROPRIATION WITH THOSE OF OTHER SURVEYS

Although Mississippi ranks 21st among the states in valuation of mineral production, the State ranks only 32nd among the 46 states appropriating funds for Geological Surveys. During 1962, these Geological Surveys had appropriations for geological research, service, and administration totaling approximately $8,500,000 or about $185,000 per Survey. This contrasts with the $70,000 appropriated to the Mississippi Geological Survey for that year. The Illinois Geological Survey receives over $1,000,000 per year; the California Survey receives over $750,000; 26 Surveys receive between $700,000 and $100,000; 10 Surveys receive be-

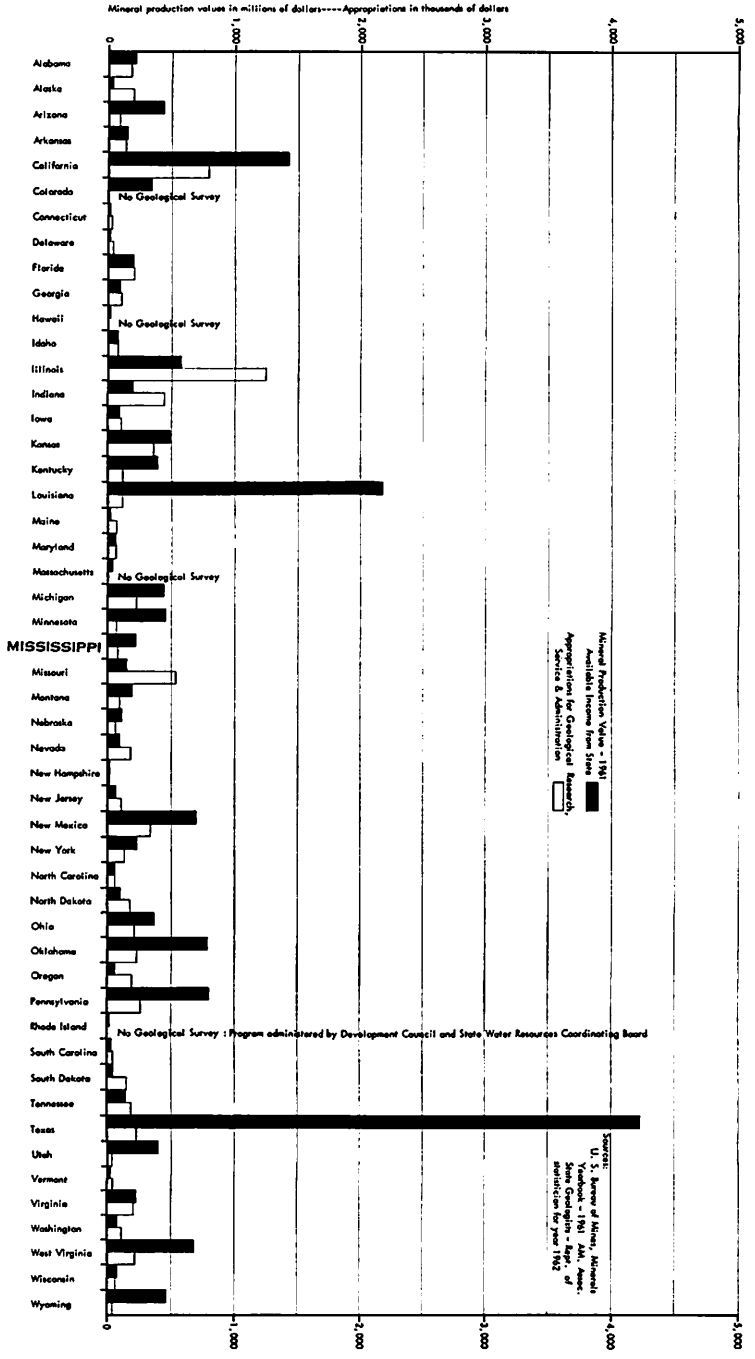

Figure 16.—Comparison by states of Geological Survey support versus annual mineral production.

tween $100,000 and $50,000; and 8 Surveys receive less than $50,000.

Figure 16 shows the appropriations of the various Geological Surveys for geological research, service, and administration in 1962 and the valuation of mineral production for each state in 1961, the latest year for which complete figures are available. Appropriations are in millions of dollars and mineral productions are in billions. A study of the Figure shows that several states have a greatly disproportionate valuation of mineral production in comparison to the respective appropriations to their Geological Surveys. This disproportion is the result of the exploitation within these states of a particular mineral or particular minerals of great demand by industry. For example, the percentages of the total evaluation of mineral production of certain minerals in several of the states are: *Petroleum and natural gas,* Texas (93%), Louisiana (94%), California (68%), Oklahoma (93%), New Mexico (65%), and Wyoming (84%); *Coal,* Pennsylvania (59%), West Virginia (81%), and Ohio (33%); *Iron ore,* Minnesota (90%); and *Copper,* Arizona (81%).

Also, Figure 16 shows that a few of the states, Illinois, Indiana, and Missouri, that generously support their Geological Surveys, have a higher ratio of appropriations for their Geological Surveys in comparison to their valuation of mineral production, and these are leaders among those states most active in mineral research work.

From the data represented in Figure 16 a general formula or index may be derived on which to base a Geological Survey's appropriation. By the elimination of both extremes, many Surveys fall near a proportion of 1 to 1000 (1 mil), that is $1.00 of appropriation for geological research, service, and administration per $1,000 dollars of valuation of mineral production. This formula seems both adequate and desirable in order to provide the necessary state financed geological work to insure continued and diversified development of our mineral resources and to provide service to the landowners and general public. For an intensified geologic research effort (such as in Illinois, Indiana, and Missouri) an increase in the rate above 1 mil would be justified.

ANALYSIS OF APPROPRIATION AS COMPARED WITH THE VALUATION OF MINERAL PRODUCTION

Since the Geological, Economic & Topographical Survey, (as we know it today), was created in 1906, the State has spent only about $1.1 million through appropriations to this Agency, an average of about $20,000 per year. During the same period (1906-1962), the State, as a whole, has reaped over $2.4 billion in income from mineral production. This seems to be an excellent return ($2,182:$1) in wealth for such a small expenditure. However, in reality it represents inadequate support for an

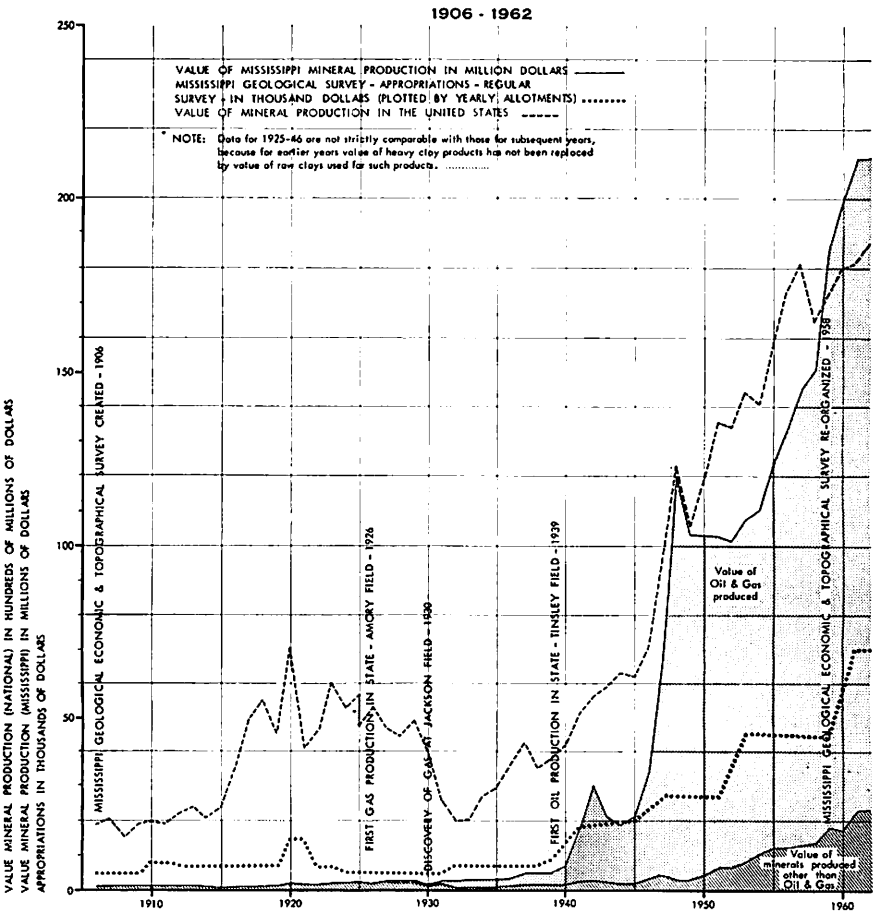

Figure 17.—Mississippi Geological Survey's appropriations compared with value of Mississippi's mineral production and National mineral production.

Agency capable of stimulating the mineral economy far beyond that which has been attained.

Figure 17 shows both the annual appropriations of the Mississippi Geological Survey and the total valuation of mineral production for Mississippi from 1906 to 1962. Appropriations are plotted in thousands of dollars and values of mineral production are in millions. The valuation of mineral production is subdivided into the value of oil and gas produced and the value of other minerals produced.

During the first 34 years of the Survey's existence, annual appropriations exceeded the 1 mil formula, $1.00 of appropriation per $1,000 of valuation of mineral production, derived in the preceeding section of "Comparison of Appropriation with those of other Surveys." However, even at this statistical advantage, the appropriation averaged only about $7,000 per year during this period.

In 1939, with the discovery of Tinsley Field, the first oil production in the State, the people of Mississippi became interested in the minerals of the State and more aware of the value of its Geological Survey. Consequently, the Survey's appropriations increased gradually thereafter.

In 1941 and 1943-1945, the Survey's appropriations fit closely the 1 mil formula. Since then appropriations have increased in a gradual "Stair-step" fashion, while the over-all value of mineral production has risen abruptly. Although the production of oil and gas has contributed by far the largest portion of this wealth, the value of minerals other than oil and gas have increased steadily, and great additional growth in the immediate future in value of "hard minerals" can be extrapolated in an exponential manner, similar to the remarkable growth in oil and gas between the years 1940 and 1950. This is where increased service of the Mississippi Geological Survey can help, through its mineral research and publication, bring about the establishments of new industries and expansions of existing ones.

The Survey has just been advised by the U. S. Bureau of Mines that for the eleventh consecutive year a substantial increase in value of mineral production is assured. Preliminary estimates of 1963 mineral income show a 7% gain over 1962 (previously the all-time high) to $224 million from the 1962

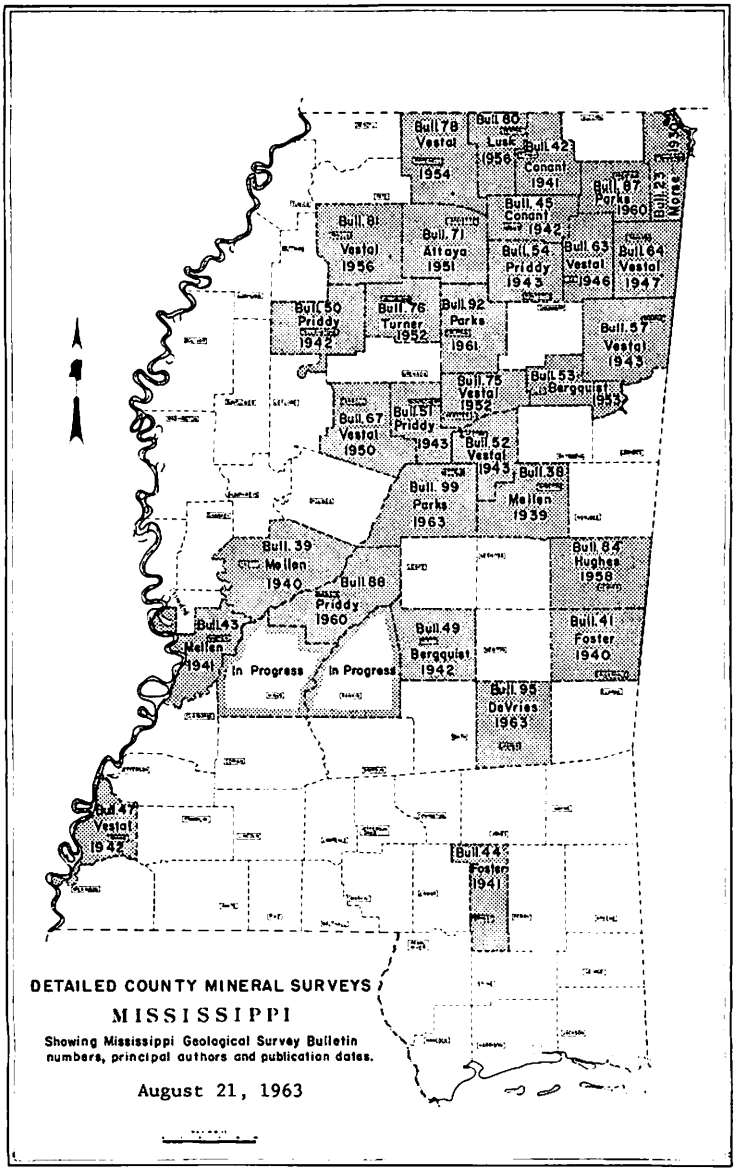

Figure 18.—Detailed county mineral surveys prepared by the Mississippi Geological Survey.

final figure of $209 million. The diversification of this income into the minerals other than oil and gas is healthy and substantial, for in 1962 these "other minerals" amounted to more than the total of all mineral products as recently as the year 1945.

PROGRAM (1964 - 1966)

The Survey's program of county-by-county minerals surveys is expected to continue (Figure 18). Moreover, plans are to increase the tempo of this work through increased specialization, through better arrangement of facilities and through increased personnel in the coming biennium. The Staff is constantly striving to speed up its work, to improve its thoroughness, and to increase the comprehensiveness and usefulness of these surveys. A number of unsurveyed counties have petitioned or are preparing to petition the Survey for such work.

The Staff has prepared a long-range "Delta Project" proposal involving a thorough study of all mineral resources and subsurface study of structure, stratigraphy, mineralogy, etc. of the "Delta" province. After review by the Board it was decided that such a project would involve 5 or 6 years intensive technical work and should be temporarily deferred. However, information leading in the direction of this work will continue to be assembled.

A similar project has been discussed which would lead to a survey of the structural materials and other mineral resources of the Coastal Counties.

Some of the projects approved and in operation during the current (29th) biennium will not be completed until the next (30th) biennium. These would probably include any county surveys begun after July 1, 1963, such as those of Hinds-Rankin or one or more others now under consideration.

The study of the iron ores of Mississippi has recently been completed. Though the results cannot be evaluated immediately, the work throws much additional light on the ferriferous sediments of Mississippi.

The Survey has made a reconnaissance investigation of manganese deposits in Mississippi for inclusion in the iron ore bulletin. Manganiferous materials are widely scattered over the State, but little is known of their composition, quantity or value. Manganese is an important metal in short supply in the United

States. It is more important in Mississippi now because of American Potash & Chemical Corporation's manganese extraction plant in Monroe County, importing its ore from India and Pakistan.

In special minerals development the Survey is working closely with other agencies in pointing out the possibilities of establishing new minerals industries in the State. As more data comes to hand the possibilities multiply. At the present time a new sulphur extraction plant, several new-type ceramic industries, and at least one large chemical industry are among the clear-cut possibilities for new plants in Mississippi which have been helped along by the Survey's work. In 1962, for example, Mississippi produced its first glass sand, and many more such "firsts" are ahead in the immediate future.

The Survey is of considerable assistance in the development of water resource data (Figure 19). Well contractors, developers, municipalities, and industries are constantly coming to the Survey for technical advice. The enormous back-log of data continues to swell and to increase in value to the public. The Survey plans to continue as much of this water resource work as possible, because it is an inalienable part of the geology with which the Survey works.

In technical research the library is the focal point. The Survey wishes to secure the services of a full-time Librarian to catalogue, repair, and service the many thousands of volumes in its library. This is an obligation of the Survey to all the people of Mississippi, to its own Staff, and particularly to the hundreds of geologists who have contributed to the Library and who have encouraged the work of the Survey in many ways.

In the increased activity of the Survey planned for the 30th biennium many necessary facilities will not then be available. The Board and Director have made plans to accomplish such needed investigations through contractural services.

The Mississippi Geological Survey, as charged by the Legislature is anxious to assist, and does assist, as far as is able, in encouraging the topographic mapping of the State. The Survey has met with and cooperated with the Mississippi Economic Council and other groups interested in this program. The Survey

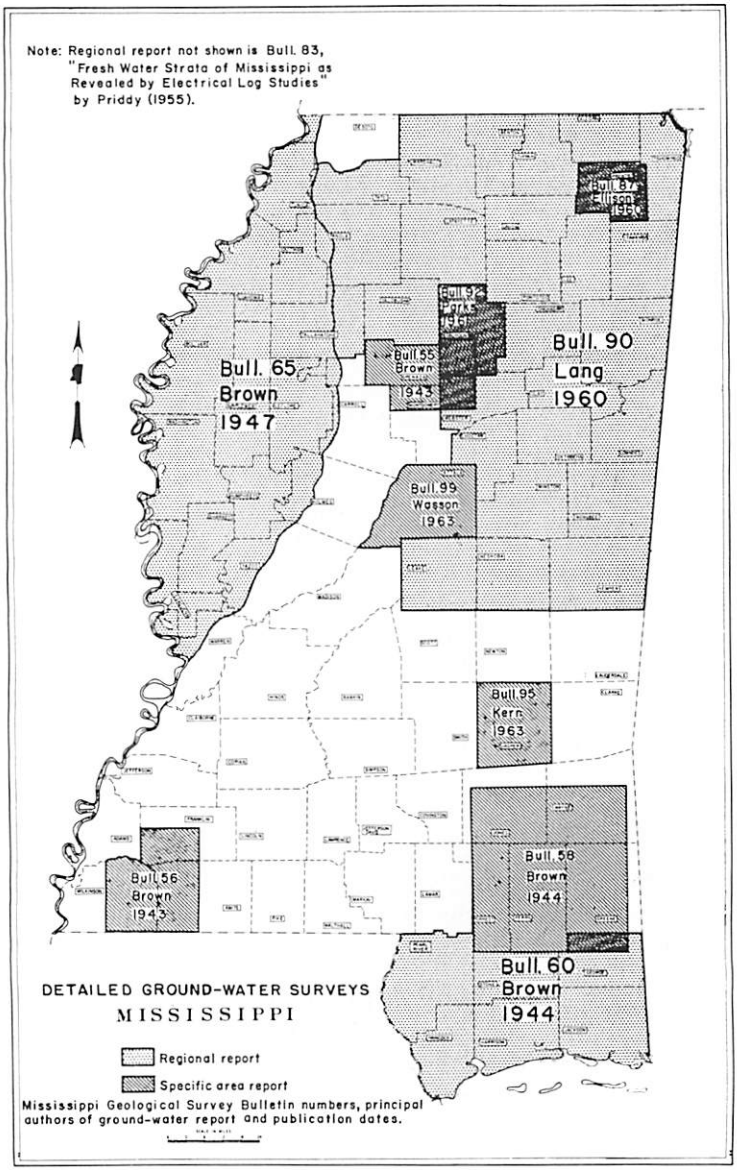

Figure 19.—Detailed ground water surveys prepared or published by the Mississippi Geological Survey.

recently organized a Mississippi Mapping Advisory Committee for the purpose of keeping up with the mapping program, assisting in the designation of priorities, and in such matters as are proper and necessary.

HOUSING

The need for adequate housing of the Survey's growing library, collections, equipment, and other facilities has never been more sharply felt.

In the Twenty-third Biennial Report written in July, 1951, Dr. W. C. Morse wrote: "Furthermore, it seems that recognition must now be given to the Survey's need of an adequate building (Figure 20), where its various activities and materials, now scattered in parts of five separate and distinct buildings, can be gathered under one roof."

In the current biennium, some twelve years later, the Survey has acquired thousands of additional books in its library, many thousands of additional bulletins of its own for distribution, and many tons of new well samples, cores, and collections, all requiring much better housing if they are to be used to maximum advantage in the development of our mineral resources.

Accordingly, the Survey Board ordered and directed that all Survey equipment and materials be assembled at the principal office of the Survey, in the Sample Library at 2525 North West Street, Jackson, Mississippi. This was officially completed on May 31, 1963 (Frontispiece).

Temporary provision for the library, materials and equipment has been made in the Sample Library. Six hundred square feet of commercial storage is being rented for some materials.

The Building Commission made temporary improvements of $2,155.00 by the addition of 16′ x 16′ office room within the Sample Library warehouse space.

The Survey Board has authorized the preparation of an additional emergency request of the Building Commission for improvements to the Sample Library Building at 2525 North West Street.

A modern Mississippi Geological Survey Building is badly needed to:

1. House adequately the present and expanded staff of the Survey.
2. House adequately the present large reference or research library collected by the Survey over a period of many decades by purchase, but principally by exchange; and to provide space for growth of this library, and for use of the library by geologists and others.
3. Provide a modest museum displaying for students, industrialists, and others the important fossils, rocks, minerals, and mineral products of Mississippi.
4. Provide space for the extensive reference collections of mineral samples, test pieces and other materials related to investigations of Mississippi's mineral resources; and adequate testing equipment with which to conduct research investigations on the oil and gas, clays, silts, sands, marls, chalks, limestones, lignite, ores and other raw materials sampled by the Survey's field men. The equipment would include regular commercial-type geochemical, ceramic, aggregate and similar facilities for working with the more abundant raw materials of the State.
5. Provide a conference room for use of geologists, geophysicists, State Officials, or others interested in development of the State's vast mineral resources.

It has been suggested that such a building could be constructed as a first unit in a Research Center which has been proposed and recommended for the State.

SUMMARY AND CONCLUSIONS

The true efficacy of the Survey's work is revealed by the case history review of the Survey's publications and subsequent developments. *Whenever there has been any important developments in the mineral economy of Mississippi the record shows that the Mississippi Geological Survey had published its findings on that possibility, often immediately preceding and, in many cases, directly and solely responsible for the development.*

The Board and Staff of the Survey are extremely proud of the legacy they, and the People of Mississippi, have received through the dedicated work involved in the preparation and

publication of the preceding 99 Bulletins of the Survey, and of Survey's history which commenced through act of the Mississippi Legislature of 1850, one hundred thirteen years ago! They recognize, too, in humility, the challenges and the opportunities, the hardships and the rewards, the responsibilities and the satisfactions that accompany them in carrying out their duties to the Mississippi Geological Survey, their obligations to the People of Mississippi, their reverence to those who have preceded, and their trusteeship to posterity.

The opportunities for further great increase in the mineral economy of Mississippi are as bright as they are for any other State in the Nation. Mineral industries not only contribute to the wealth of the communities in which they locate, but they tend to assist and supplement the beneficial effects of other mineral industries, a chain reaction within the economy. Similarly, funds wisely spent in research investigations, specifically in the field of geology and minerals technology, cannot fail to play an important part in the stimulation and establishment of existing and new industries, and continue to pay large monetary dividends, as has been true in the past.

Figure 20.—Old Library Building at the University of Mississippi, home of Mississippi Geological Survey from July, 1924 (10th Biennial Report) until May, 1963 (29th Biennial Report). This building was inadequate and antiquated for its best service prior to 1951 (see Morse, 23rd Biennial Report). Richard J. Hughes, Jr. photo

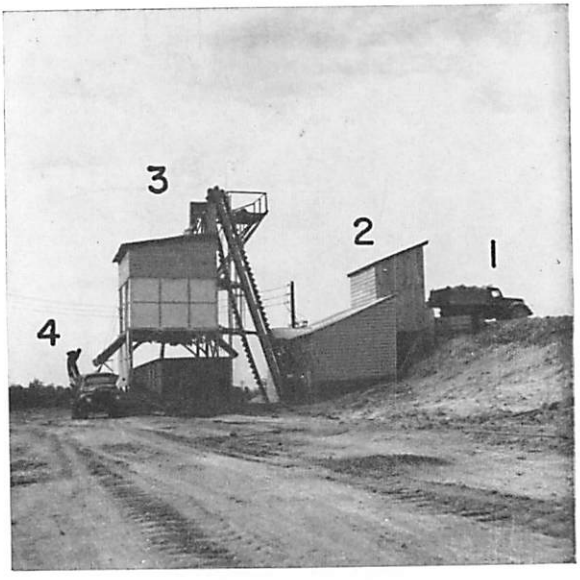

Figure 21.—Plant of Division of Lime, Mississippi Department of Agriculture, Clay County: (1) truck unloading chalk lumps, (2) crusher shed, (3) storage and loading bin, (4) rail and highway transportation. Division of Lime photo, December, 1958. (M.G.S. Bull. 86, Fig. 33).

Figure 22.—Commercial clay bed in the Kentucky-Tennessee Clay Company's pit (NW.¼, Sec.21, T.7 S., R.9 W.), 3 miles southeast of Crenshaw, Panola County: (M.G.S. Bull. 81, Fig. 42; M.G.S. Bull. 86, Fig. 17). F. E. Vestal photo, May 9, 1956.

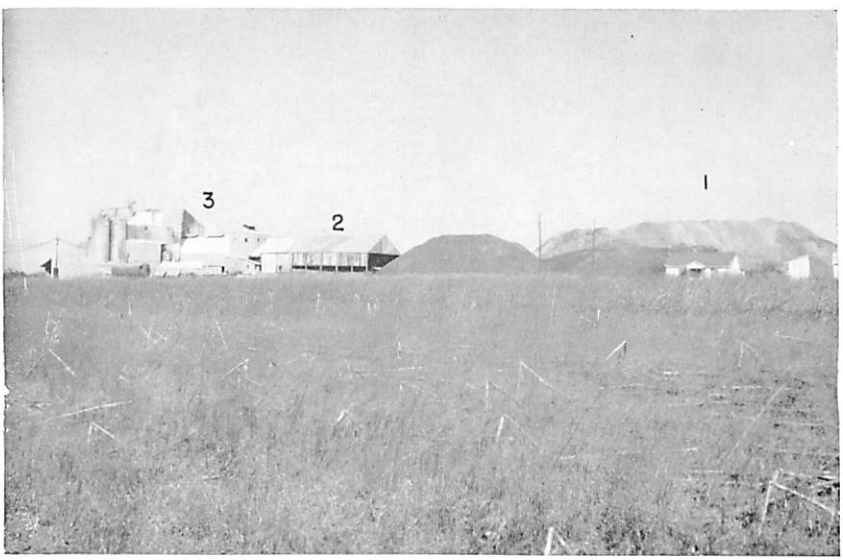

Figure 23.—"Dixie Bond" plant of Eastern Clay Products Department of International Mineral & Chemical Corporation at Smithville, Monroe County: (1) stock pile, approximately 65,000 tons of bentonite, (2) dry shed, (3) kiln, mill and storage housing. (M.G.S. Bull. 86, Fig. 19). Eastern Clay Products photo, January 21, 1959.

Figure 24.—"Miss-Lite" aggregate plant of Jackson Ready-Mix Concrete at Cynthia, Hinds County: (1) pits opened in the Yazoo clay, (2) clay dry shed, (3) rotary kiln, (4) cinder storage area, (5) grinding, screening and storage of graded aggregates, and (6) rail or truck shipping facilities. (M.G.S. Bull. 86, Fig. 24). Frank Noone photo, July 2, 1958.

Figure 25.—Filtrol Corporation's bentonite activation plant at Jackson, Hinds County, producing adsorbent clays for oil decolorization and other uses. Looking northeast. (M.S.G. Bull. 86, Fig. 21). Photo by Manley, Tucson.

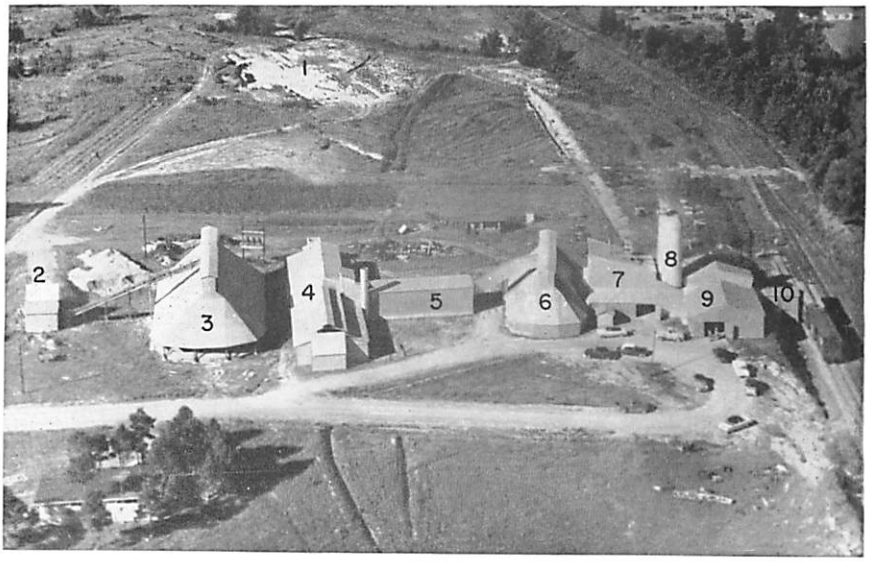

Figure 26.—Plant of Howell-Southern Products, Inc., Ripley, Tippah County, which produces fired clay aggregate for absorbent and deodorizing purposes: (1) clay pit—basal Porters Creek, (2) shredding shed, (3) dry shed, (4) kiln building, (5) cooler, (6) product storage, (7) screening and crushing, (8) silos, (9) bagging, and (10) loading. Looking south. (M.G.S. Bull. 86, Fig. 22). Richard Allin photo, December, 1958.

Figure 27.—Mississippi Valley Portland Cement Company plant at Haynes Bluff, Warren County: (1) quarry face, (2) primary crusher, (3) washing and screening, (4) overhead conveyor, (5) Mississippi State Highway 3, Yazoo City to Vicksburg, (6) limestone storage, (7) milling house, (8) slurry blending and storage, (9) slurry tanks and kiln feeding equipment, (10) kiln, (11) clinker cooler, (12) clinker storage, (13) silos, and (14) sack house. (M.G.S. Bull. 86, Fig. 56). Since this photo was taken, another kiln has been added and the quarry face has deepened into the hill at right. Newton Advertising Agency photo, January 25, 1959.

Figure 28.—Misceramic Tile Company's Cleveland, Bolivar County, plant has an estimated 7,000,000 square feet annual capacity of floor and wall tile. Although largely financed in Mississippi, all of the ceramic ingredients except some of the ball clay, are imported. (M.G.S. Bull. 86, Fig. 44). Photo by Sawyer, 1959.

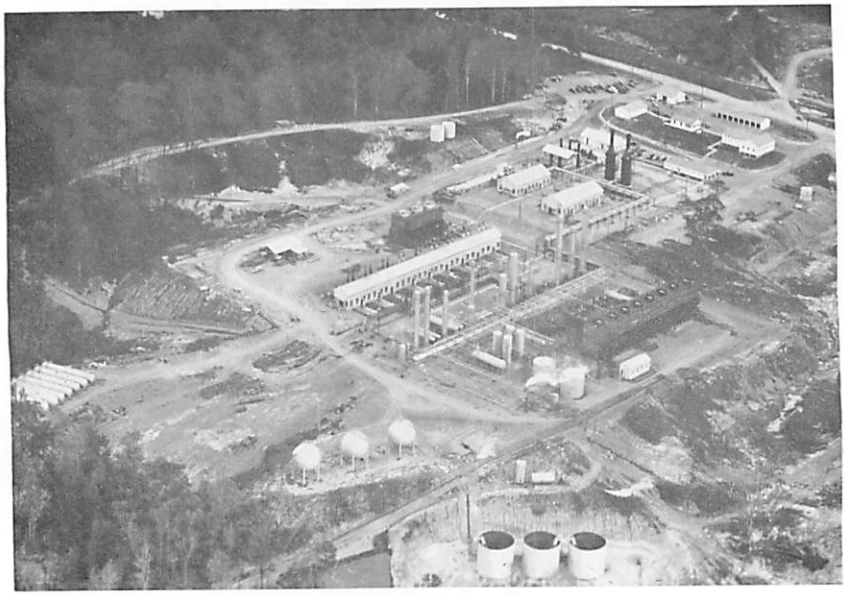

Figure 29—The California Company's Cranfield Field Unit, Adams County, showing U. S. Highway 84 (right background), field offices, unit cycling plant, and a few individual lease installations. (M.G.S. Bull. 86, Fig. 11). Elwood M. Payne photo, October 24, 1947.

Figure 30.—Marquette Cement Manufacturing Company plant at Brandon, Rankin County. This larger of the State's two cement plants has an annual capacity of more than 5,000,000 sacks of cement. (M.G.S. Bull. 86, Fig. 31). Bob Hand photo.

Figure 31.—Mississippi Geological Survey's Failing Model 750 rotary drilling rig being used by the Survey's personnel in coring the type locality of the Yazoo clay, September 27, 1963. This research exploratory hole was cored and drilled to a depth of 230 feet and logged with the Survey's electrical logger. Samples and cores are being studied by commercial and academic research methods to determine the economic characteristics of the Yazoo clay at its type locality. Cores and samples from this and other similar core holes provide a wealth of accurate scientific working material especially valuable for academic research problems in micro-paleontology, sedimentation, mineralogy, foundation engineering geology, and economic mineral resource studies. Norman A Mott photo.

Figure 32.—The new Standard Oil Company of Kentucky's refinery at Pascagoula is by far Mississippi's largest mineral industry. This facility, the largest "grass-roots" plant built in the United States since 1957, is the first U. S. refinery designed to profit by higher gasoline yields and product flexibility offered by hydrocracking. Built in record time for a plant its size, it was constructed on a 2,700 acre site on Bayou Casotte at an expenditure of about $150 million. The initial capacity is 100,000 barrels of crude daily. The refinery is supplied by a 153-mile, 100,000-plus bpd capacity pipeline from the offshore Bay Marchand Field in the Louisiana Delta area. Crude may also be delivered by tankers up to 33,000 dead-weight tons. A 115-mile feeder pipeline from the plant connects at Collins with the Plantation pipeline, a products system serving inland distribution points. The refinery wharf serves for shipping finished products by tankers and barges to distribution points along the Gulf and up the Mississippi and Ohio Rivers. Primary products are aviation and automobile gasolines, jet fuel, kerosene and fuel oil. The California Company, an exploration and development Company in Mississippi, is a partner in this giant industrial complex.

MISSISSIPPI LEGISLATURE REGULAR SESSION 1958

SENATE BILL 2012

(General Laws of Mississippi, 1958, Chapter 477)

Introduced by Senators

William Brooks Lucas (Noxubee)

George Lawrence Adams (Adams)

H. B. Mayes McGehee (Franklin & Pike)

AN ACT to establish a Geological, Economic and Topographical Survey; to provide a governing board and set forth its qualifications and terms; to provide for a State Geologist; to set forth the objects of the Survey; to provide that the board shall report to the Legislature; to provide for publication of its reports; to provide for regular meetings; to provide for cooperative programs with the United States Geological Survey; to provide that Survey employees may go on lands; to further provide for the repeal of Sections 8954-8960, Mississippi Code of 1942; and for related purposes.

Be it enacted by the Legislature of the State of Mississippi:

Section 1. There is established a geological, economic, and topographical survey of the State of Mississippi which shall be under the direction of the Board hereby established and said Board shall be appointed by the Governor. The Board shall consist of five (5) members to be appointed for staggered terms, as follows: one member shall be a businessman of established reputation whose term shall expire June 30, 1960; one member shall be a geologist of established reputation, engaged in the practice of his profession, either in the academic or commercial field in this State, whose term shall expire June 30, 1961; one member shall be a licensed civil engineer of established reputation engaged in the practice of his profession, either in the academic or commercial fields in this State, whose term shall expire June 30, 1962; one member shall be a businessman of established reputation whose term shall expire June 30, 1963; and one member shall be a geologist of established reputation, engaged in the practice of his profession, either in the academic or commercial fields in this State whose term shall expire June 30, 1963. At the expiration of the terms set out above, successors with like qualifications shall be chosen for a full four (4) year term.

At its organizational meeting the Board shall select one of its members as Chairman and another member as Vice Chairman, both of whom shall serve for a period of one year.

The members of the Board shall be reimbursed for actual expenses incurred and a per diem of Twenty Dollars ($20.00) for days actually spent in the performance of official duties. The Board shall have general charge of the survey and shall appoint a full time Director of the survey who shall be a geologist of established reputation, who shall be known as the State Geologist. The Director shall have authority to appoint such assistants and employees as, in the opinion of the Board, may be deemed necessary. The Director also shall have authority to remove such assistants and employees at will.

Section 2. The regular and special reports of the survey, with proper illustrations and maps shall be printed as the Board may direct, and the reports shall be distributed or sold by the said Board as interest of the State and of science may demand, and all money obtained by the sale of the reports shall be paid into the State Geological Survey Publications Fund.

Section 3. A regular meeting of the Board shall be held quarterly each year. Said regular meetings shall be held on the first Wednesday of the months of March, June, September, and December. Special meetings of the Board may be held at the call of the Chairman, or by a majority of the Board when the business of the Board shall require a special meeting.

Section 4. The Board of the Mississippi Geological Survey, in the conduct of its work may confer with, and when deemed advisable, may act in cooperation with the United States Geological Survey or other federal agencies in making and publishing the results of topographic, geologic and hydrographic surveys in the State of Mississippi. Such cooperative efforts may be directed by either of the contracting parties at the discretion of said Board.

Section 5. For the purpose of making the survey hereinbefore provided for, it shall be lawful for the persons employed by the survey in making the same to enter upon all lands within the boundaries of this state, but this Act shall not be construed as authorizing unnecessary interference with private rights.

Section 6. The Board shall determine the compensation of the Director and all personnel employed by the survey.

Section 7. The object of the survey shall be:

(a) An examination of the mineral natural resources of the State, viz: the metalliferous deposits, petroleum, nautral gas, as well as building stones, clays, coals, cements, waters, and all other mineral substances of value.

(b) The investigation, mapping, and compilation of reports upon the water supplies, water power of the State, gauging the streams, etc., with reference to their application to irrigation, protection from overflow and other purposes.

(c) Studies and reports on constructional materials and their values.

(d) The preparation and completion of special geologic, topographic, and economic maps to illustrate the resources of the State.

(e) The preparation of special reports with necessary illustrations and maps which shall embrace both a general and detailed description of the geological and natural resources of the state. Said reports are to be provided in sufficient number for distribution to the educational institutions of the State, the State Library and as demand may otherwise justify.

(f) The consideration of such other kindred scientific, educational, and economic questions as, in the judgment of the Board, shall be deemed of value to the people of the State.

Section 8. The said Board shall cause to be prepared a report to the Legislature before each regular session of the same showing the progress and condition of the survey, together with such other information as it may deem necessary and useful, or as the Legislature may require.

Section 9. Sections 8954 through 8960, Mississippi Code of 1942, are hereby repealed, and all laws and parts of laws in conflict herewith be and the same are hereby repealed.

Section 10. This Act shall take effect and be in force from and after its passage.

STATE GEOLOGISTS OF MISSISSIPPI

John N. Millington (June, 1850-1853)

(Professor of Chemistry and Natural Philosophy at the University; his assistants, who actually did the geological work, were Oscar M. Lieber, employed July 15, 1851 to January 14, 1852 and B. L. C. Wails, employed January, 1852 to February, 1854.)

John C. Keeney (1853-February, 1854)

(Professor of Chemistry, Agriculture and Geology at the University, replaced Dr. Millington on his resignation. He served one year with Wailes as the active geologist of the Survey.)

Ludwig Hafner [Lewis Harper] (February, 1854-1857)

(Professor of Geology and Agriculture at the University; did no field work until September, 1855, at which time he was relieved of his teaching duties and was furnished Dr. Eugene W. Hilgard as his field assistant. *In the interest of efficiency, the Survey was separated from the University in* 1856 *by act of the Legislature, on recommendation of the Governor, and transferred to Jackson.* Hafner resigned toward the end of 1857.)

Eugene W. Hilgard (early 1858-October, 1866)

(Dr. Hilgard moved the Survey back to the University in 1858; his assistant was: Dr. George Little, employed July 1866, and, upon Hilgard's resignation to accept the chair of Chemistry, Little was made State Geologist.)

George Little (October, 1866-1871)

(His assistants were: Dr. Eugene A. Smith, December, 1866 until his resignation in 1871, and Mr. R. H. Loughridge, who served from 1871 until the Survey was abandoned in 1872.)

Eugene W. Hilgard (1871-1872)

(With the organization of the School of Agriculture and Mechanic Arts at the University in 1871, Dr. Hilgard was

elected to the chair of Economic and Agricultural Chemistry and Special Geology and Agriculture, bearing, also the title of State Geologist; Dr. Little and Mr. Loughridge were associated during all or part of this final year.)

Albert F. Crider (April 14, 1906-May 31, 1909)

Ephraim N. Lowe (June 4, 1909-September 12, 1933)

William C. Morse (September 1, 1934-June 30, 1958)

Tracy W. Lusk (July 1, 1958-June 30, 1962)

Frederic F. Mellen (July 1, 1962-)

INDEX TO BULLETINS 1-99

WILLIAM S. PARKS

ABSTRACT

The Mississippi Geological Survey has published 99 Bulletins over the last 56 years, an average of about two per year. The first Bulletin was published in 1907. Since then a total of 65 authors have contributed to the geology of the State through the Bulletin series.

Incorporated in these 99 Bulletins is a wealth of information dealing with the various aspects of the geology of Mississippi. The need for an index to make this information more readily available to laymen and to various workers is obvious.

The Index to Bulletins 1-99 consists of three parts—(1) the List of Bulletins, (2) the Author Index, and (3) the Subject Index. The Subject Index was compiled by a method of selective analytical indexing.

INTRODUCTION

With the publication of the Mississippi Geological Survey's Bulletin 100, A Centennial, it is an appropriate place in which to include an index to Bulletins. The preceeding 99 Bulletins in the series were published over a period of 56 years, an average of about two per year. The first Bulletin was published in 1907, a year after the present Survey was created. Since 1907, a total of 65 authors have contributed to the geology of the State through this series.

PURPOSE AND SCOPE OF THE INDEX

Incorporated in the 99 Bulletins thus far published by the Survey is a wealth of information dealing with the various aspects of the geology of Mississippi. Daily the Survey receives requests for geological information on specific areas and specific subjects relative to the State. To fulfill these requests, it commonly requires some library research on the part of the Survey staff. Unless there is a Bulletin dealing with the area or subject of interest, a request may require careful searching through several Bulletins in order to locate the data needed. On the other hand, even if there is a Bulletin dealing with the particular area or subject, other Bulletins may contain supplementary data. Also in Survey work, there is commonly a certain amount of library research necessary before the beginning of a new project.

Therefore, this index will serve as a guide and should speed the finding of data, thus increasing the efficiency of the Survey's work. For example, if it is necessary to find out what material is available on a subject relative to a particular county, the index should show immediately where to look for this information.

More important is the fact that this index will make the information contained in the 99 Bulletins more readily available to laymen and to various workers such as geologists, engineers, industrialists, etc. It is for the laymen and workers that this index is published.

The index was compiled exclusively from the regular Bulletin series. Earlier reports of the Survey, prior to 1907, and the few Circulars and miscellaneous publications are not included. The more important early reports that are not indexed are: (1) "Report on the Agriculture and Geology of Mississippi" by B. L. C. Wailes (1854); (2) "Preliminary Report on the Geology and Agriculture of the State of Mississippi" by L. Harper (1857); and (3) "Report on the Geology and Agriculture of the State of Mississippi" by Eugene W. Hilgard (1860).

The system used in compiling the Index to Bulletins 1-99 is patterned after the U. S. Geological Survey *Bibliography of American Geology* and the index to the American Geological Institute *GeoScience Abstracts*. Modifications of these systems were necessary in order to serve the present purpose. The method in which the Subject Index was compiled is one of selective analytical indexing.

The Index to Bulletins 1-99 consists of three parts: (1) the List of Bulletins; (2) the Author Index; and (3) the Subject Index. The List of Bulletins is a numerical listing, giving full title and publication data of the various Bulletins. The Author Index is an alphabetical listing of all authors who have contributed to the Bulletins, and it is keyed to the List of Bulletins. The Subject Index is keyed to the List of Bulletins and also gives the specific page or pages, etc. in reference.

ORGANIZATION OF THE SUBJECT INDEX

In order that the Subject Index can be used most effectively by the reader, the system of headings, subheadings and entries

are described. Familiarization of the construction of the Subject Index by the reader should aid in a broader usage.

Headings.—The headings comprise the main subdivisions of the Subject Index and are recognized by their position, that is, flush with the margin of the column. The headings are in capital letters. They are two general types—geographic and subject headings. Examples are: ADAMS COUNTY, BIBLIOGRAPHY, CAVES AND SINK HOLES, and ECONOMIC GEOLOGY. Some headings have cross reference only, that is, no entries are listed under the heading and the reader is referred to another heading. Examples are:

AGRICULTURAL LIME, See ECONOMIC GEOLOGY.

CHEMICAL ANALYSES, See TESTS AND ANALYSES.

FOSSILS, See MICROPALEONTOLOGY, PALEOBOTANY, and PALEOZOOLOGY.

Some headings have entries under them but also have cross references to other headings of a similar or related nature or to other headings under which additional information may be found. Examples are:

COUNTY REPORTS, See also individual county listings.

ENGINEERING GEOLOGY, See also HIGHWAY GEOLOGIC PROFILES.

GEOMORPHOLOGY, See also PHYSIOGRAPHY.

Geographic Headings.—The geographic headings are the names of the 82 counties that make up the State and a few area or region names such as ALLUVIAL PLAIN and COASTAL AREA. The degree of indexing of the individual counties is the "backbone" of the Subject Index inasmuch as especial attention was made to index all pertinent information, fragmental or otherwise, regarding the geology of each county. Thirty counties are covered by individual county reports that contain the most detailed overall information available on these counties. No attempt was made to index the individual county reports under the county-name headings, but rather the county report is entered in its entirety, immediately succeeding the county-name heading

and preceding the regular system of subheadings. A brief description of the scope of each county report is given. An example is:

ADAMS COUNTY.

Geology and mineral resources: *47*, **200 pp.**

Economic geology.

Subject Headings.—The subject headings deal with selected subjects that are of more or less general interest. These headings were selected for the most part from the subject headings used in the *Bibliography of North American Geology.* Many headings used in the *Bibliography* were discarded because they were not applicable or because there was lack of material on the subject or because the material was too fragmental and scattered. Special attention was given the indexing of several of the subject headings because of their obvious importance to the geology of the State and because of the relative abundance of material available. These headings are ECONOMIC GEOLOGY, PALEOZOOLOGY, STRATIGRAPHY, STRUCTURE and TESTS AND ANALYSES.

Subheadings.—Subheadings, in *italics* and indented two spaces, are used to group entries under the county-name geographic headings. The subheadings used are: *Economic geology, Engineering geology, Geomorphology, Ground Water, Paleontology, Petrography, Stratigraphy, Structure, Surface Water,* and *Vegetation.* No subheadings are used under subject headings.

Entries.—Entries form the main subdivisions of headings and are indented four spaces. Entries for county-name geographic headings commonly follow a subheading, except for county report entries which follow the main heading directly. Under both geographic and subject headings, the entries may be either geographic or subject or they may be of both types. Each entry is followed by the Bulletin number, in *italics,* and by the page or pages in reference and by any Tables (T.), Plates (P.) or Figures (F.), etc. that may contain pertinent data. Tables, Plates, and Figures, etc. are commonly followed by their page numbers in parentheses. When reference is made to an entire Bulletin, it is entered showing total number of pages. Bulletins that are important references to a particular subject or area are in **bold type.**

Examples of entries under geographic and subject headings are as follows:

PERRY COUNTY.

Economic geology.

Clays and clay industry: *4,* 55-56.

Gravel: *16,* 70; *85,* F. 12 (27), T. 2 (29).

Oil and gas, shows in Lower Cretaceous: *79,* T. III (36).

PETROGRAPHY.

Distribution of heavy minerals and some feldspars in outcrop and well samples, Camp Shelby area: *58,* T. 2 (30).

Eocene sediments: *30,* **240 pp.**

Use of the Subject Index.—In general, if the reference sought deals with a specific mineral resource or some other specific aspect of the geology of a county, it should be found as an entry under the appropriate subheading of the county-name geographic heading, except for information included in a county report. If a county report is entered under a county-name heading, it is possible to determine whether or not a subject is covered in the county report by checking the Bulletin numbers listed with the entry for that particular subject under its appropriate heading such as ECONOMIC GEOLOGY, PALEOZOOLOGY, STRATIGRAPHY, etc. For example, if the subject is Iron ore in Benton County, first look under BENTON COUNTY. Under BENTON COUNTY the reader finds an entry for Iron Ore under the subheading *Economic geology.* Nevertheless, there is also a county report (*80,* **104 pp.**) entered, so it is possible to determine what information is available in this county report by checking the entry Iron ore under the heading ECONOMIC GEOLOGY elsewhere in the Subject Index. Under Iron ore the reader finds *80,* 73-79 which shows that there is information on iron ore in the county report and gives the pages on which it is to be found.

Information refered to under the subheadings of a county-name heading is commonly supplementary to the detailed county report. A comparison of the Bulletin number of a supplementary

reference and the Bulletin number of the county report will in many cases indicate the importance of the supplementary data, that is, if the supplementary reference Bulletin number is larger than the county report Bulletin number then the information post dates the county report and *vice versa.*

By using the List of Bulletins along with the Subject Index, the reader commonly can obtain some idea of the nature of the information available to him. Also, the nature of an entry as to number of pages, etc. gives an idea as to the amount of data available.

LIST OF BULLETINS

1. Cement and Portland Cement Materials of Mississippi: Albert F. Crider, 73 pp., 1907. **Indexed.**
2. Clays of Mississippi: Part I, Brick Clays and Clay Industry of Northern Mississippi: William N. Logan, 255 pp., 1907. **Indexed.**
3. The Lignite of Mississippi: Calvin S. Brown, 71 pp., 1907. **Indexed.**
4. Clays of Mississippi: Part II, Brick Clays and Clay Industry of Southern Mississippi: William N. Logan, 72 pp., 1908. **Indexed.**
5. A Study of Forest Conditions of Southwestern Mississippi: The United States Forest Service (cooperating); J. S. Holmes and J. H. Foster, 56 pp., 1908.
6. The Pottery Clays of Mississippi: William N. Logan, 228 pp., 1914. **Indexed.**
7. Preliminary Examination of the Forest Conditions of Mississippi: C. E. Dunston, 76 pp., 1910.
8. A Preliminary Study of Soils of Mississippi: E. N. Lowe, 220 pp., 1911.
9. The Structural Materials of Mississippi: William N. Logan, 78 pp., 1911.
10. Preliminary Report on Iron Ores of Mississippi: E. N. Lowe, 70 pp., 1913.
11. Forest Conditions of Mississippi, being a reprint with additions of Bulletins Nos. 5 and 7: 166 pp., 1913.
12. Mississippi, Its Geology, Geography, Soils and Mineral Resources: E. N. Lowe, 335 pp., 1915. **Indexed.**
13. Preliminary Report on the Marls and Limestone of Mississippi: William N. Logan, 82 pp., 1916.
14. Mississippi, Its Geology, Geography, Soil and Mineral Resources: A revision with additions of Bulletin No. 12; E. N. Lowe, 346 pp., 1919. **Indexed.**
15. Oil and Gas Prospecting in Mississippi: E. N. Lowe, 80 pp., 1919.
16. Road-Making Materials of Mississippi: E. N. Lowe, 139 pp., 1920. **Indexed.**
17. Plants of Mississippi, A List of Flowering Plants and Ferns: E. N. Lowe, 293 pp., 1921.
18. A Questionnaire on the Mineral Resources of Mississippi and the Work of the State Geological Survey: E. N. Lowe, 32 pp., 1923. **Indexed.**
19. The Bauxite Deposits of Mississippi: Paul Franklin Morse, 208 pp., 1923. **Indexed.**

20. Geology and Mineral Resources of Mississippi: E. N. Lowe, 140 pp., 1925 (151 pp. 1933 reprint). **Indexed.**

21. Recent Oil and Gas Prospecting in Mississippi with a Brief Study of Sub-surface Geology: Ralph E. Grim, 98 pp., 1928. **Indexed.**

22. A Preliminary Report on Bentonite in Mississippi: Ralph E. Grim, 14 mimeographed pages, 1928.

22a. A Supplementary Report on Bentonite in Mississippi: Hugh McD. Morse, 32 mimeographed pages, 1934.

23. Paleozoic Rocks: William Clifford Morse, 212 pp., 1930. **Indexed.**

24. Being a Series of Papers Presented by the State Geological Survey at a Meeting of the Institute on Mississippi Affairs: Contains Soil Erosion by W. E. Tharp, The Development of Mineral Resources by George I. Adams, Mineral Resources of Mississippi by E. N. Lowe, Hydro-Electric Power and the Development of Industries by B. E. Eaton, and The Climate of Mississippi by W. L. Kennon. 33 mimeographed pages, 1933.

25. Coastal Plain Stratigraphy of Mississippi: Lloyd W. Stephenson, C. Wythe Cook, and E. N. Lowe: Part First, Midway and Wilcox Groups: E. N. Lowe, 125 pp., 1933. **Indexed.**

26. The Highland Church Sandstone as a Building Stone: William Clifford Morse, 30 pp., 1935.

27. Geologic Conditions Governing Sites of Bridges and Other Structures: William Clifford Morse, 20 pp., 1935.

28. The Geological History of the Vicksburg National Military Park Area: William Clifford Morse, 20 pp., 1935.

29. A Preliminary Investigation of the Bleaching Clays of Mississippi: Harry X. Bay, 62 pp., 1935.

30. The Eocene Sediments of Mississippi: Ralph Early Grim, 240 pp., 1936. **Indexed.**

31. The Tupelo Tornado: William Clifford Morse, 32 pp., 1936.

32. Tishomingo State Park: Geologic History by William Clifford Morse; Botany by Calvin S. Brown, 77 pp., 1936. **Indexed.**

33. The Geologic History of Tombigbee State Park: William Clifford Morse, 22 pp., 1936.

34. The Little Bear Residuum: Frederic Francis Mellen, 36 pp., 1937.

35. Geologic History of Legion State Park: William Clifford Morse, 17 pp., 1937.

36. The Jackson Gas Field and the State Deep Test Well: Watson Hiner Monroe and Henry Niles Toler, 52 pp., 1937.

37. The Geologic History of Magnolia State Park: William Clifford Morse, 19 pp., 1938.

38. Winston County Mineral Resources: Geology by Frederic Francis Mellen and Tests by Thomas Edwin McCutcheon, 169 pp., 1939.

39. Yazoo County Mineral Resources: Geology by Frederic Francis Mellen and Tests by Thomas Edwin McCutcheon, 132 pp., 1940.

40. The Upper Cretaceous Deposits: Lloyd William Stephenson and Watson Hiner Monroe, 296 pp., 1940 (Reprinted in 1959). **Indexed.**

41. Lauderdale County Mineral Resources: Geology by V. M. Foster and Tests by Thomas Edwin McCutcheon, 246 pp., 1940.

42. Tippah County Mineral Resources: Geology by Louis Cowles Conant and Tests by Thomas Edwin McCutcheon, 228 pp., 1941. **Indexed.**

43. Warren County Mineral Resources: Geology by Frederic Francis Mellen; Tests—Clays by Thomas Edwin McCutcheon; Tests—Marls and Limestone by Malcolm Rogers Livingston, 140 pp., 1941.

44. Forrest County Mineral Resources: Geology by Vellora Meek Foster and Tests by Thomas Edwin McCutcheon, 87 pp., 1941.

45. Union County Mineral Resources: Geology by Louis Cowles Conant and Tests by Thomas Edwin McCutcheon, 158 pp., 1942. **Indexed.**

46. Mississippi Agricultural Limestone: Frederic Francis Mellen, 20 pp., 1942.

47. Adams County Mineral Resources: Geology by Franklin Earl Vestal and Tests by Thomas Edwin McCutcheon, 200 pp., 1942. **Indexed.**

48. The Claiborne: Emil Paul Thomas, 96 pp., 1942.

49. Scott County: Geology by Harlan Richard Bergquist; Tests by Thomas Edwin McCutcheon; Fossils by Harlan Richard Bergquist, 136 and 146 pp., 1942. **Indexed.**

49-F. Scott County, Fossils: Jackson Foraminifera and Ostracoda: Harlan Richard Bergquist, 146 pp., 1942. **Indexed.**

50. Tallahatchie County Mineral Resources: Geology by Richard Randall Priddy and Tests by Thomas Edwin McCutcheon, 157 pp., 1942. **Indexed.**

51. Montgomery County Mineral Resources: Geology by Richard Randall Priddy and Tests by Thomas Edwin McCutcheon, 116 pp., 1943. **Indexed.**

52. Choctaw County Mineral Resources: Geology by Franklin Earl Vestal and Tests by Thomas Edwin McCutcheon, 156 pp., 1943. **Indexed.**

53. Clay County: Geology by Harlan Richard Bergquist; Tests by Thomas Edwin McCutcheon; Fossils by Virginia Harriett Kline, 91 and 98 pp., 1943. **Indexed.**

53-F. Clay County, Fossils: Midway Foraminifera and Ostracoda: Virginia Harriett Kline, 98 pp., 1943. **Indexed.**

54. Pontotoc County Mineral Resources: Geology by Richard Randall Priddy and Tests by Thomas Edwin McCutcheon, 139 pp., 1943. **Indexed.**

55. Geology and Ground-Water Supply at Camp McCain: Glen Francis Brown and Robert Wynn Adams, 116 pp., 1943. **Indexed.**

56. Geology and Ground-Water Supply at Camp Van Dorn: Glen Francis Brown and William Franklin Guyton, 68 pp., 1943. **Indexed.**

57. Monroe County Mineral Resources: Geology by Franklin Earl Vestal and Tests by Thomas Edwin McCutcheon, 218 pp., 1943. **Indexed.**

58. Geology and Ground-Water Resources of the Camp Shelby Area: Glen Francis Brown, 72 pp., 1944. **Indexed.**

59. Mississippi Minerals: William Clifford Morse, 13 pp., 1944.

60. Geology and Ground-Water Resources of the Coastal Area in Mississippi: Glen Francis Brown, Vellora Meek Foster, Robert Wynn Adams, Edwin William Reed and Harold Dement Padgett, Jr., 232 pp., 1944. **Indexed.**

61. Light-Weight Aggregate: Geology by William Clifford Morse and Tests by Thomas Edwin McCutcheon and Bernard Frank Mandlebaum, 56 pp., 1945.

62. Rock Wool: Geology by William Clifford Morse and Tests by Thomas Edwin McCutcheon, 19 pp., 1945.

63. Lee County Mineral Resources: Franklin Earl Vestal, 140 pp., 1946. **Indexed.**

64. Itawamba County Mineral Resources: Geology by Franklin Earl Vestal and Tests by Harry J. Knollman, 151 pp., 1947. **Indexed.**

65. Geology and Artesian Water of the Alluvial Plain in Northwestern Mississippi: Glen Francis Brown, 424 pp., 1947.

66. North Mississippi Floods of February 1948: Irving E. Anderson and staff, 55 pp., 1948.

67. Carroll County Geology: Franklin Earl Vestal, 114 pp., 1950. **Indexed.**

68. Surface Waters of Mississippi: Irving E. Anderson, 338 pp., 1950.

69. Status of Fearn Springs Formation: Frederic Francis Mellen, 20 pp., 1950.

70. Rate of Depletion of Water-Bearing Sands: Frederic Hartwell Kellogg, 15 pp., 1950.

71. Lafayette County Geology: James Samuel Attaya, 49 pp., 1951.

72. Ground Water Investigations along Bogue Phalia, between Symonds and Malvina, Bolivar County: Tracy Wallace Lusk, 19 pp., 1951.

73. Webster County Iron Ores: Franklin Earl Vestal, 48 pp., 1951.

74. Lafayette County Iron Ores: James Samuel Attaya, 26 pp., 1952.

75. Webster County Geology: Franklin Earl Vestal, 141 pp., 1952. **Indexed.**

76. Yalobusha County Geology: James Turner, 48 pp., 1952.

77. Water Levels and Artesian Pressures in Observation Wells in Mississippi, 1938-1952: Tracy W. Lusk, 65 pp., 1953.

78. Marshall County Geology: Franklin Earl Vestal, 193 pp., 1954. **Indexed.**

79. Lower Cretaceous Stratigraphy of Mississippi: Jeff Doris Nunnally and Henry Florey Fowler, 45 pp., 1954.

80. Benton County Geology: Tracy Wallace Lusk, 104 pp., 1956. **Indexed.**

81. Panola County Geology: Franklin Earl Vestal, 157 pp., 1956. **Indexed.**

82. Sediments of Mississippi Sound and Inshore Waters: Richard Randall Priddy, Robert Malcolm Crisler, Jr., Clarence Paul Sebren, James David Powell, and Hugh Burford, 54 pp., 1955.

83. Fresh Water Strata of Mississippi as Revealed by Electrical Log Studies: Richard Randall Priddy, 71 pp., 1955.

84. Kemper County Geology: Richard John Hughes, Jr., 274 pp., 1958. **Indexed.**

85. Cretaceous Shelf Sediments of Mississippi: Frederic Francis Mellen, 112 pp., 1958. (Discussion on the Foraminifera by William S. Parks and Discussion on the Ostracoda by Robert H. Shaver).

86. Mississippi Mineral Resources: Frederic Francis Mellen, 100 pp., 1959.

87. Prentiss County Geology: William Scott Parks. Ground-Water Resources: E. B. Ellison and E. H. Boswell. 110 and 44 pp., 1960.

88. Madison County Geology: Richard Randall Priddy, 123 pp., 1960.

89. Geologic Study along Highway 16 from Alabama Line to Canton, Mississippi: Bahngrell W. Brown, 52 pp., 1960.

90. Public and Industrial Supplies in a Part of Northern Mississippi: Joe W. Lang and Ernest H. Boswell, 104 pp., 1960.

91. Geologic Study along Highway 80 from Alabama Line to Jackson, Mississippi: Richard Randall Priddy, 62 pp., 1961.

92. Calhoun County Geology and Ground-Water Resources: William Scott Parks, 113 pp., 1961.

93. Heavy Minerals of Sand from Recent Beaches of the Gulf Coast of Mississippi and Associated Islands: Richard D. Foxworth, Richard R. Priddy, Wendell B. Johnson, and Willard S. Moore, 92 pp., 1962.

94. Geologic Study along Highway 45 from Tennessee Line to Meridian, Mississippi: Donald M. Keady, 64 pp., 1962.

95. Jasper County Mineral Resources: Surface Geology by David A. DeVries, Subsurface Stratigraphy by William H. Moore, Ground-Water Resources by Marshall K. Kern, Oil and Gas Fields by Hugh McD. Morse, and North Twistwood Creek Clay Corrected Name for North Creek Clay by Grover E. Muray, 101 pp., 1963.

96. The Tula Prospect, Lafayette County, Mississippi: Frederic Francis Mellen and William Halsell Moore, 30 pp., 1962.

97. Mississippi Geologic Research Papers—1962: Contains Economic Potential of Alumina-Rich Clays and Bauxite in Mississippi by Marshall K. Kern, Stratigraphic Implications from Studies of the Mesozoic of Central and Southern Mississippi by William H. Moore, Land Snails from the Loess of Mississippi by Leslie Hubricht, Pleistocene Land Snails of Southern Mississippi and Adjacent Louisiana by Leslie Hubricht, Problem of Dessication Sinking at Clarksdale by Tracy W. Lusk, and Geologic History and Oil and Gas Possibilities of Mississippi by E. H. Rainwater, 106 pp., 1963.

98. Geologic Study along Highway 25 from Starkville to Carthage: Tracy Wallace Lusk, 48 pp., 1963.

99. Attala County Mineral Resources: Surface Geology by William Scott Parks, Ceramic Tests by Thomas E. McCutcheon, Subsurface Geology by William H. Moore, and Water Resources by B. E. Wasson, 192 pp., 1963.

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Limestones and marl: *1*, 60-62, 70; *2*, 240; *9*, 75-76; *13*, 75-78; *16*, 77, 90; *46*, T. 1 (10), T. 2 (11).
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Structure.
Vicksburg area: *15*, 28-29.

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Gravel: *16*, 78, 132, 133; *86*, F. 12 (27), T. 2 (28).
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Road-making materials: *16*, 78, 132, 133.

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Alluvium, thicknesses: *65*, T. 9 (73).
Aquifers, indicated by electrical logs: *83*, 68, 69.
Chemical analyses, water: *65*, T. 4 (67), T. 5 (68), T. 7 (71).
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Bleaching clay: *29*, 44-46, 55-56.
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Limestone and marl: *1*, 66-67; *9*, 77-78; *13*, 79-82; *16*, 78-79, 83; *46*, 20, T. 1 (10), T. 2 (11).
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