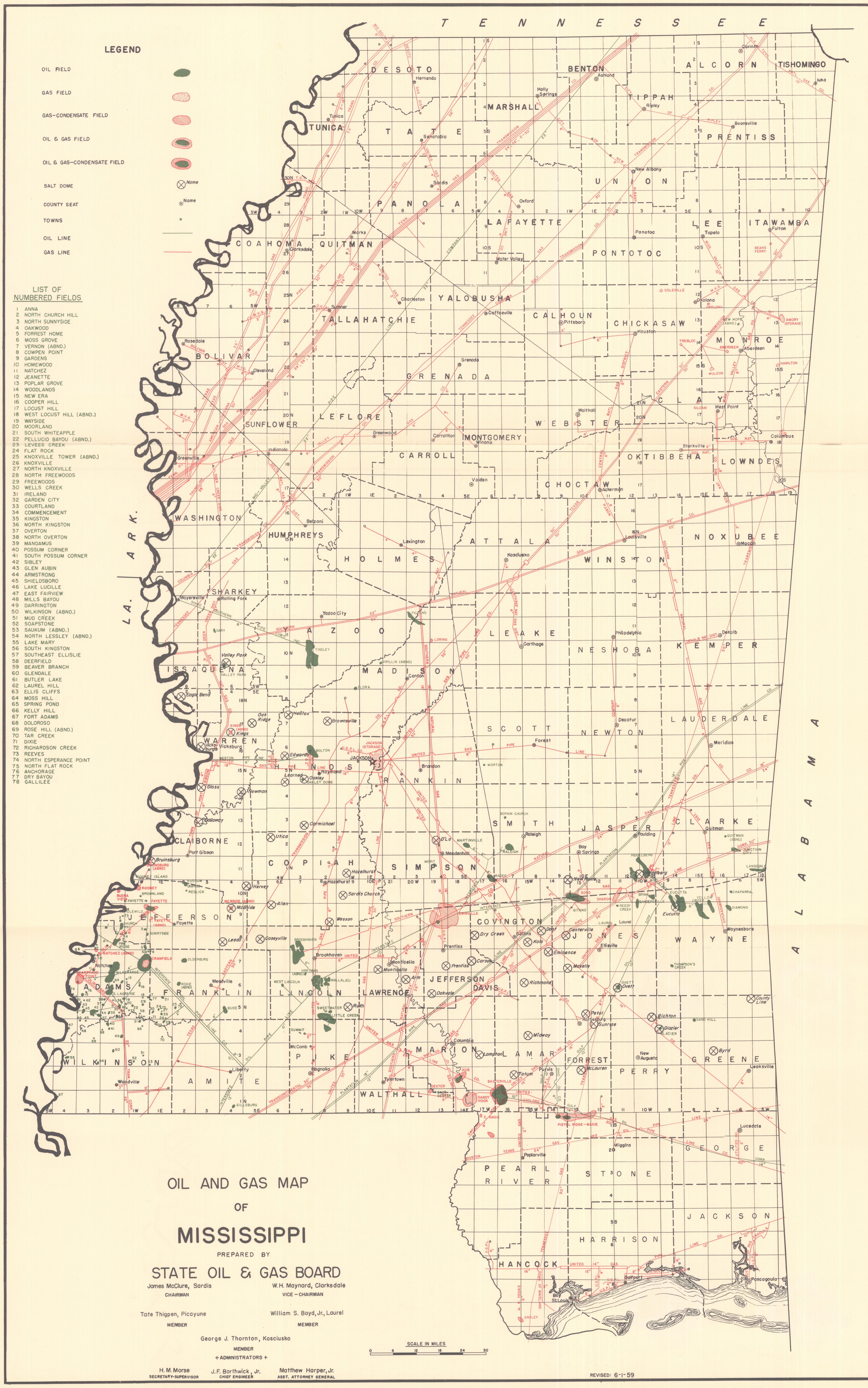
Mississippi Mineral Resources

FREDERIC FRANCIS MELLEN

BULLETIN 86

MISSISSIPPI STATE GEOLOGICAL SURVEY
TRACY WALLACE LUSK
DIRECTOR and STATE GEOLOGIST

UNIVERSITY, MISSISSIPPI
1959


LEGEND
OIL FIELD
GAS FIELD
GAS-CONDENSATE FIELD
OIL & GAS FIELD
OIL & GAS-CONDENSATE FIELD
SALT DOME
COUNTY SEAT
TOWNS
OIL LINE
GAS LINE
LIST OF NUMBERED FIELDS
1 ANNA
2 NORTH CHURCH HILL
3 NORTH SUNNYSIDE
4 OAKWOOD
5 FORREST HOME
6 MOSS GROVE
7 VERNON (ABND.)
8 COWPEN POINT
9 GARDENS
10 HOMEWOOD
11 NATCHEZ
12 JEANETTE
13 POPLAR GROVE
14 WOODLANDS
15 NEW ERA
16 COOPER HILL
17 LOCUST HILL
18 WEST LOCUST HILL (ABND.)
19 WAYSIDE
20 MOORLAND
21 SOUTH WHITEAPPLE
22 PELLUCID BAYOU (ABND.)
23 LEVEES CREEK
24 FLAT ROCK
25 KNOXVILLE TOWER (ABND.)
26 KNOXVILLE
27 NORTH KNOXVILLE
28 NORTH FREEWOODS
29 FREEWOODS
30 WELLS CREEK
31 IRELAND
32 GARDEN CITY
33 COURTLAND
34 COMMENCEMENT
35 KINGSTON
36 NORTH KINGSTON
37 OVERTON
38 NORTH OVERTON
39 MANDAMUS
40 POSSUM CORNER
41 SOUTH POSSUM CORNER
42 SIBLEY
43 GLEN AUBIN
44 ARMSTRONG
45 SHIELDSBORO
46 LAKE LUCILLE
47 EAST FAIRVIEW
48 MILLS BAYOU
49 DARRINGTON
50 WILKINSON (ABND.)
51 MUD CREEK
52 SOAPSTONE
53 SAUKUM (ABND.)
54 NORTH LESSLEY (ABND.)
55 LAKE MARY
56 SOUTH KINGSTON
57 SOUTHEAST ELLISLIE
58 DEERFIELD
59 BEAVER BRANCH
60 GLENDALE
61 BUTLER LAKE
62 LAUREL HILL
63 ELLIS CLIFFS
64 MOSS HILL
65 SPRING POND
66 KELLY HILL
67 FORT ADAMS
68 DOLOROSO
69 ROSE HILL (ABND.)
70 TAR CREEK
71 DIXIE
72 RICHARDSON CREEK
73 REEVES
74 NORTH ESPERANCE POINT
75 NORTH FLAT ROCK
76 ANCHORAGE
77 DRY BAYOU
78 GALLILEE
TENNESSEE
ALABAMA
LA.
ARK.
OIL AND GAS MAP
OF
MISSISSIPPI
PREPARED BY
STATE OIL & GAS BOARD
James McClure, Sardis
CHAIRMAN
W.H. Maynard, Clarksdale
VICE-CHAIRMAN
Tate Thigpen, Picayune
MEMBER
William S. Boyd, Jr., Laurel
MEMBER
George J. Thornton, Kosciusko
MEMBER
+ ADMINISTRATORS +
H.M. Morse
SECRETARY-SUPERVISOR
J.F. Borthwick, Jr.
CHIEF ENGINEER
Matthew Harper, Jr.
ASST. ATTORNEY GENERAL
SCALE IN MILES
0 6 12 18 24 30
REVISED: 6-1-59

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TRACY WALLACE LUSK
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LETTER OF TRANSMITTAL

Office of the Mississippi Geological Survey
University, Mississippi
June 25, 1959

Hon. James R. Park, Chairman, and
Members of the Geological Survey Board

Gentlemen:

Herewith is Mississippi Geological Survey Bulletin 86, Mississippi Mineral Resources, by Frederic Francis Mellen.

The report is designed to serve as a guide to the numerous development possibilities of the mineral resources of Mississippi. The author points out the mineral substances that are known to be abundant and worthy of immediate exploration and development, and also the lesser known mineral substances worthy of further study.

This report should provide many answers to the questions of industry and those seeking investment opportunities — the first link of the chain toward a greater Mississippi.

Respectfully submitted,

Tracy W. Lusk

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MISSISSIPPI MINERAL RESOURCES

FREDERIC F. MELLEN

ABSTRACT

The report summarizes Mississippi's contribution to the National mineral economy, reviews the trends in production of various mineral items, discusses the geographic and geologic distribution of the various raw mineral materials and suggests opportunities for further development of these resources.

From 1915 through 1930 Mississippi ranked 47th in mineral production among the 50 reporting political units in the Nation. With the discovery of gas at Jackson in 1930 and oil at Tinsley in 1939, the Petroleum Industry has given impetus to growth in mineral economy so that Mississippi now ranks 24th in the Nation, the dollar value of mineral production rising from less than $2,000,000 in 1926 to over $132,000,000 in 1956.

Industries other than oil and gas are beginning to show material growth, and local capital is increasingly used in development of new mineral-using industries. Although mineral raw materials in large quantities are imported for processing in Mississippi, and although many finished mineral products are brought into the State for distribution and sale, much, if not all of the demand for these materials and products can be satisfied by proper exploration and exploitation of local raw materials. An improvement in the degree of self-sufficiency of the State is necessary to a virile economy.

Industries whose expansions appear desirable are agricultural lime, refining of oil, the ceramic industries (including brick, tile, pottery, etc.), portland cement, and concrete aggregates, natural and fired.

Industries which appear to offer opportunity for initial development in Mississippi are the production of salt, rock wool, and drilling mud.

Mineral substances appearing deserving of further study toward industrial use are glass sand, lignite, carbon dioxide gases, sulfur gases, iron ores, glauconite, heavy minerals, clays for alumina extraction, tripoli and chert.

The report is illustrated with numerous maps showing distribution, with numerous photographs of plants in operations; it gives numerous selected chemical analyses, and it includes several pages of selected topical references.

INTRODUCTION

PURPOSE

Mineral resources have become a vital part of the economy of Mississippi. Demand for mineral information has been so great that the Mississippi Geological Survey Board feels the need for a short general review of these resources, to point out their nature, their types, and their values. Mineral substances which today form the bulk of the produced mineral wealth of Mississippi were unsuspected or unproved latent reserves thirty-five years ago. By the very nature of scientific discovery, new uses will be found for those mineral substances already in production, new techniques and applications will permit the utilization of those known but not now used, and continuous geologic research will discover in Mississippi mineral resources that now are unproved or even unsuspected. In short, this report will attempt to review the present stage of commercial development of our mineral resources and to point out other mineral materials that may find a place in the State's economy.

DEFINITION

In a broad concept mineral resources are those non-living materials within the Earth's lithosphere that are being used, or that may at some future date be used, for the benefit of human habitation. Still within this concept, these mineral resources exist in the three conditions of matter, as solids, liquids and gases. Most of our mineral resources do not meet the strict definition of minerals — that they have definite chemical composition — but commonly are mixtures of minerals or, perhaps more properly, they are mineral substances. These mineral substances may be chemically active or chemically inert, and their individual properties, of course, determine their ultimate utilization in the service of Man.

CLASSIFICATION

In a general way, Mississippi's mineral resources may be classified as (1) fuels, (2) non-metallic minerals, and (3) metallic minerals. To some extent, the classification is over-lapping, such as non-fuel use of lignite, or such as fuel use of uranium, but on the whole the classification is adequate.

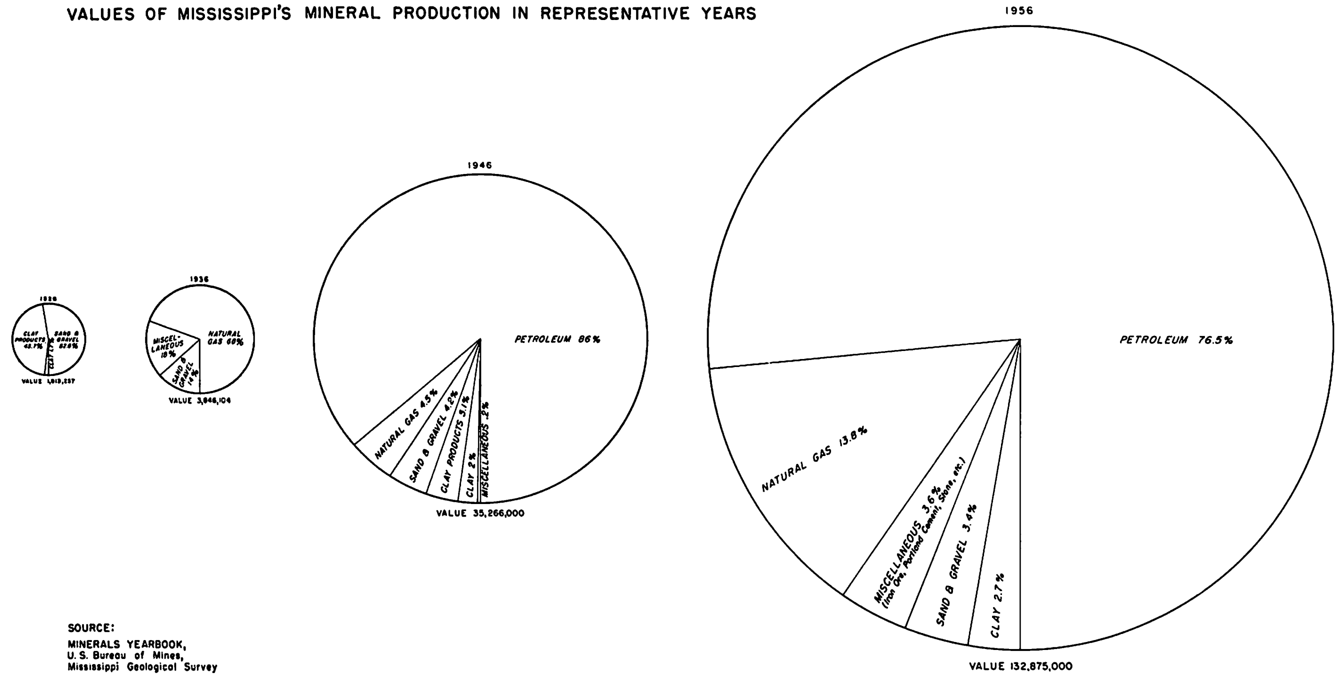
In fuels, Mississippi long a user of wood, later of imported coal and petroleum products, and still later of foreign-generated electricity is currently an important producer of petroleum and natural gas which make up the bulk of the annual mineral production. Large deposits of lignite in the northern half of the State are mineable but have been little explored. Deeply buried coal in the Pennsylvanian of north Mississippi is known but has not been carefully studied. Fissionable materials, an increasingly important source of fuel and energy, are known to be present in some of the deposits of the State, but are, at present, thought to be in trace amounts. However, it is hoped that exploratory work and increasing research technology will discover commercial sources.

Non-metallic minerals, although at present playing a relatively minor part in economic participation, are a large, diverse and very essential group. Gravels, sands, many types of clays, stone, asphaltic rock, limestone and chalk, tripoli and chert, rock salt, waters, glauconite and minor substances comprise this group. Expanded application of old uses and the development of new uses of these minerals will undoubtedly contribute a great deal to the economic advancement of Mississippi. Their use was retarded in the past by poor transportation facilities and especially by the lack of adequate and cheap fuel supplies.

For the first time in Mississippi's history, the State is crisscrossed by an excellent transportation system, railway and highway (Plate 1), and, what is more important, by an intricate network of gas lines (Plate 2), carrying a potential fuel supply to any part of the State. Many of the new mineral-using plants in Mississippi would not now be here were it not for this vast fuel supply. Is it not also logical to assume that many more new industries will be created in the near future by this fortunate combination of raw materials, fuel supply, and transportation?

The principal metallic minerals are ores of iron and aluminum, both found chiefly in the northeast quarter of the State. The principal iron ore is in the form of large lenses of siderite (iron carbonate) much of which has oxidized to form a low-sulphur, low-phosphorous limonite. The carbonate ore was mined in years past for roasting to form hematite, a red paint pigment. The limonite was once utilized temporarily in a charcoal blast furnace at Winborn, Benton County, and in more recent years,

VALUES OF MISSISSIPPI'S MINERAL PRODUCTION IN REPRESENTATIVE YEARS



SOURCE:
MINERALS YEARBOOK,
U. S. Bureau of Mines,
Mississippi Geological Survey

Figure 1

has been shipped to Birmingham, reportedly for up-grading the ores now in use there. Bauxite exists as a pre-Wilcox residuum on the surface of the Midway formation. Thus far the grade and quantity of bauxite have not been found acceptable for development. Titanium is an accessory metallic mineral in some analyses, but its importance remains to be demonstrated. Both iron and aluminum ores may be produced in commercial volumes in the State in time, and it is possible that economic conditions will one day permit these metals to be smelted here.

GROWTH OF MISSISSIPPI'S MINERAL INDUSTRY

According to the U. S. Bureau of Mines Mineral Yearbook, the production of minerals in the United States and possessions reached an all-time high in 1957. Mineral producing and utiliz-

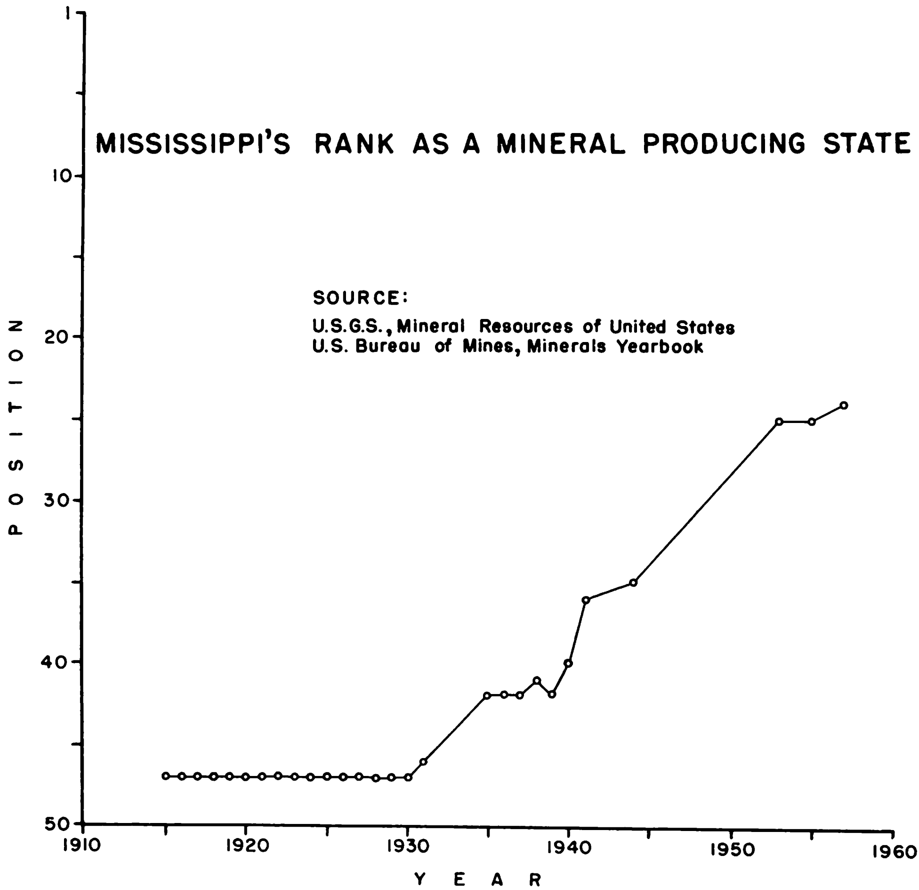


Figure 2

ing industries have shown a phenomenal growth since 1900; and Mississippi, which produced almost nothing a few decades ago has shown marked improvement in valuation of products and in rank (Figure 1).

Until the 1939 discovery of commercial oil in Mississippi, the State's position as a mineral producer was unimportant. In 1911 when the value of production was $1,052,842, the U. S. Geological Survey reported: "The only title of Mississippi to inclusion in the list of mining states rests in the utilization of some of its clays, in the digging of sand, chiefly for building purposes, and gravel, and in the sale of mineral waters." From 1915 through 1930 Mississippi ranked only 47th among the 50 reporting political units of the Nation (Figure 2). The discovery of new and greater reserves of oil and gas in Mississippi, as sources of fuel and as sources of increased capital, together with improvement in transportation systems and a generally stable economy, has contributed to the advancement of Mississippi to 24th place in rank. Now, with all the economic advantages that the State has for fuller development of its latent mineral resources, it may be expected to rise quickly to an even higher position in the Nation's mineral economy.

SOURCES OF INFORMATION

The most prolific sources of information on the mineral resources of Mississippi are the numerous specific and general reports published by the Mississippi Geological Survey. The Mississippi Geological Society has issued stratigraphic and petroleum publications and the U. S. Geological Survey has done some original work from time to time, the results of which have, in large part, been published by the Mississippi Geological Survey. Specific information on local developments have been furnished by the operators themselves, as credited throughout the report. With few exceptions, the operators readily furnished photographs and other data when called upon. Much valuable information has been taken from the records and publications of the Mississippi Oil & Gas Board. The Mississippi Highway Department, the Mississippi Tax Commission, the Mississippi Department of Agriculture and the Agricultural Stabilization and Conservation Committee lent ready assistance to this endeavor. For data on mineral production, the series Mineral Resources (U.S.G.S.), succeeded by the Minerals Yearbook (U.S. Bur. Mines), has been used.

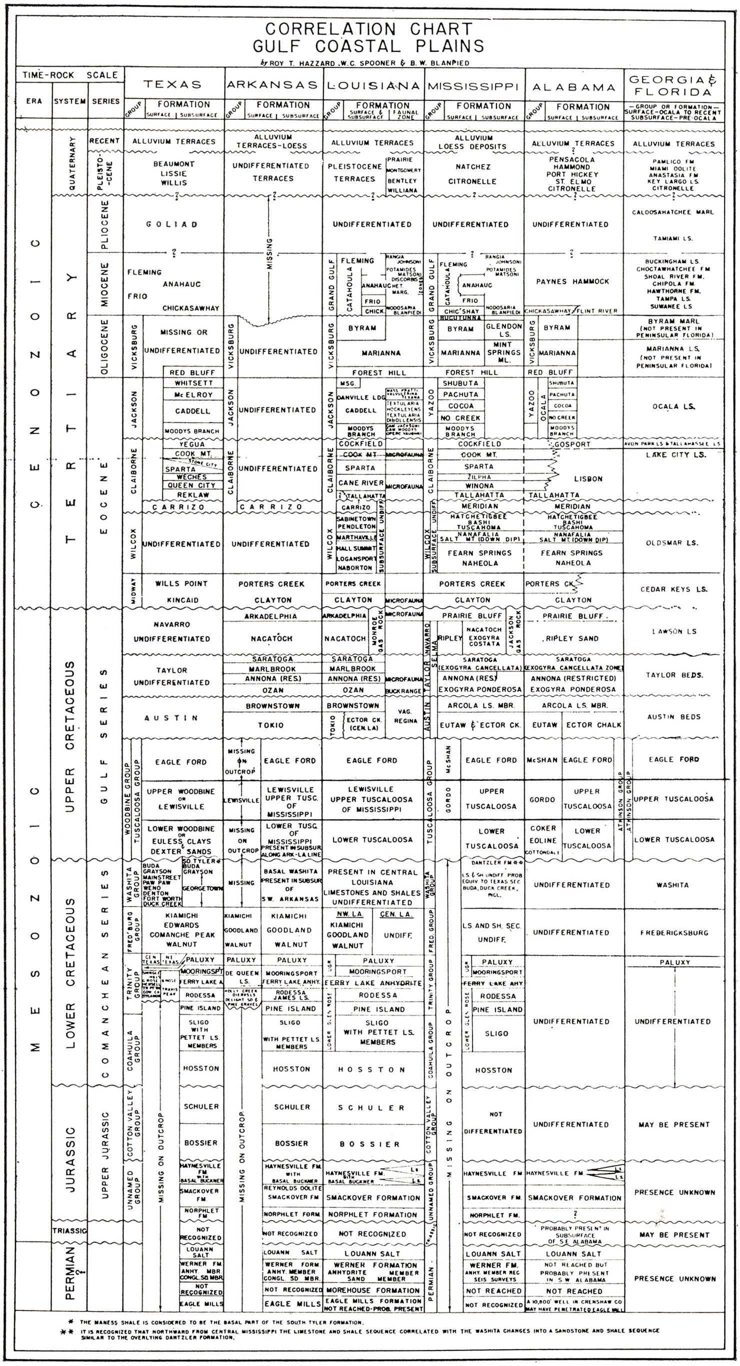

CORRELATION CHART
GULF COASTAL PLAINS
by ROY T. HAZZARD, W.C. SPOONER & B. W. BLANPIED
TIME-ROCK SCALE
ERA
SYSTEM
SERIES
TEXAS
ARKANSAS
LOUISIANA
MISSISSIPPI
ALABAMA
GEORGIA & FLORIDA
GROUP
FORMATION
SURFACE | SUBSURFACE
SURFACE & SUBSURFACE | FAUNAL ZONE
— GROUP OR FORMATION — SURFACE-OCALA TO RECENT SUBSURFACE-PRE-OCALA
CENOZOIC
TERTIARY
QUATERNARY
RECENT
ALLUVIUM TERRACES
ALLUVIUM TERRACES-LOESS
ALLUVIUM TERRACES
ALLUVIUM LOESS DEPOSITS
ALLUVIUM TERRACES
ALLUVIUM TERRACES
PLEISTO-CENE
BEAUMONT
LISSIE
WILLIS
UNDIFFERENTIATED TERRACES
PLEISTOCENE TERRACES
PRAIRIE
MONTGOMERY
BENTLEY
WILLIANA
NATCHEZ
CITRONELLE
PENSACOLA
HAMMOND
PORT HICKEY
ST. ELMO
CITRONELLE
PAMLICO FM
MIAMI OOLITE
ANASTASIA FM
KEY LARGO LS.
CITRONELLE
PLIOCENE
GOLIAD
MISSING
UNDIFFERENTIATED
UNDIFFERENTIATED
UNDIFFERENTIATED
CALOOSAHATCHEE MARL
TAMIAMI LS.
MIOCENE
FLEMING
ANAHAUC
FRIO
CHICKASAWHAY
GRAND GULF
CATAHOULA
FLEMING
ANAHAUC
FRIO
CHICK.
RANGIA JOHNSONI
POTAMIDES MATSONI
DISCORBIS
HET. MARG.
NODOSARIA BLANPIEDI
ZONES
CHIC'SHAY
PAYNES HAMMOCK
CHICKASAWHAY
FLINT RIVER
BUCKINGHAM LS.
CHOCTAWHATCHEE FM
SHOAL RIVER FM.
CHIPOLA FM.
HAWTHORNE FM.
TAMPA LS.
SUWANEE LS
OLIGOCENE
VICKSBURG
MISSING OR UNDIFFERENTIATED
RED BLUFF
UNDIFFERENTIATED
BYRAM
MARIANNA
FOREST HILL
BUCATUNNA
GLENDON LS.
MINT SPRINGS ML.
BYRAM MARL (NOT PRESENT IN PENINSULAR FLORIDA)
MARIANNA LS. (NOT PRESENT IN PENINSULAR FLORIDA)
EOCENE
JACKSON
WHITSETT
McELROY
CADDELL
MOODYS BRANCH
MSG.
DANVILLE LDG
MASS. PRATTI VALVULINERIA TEXANA
TEXTULARIA HOCKLEYENS
TEXTULARIA DIBOLLENSIS
CAM. JACKSONI CAM. MOODYS OPERC. VAUGHNI
YAZOO
SHUBUTA
PACHUTA
COCOA
NO CREEK
MOODYS BRANCH
OCALA
OCALA LS.
CLAIBORNE
YEGUA
COOK MT.
STONE CITY
SPARTA
WECHES
QUEEN CITY
REKLAW
CARRIZO
COCKFIELD
MICROFAUNA
CANE RIVER
TALLAHATTA
ZILPHA
WINONA
GOSPORT
LISBON
MERIDIAN
AVON PARK LS & TALLAHASSEE LS
LAKE CITY LS.
WILCOX
SABINETOWN
PENDLETON
MARTHAVILLE
HALL SUMMIT
LOGANSPORT
NABORTON
SUBSURFACE UNDIFF.
HATCHETIGBEE
BASHI
TUSCAHOMA
NANAFALIA
SALT MT (DOWN DIP)
FEARN SPRINGS
NAHEOLA
OLDSMAR LS.
MIDWAY
WILLS POINT
KINCAID
PORTERS CREEK
CLAYTON
PORTERS CK
CEDAR KEYS LS.
MESOZOIC
UPPER CRETACEOUS
GULF SERIES
NAVARRO UNDIFFERENTIATED
ARKADELPHIA
NACATOCH
MONROE GAS ROCK
PRAIRIE BLUFF
RIPLEY
EXOGYRA COSTATA
JACKSON GAS ROCK
SELMA
RIPLEY SAND
LAWSON LS
TAYLOR UNDIFFERENTIATED
SARATOGA
MARLBROOK
ANNONA (RES.)
OZAN
BUCKRANGE
(EXOGYRA CANCELLATA)
EXOGYRA PONDEROSA
EXOGYRA CANCELLATA ZONE
ANNONA (RESTRICTED)
TAYLOR BEDS.
AUSTIN
BROWNSTOWN
TOKIO
ECTOR CK. (CEN. LA)
VAG. REGINA
ARCOLA LS. MBR.
EUTAW & ECTOR CK.
EUTAW
ECTOR CHALK
AUSTIN BEDS
WOODBINE GROUP
TUSCALOOSA GROUP
EAGLE FORD
MISSING ON OUTCROP
McSHAN
UPPER WOODBINE OR LEWISVILLE
LEWISVILLE
LEWISVILLE UPPER TUSC. OF MISSISSIPPI
LEWISVILLE UPPER TUSCALOOSA OF MISSISSIPPI
GORDO
UPPER TUSCALOOSA
ATKINSON GROUP
LOWER WOODBINE OR EULESS CLAYS & DEXTER SANDS
LOWER TUSC. OF MISSISSIPPI PRESENT IN SUBSURF ALONG ARK-LA LINE
LOWER TUSCALOOSA
COKER
EOLINE
COTTONDALE
LOWER CRETACEOUS
COMANCHEAN SERIES
WASHITA GROUP
BUDA
GRAYSON
MAINSTREET
PAW PAW
WENO
DENTON
FORT WORTH
DUCK CREEK
SO. TYLER*
GEORGETOWN
MISSING
BASAL WASHITA PRESENT IN SUBSURF OF SW. ARKANSAS
PRESENT IN CENTRAL LOUISIANA LIMESTONES AND SHALES UNDIFFERENTIATED
DANTZLER FM**
LS & SH UNDIFF PROB EQUIV TO TEXAS SEC BUDA, DUCK CREEK, INCL.
UNDIFFERENTIATED
WASHITA
FRED'BURG GROUP
KIAMICHI
EDWARDS
COMANCHE PEAK
WALNUT
GOODLAND
NW. LA.
CEN. LA.
UNDIFF.
LS. AND SH. SEC. UNDIFF.
FREDERICKSBURG
TRINITY GROUP
CEN. TEXAS
NE TEXAS
PALUXY
MOORINGSPORT
FERRY LAKE A
RODESSA
TRAVIS PEAK
PINE ISLAND
DE QUEEN LS.
HOLLY CREEK DIERKS LS DELIGHT SD & PIKE GRAVEL
FERRY LAKE ANHY.
RODESSA JAMES LS.
UGR
LOWER GLEN ROSE
FERRY LAKE ANHYDRITE
FERRY LAKE AHY.
COAHUILA GROUP
SLIGO WITH PETTET LS. MEMBERS
SLIGO
HOSSTON
MISSING ON OUTCROP
UNDIFFERENTIATED
JURASSIC
UPPER JURASSIC
COTTON VALLEY GROUP
SCHULER
BOSSIER
NOT DIFFERENTIATED
MAY BE PRESENT
UNNAMED GROUP
HAYNESVILLE FM. WITH BASAL BUCKNER
Ls
SMACKOVER FM.
REYNOLDS OOLITE SMACKOVER FM
SMACKOVER FORMATION
NORPHLET FM
NORPHLET FORM.
NORPHLET FORMATION
PRESENCE UNKNOWN
TRIASSIC
NOT RECOGNIZED
PROBABLY PRESENT IN SUBSURFACE OF S.E. ALABAMA
PERMIAN ?
LOUANN SALT
WERNER FM. ANHY. MBR. CONGL. SD. MBR.
WERNER FORMATION ANHYDRITE MEMBER SAND MEMBER
MOREHOUSE FORMATION
EAGLE MILLS
EAGLE MILLS FORMATION NOT REACHED-PROB. PRESENT
WERNER FM. ANHY. MEMBER REC SEIS SURVEYS
NOT REACHED BUT PROBABLY PRESENT IN S.W. ALABAMA
NOT REACHED
A 10,800' WELL IN CRENSHAW CO MAY HAVE PENETRATED EAGLE MILLS
* THE MANESS SHALE IS CONSIDERED TO BE THE BASAL PART OF THE SOUTH TYLER FORMATION.
** IT IS RECOGNIZED THAT NORTHWARD FROM CENTRAL MISSISSIPPI THE LIMESTONE AND SHALE SEQUENCE CORRELATED WITH THE WASHITA CHANGES INTO A SANDSTONE AND SHALE SEQUENCE SIMILAR TO THE OVERLYING DANTZLER FORMATION.

Figure 3

GEOLOGY OF MISSISSIPPI

SURFACE

The geological formations exposed at the surface in Mississippi (Figure 3) range from lower Devonian to Recent.* Hard Paleozoic rocks of Devonian and Mississippian age crop out in Tishomingo County and dip south-southwesterly into the Black Warrior Basin. The Cretaceous sediments, ranging from upper Tuscaloosa (Gordo) through Prairie Bluff, crop out in arcuate belts from Kemper-Monroe Counties on the Alabama line to Tippah-Tishomingo Counties on the Tennessee line. The dip of these beds, normal to their strike, varies from southwesterly to west-northwesterly at rates of 45 to 25 feet per mile. Younger Tertiary sediments of Midway, Wilcox and Claiborne (early and middle Eocene) age crop out arcuately in belts lying west of the Cretaceous. The rates of dip are similar to those of the Cretaceous. The upper Eocene, Oligocene, and Miocene sediments strike more nearly uniformly northwesterly, dipping at relatively low angles to the south-southwest and southwest. Local anticlinal, synclinal and fault structures interrupt the normal homoclinal attitudes of the outcropping bedrock formations. Blanketing large portions of the State and masking the bedrock geology are high-level terraces along the larger stream courses, the "Citronelle" complex across south Mississippi, and the great Mississippi River Alluvial Plain, the "Delta", of northwestern Mississippi.

Most of the surface formations increase in thicknesses downdip. In addition, new formations develop that have no surface representation. Collectively, the sediments of Mississippi exhibit progressive southward downwarping and repeated northward transgressions of the sea. The beds are nearly all very shallow marine deposits, littoral deposits, lacustrine, estuarine and fluviatile deposits of the various ages. Cyclical deposition is well exhibited in some portions of the State, typically containing coarse basal transgressive sand or gravel, succeeded by marine or swampy clays or clay-shales, and, in turn, by regressive silty

*The correlation chart does not agree in all details with usages of the Mississippi Geological Survey or of the writer. The principal differences are well known to stratigraphers, are discussed in detail in many stratigraphic publications and need not be pointed out here. This chart was selected above others available because it will, perhaps, most nearly satisfy the Profession. Pre-Permian rocks are not shown.

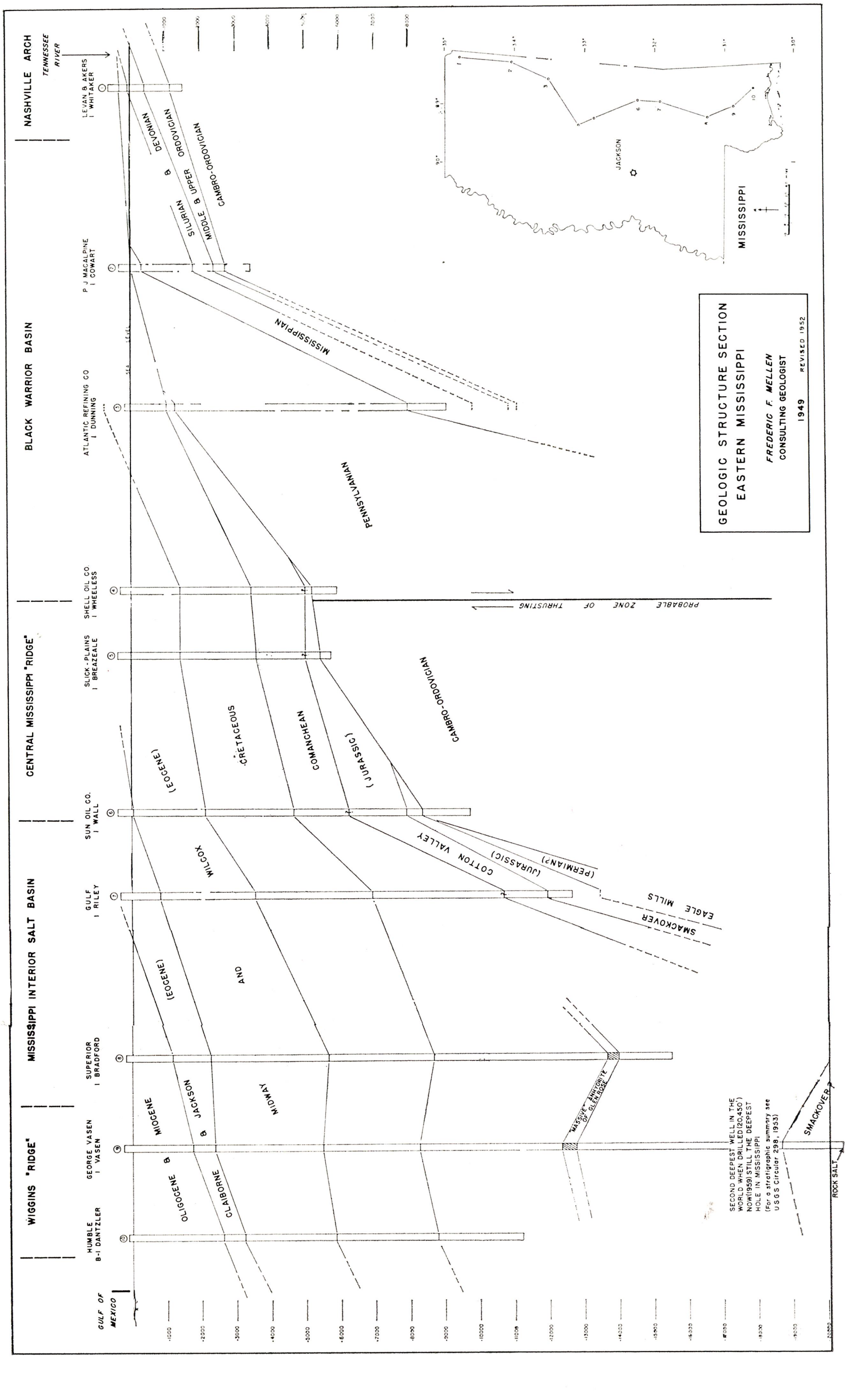

GEOLOGIC STRUCTURE SECTION
EASTERN MISSISSIPPI
FREDERIC F. MELLEN
CONSULTING GEOLOGIST
1949
REVISED 1952
NASHVILLE ARCH
BLACK WARRIOR BASIN
CENTRAL MISSISSIPPI "RIDGE"
MISSISSIPPI INTERIOR SALT BASIN
WIGGINS "RIDGE"
GULF OF MEXICO
TENNESSEE RIVER
LEVAN & AKERS 1 WHITAKER
P J MACALPINE 1 COWART
ATLANTIC REFINING CO 1 DUNNING
SHELL OIL CO 1 WHEELESS
SLICK - PLAINS 1 BREAZEALE
SUN OIL CO. 1 WALL
GULF 1 RILEY
SUPERIOR 1 BRADFORD
GEORGE VASEN 1 VASEN
HUMBLE B-1 DANTZLER
DEVONIAN
SILURIAN & ORDOVICIAN
MIDDLE & UPPER ORDOVICIAN
CAMBRO-ORDOVICIAN
MISSISSIPPIAN
PENNSYLVANIAN
PROBABLE ZONE OF THRUSTING
(EOCENE)
CRETACEOUS
COMANCHEAN
(JURASSIC)
WILCOX
COTTON VALLEY
(JURASSIC)
(PERMIAN?)
EAGLE MILLS
SMACKOVER
AND
MIOCENE
JACKSON
MIDWAY
OLIGOCENE
CLAIBORNE
MASSIVE ANHYDRITE OF GLEN ROSE
SECOND DEEPEST WELL IN THE WORLD WHEN DRILLED (20,450') NOW (1959) STILL THE DEEPEST HOLE IN MISSISSIPPI
(For a stratigraphic summary see U S G S Circular 298, 1953)
SMACKOVER ?
ROCK SALT
MISSISSIPPI
JACKSON

Figure 4

sands or silty clays. In this manner the epi-continental deposits of gravel, sand, clay, marl, limestone and chalk, lignite, siderite and other surface mineral substances were laid down.

SUBSURFACE

The study of the subsurface geology of Mississippi is still in its infancy. It owes its present stage of progress largely to the deep wells drilled for oil and gas. Without cuttings and cores, and the assistance afforded by modern well-logging techniques, it would be impossible to work out the deeply buried stratigraphic sequences and to reconstruct the geologic history with all its complexities of sedimentation and tectonics. Subsurface structural mapping is beginning to be an important tool in the finding of new oil and gas fields, because heretofore the densities of well control and the shallow depths to which wells were drilled were insufficient to be of much help.

A north-south cross-section (Figure 4) through eastern Mississippi illustrates the alternation of structural basins and structural ridges. The tectonic sequences are progressively younger toward the south: The Black Warrior Basin is largely late Paleozoic in age; the Interior Salt Basin is largely Mesozoic in age; and the Miocene Basin is largely Tertiary in age. In western Mississippi a series of volcanoes in Cretaceous times produced profound results in stratigraphy, structure and sedimentation. There are evidences that there may have been volcanic clusters in north-central Mississippi at one period or more than one in the Paleozoic era, but the actual proof of this is one of the many revelations remaining to deep drilling. Wells drilled to date have indicated some twelve miles of total sedimentary section in Mississippi, but no well has yet encountered "basement" rock. If the rate of development continues as progressively for another ten years as it has over the last twenty, the human mind can not now conceive of the wonders that subsurface geological discoveries will have made by the year 1969.

THE MINERAL RESOURCES

FUELS

OIL

The first commercial oil production in Mississippi was Union Producing Company's G. C. Woodruff No. 1 (Figure 5) on August

Figure. 5.—Mississippi's first commercial oil well, Union Producing Company's No. 1 G. C. Woodruff, discovery well, Tinsley Field, Yazoo County, Mississippi. First production, muddy and watery, is being burned in open pit. September 5, 1939.

29, 1939. The well, which opened the Tinsley Field, was a result of surface geological work in Yazoo County by the Mississippi Geological Survey as part of a project supported by the Works

Projects Administration, the Yazoo County Board of Supervisors and the Yazoo City Chamber of Commerce. The Tinsley Field is still the largest field in the State from the standpoint of total ultimate oil reserve; but it is hoped that larger fields will be found. In 1958 Tinsley passed the 150 million barrel mark of cumulative production. During the development of the Jackson Gas Field several of the wells on the south edge of the gas reservoir produced heavy asphaltic oil for which a small refinery

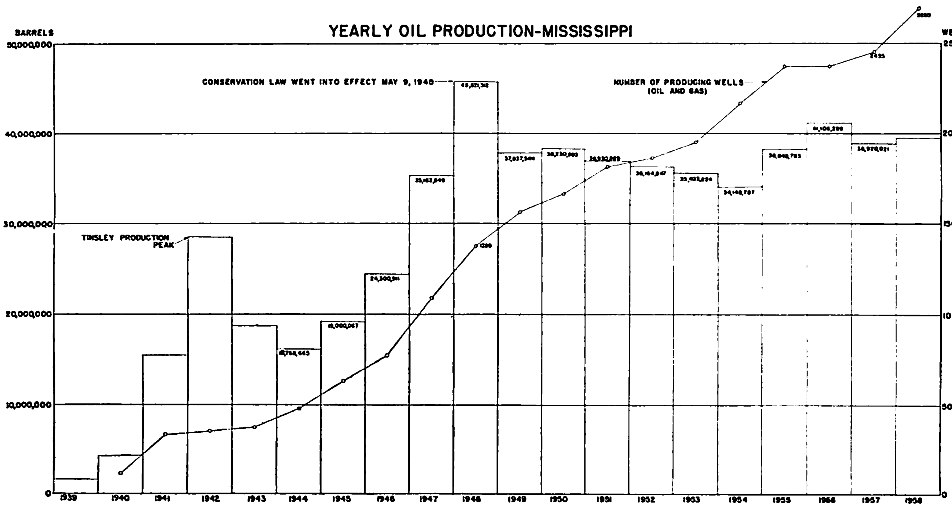
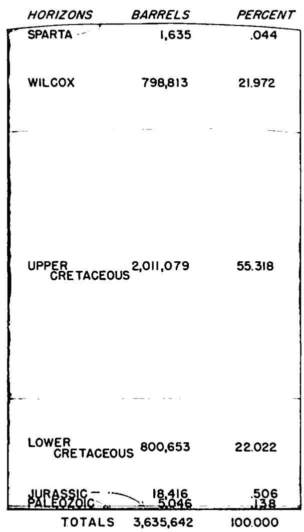


Figure 6

was promoted. Although this small oil production was not considered to be commercial, it was one of the first real indications that oil existed in commercial quantities in Mississippi.

In 1931 the Gulf No. 1 Long Bell in Clarke County, Mississippi, was drilled on a surface structure discovered by Tom McGlothlin and made a small amount of heavy oil and salt water from the Eutaw formation. It is significant that the Jackson Gas Field, the Quitman Fault and the Tinsley Dome were discovered by surface geological work. Subsequently seismic, gravity, magnetic and core drill exploration have become very important in the State.

The total oil produced and marketed from the wells in Mississippi was 583,388,637 barrels through December, 1958. Mississippi now ranks 9th among the oil producing states of the Nation. The yearly oil production is shown graphically by Figure 6, and the location of the fields is shown by Plate I. The State is currently producing approximately 40 million barrels of oil annually, which is by far the largest single item in the value of its mineral production. The Mississippi State Oil and Gas Board, which has regulatory supervision of drilling and producing the oil and gas wells and fields of the State, regularly publishes statistical reports giving the basic production data reported by the operators. These reports are outstanding in their completeness and accuracy.



STRATIGRAPHIC DISTRIBUTION
MISSISSIPPI OIL PRODUCTION
OCTOBER, 1958

Figure 7

By far the most oil productive strata in Mississippi are the upper Cretaceous beds. In October, 1958, more than 55 percent of the oil produced in Mississippi was from upper Cretaceous reservoirs (Figure 7). Nine years earlier this figure was 85 percent. Recent developments in the lower Cretaceous or Comanchean in southcentral Mississippi indicate that the lower Cretaceous yield will play an important role in sustaining future oil production. It is probable that the Wilcox has passed its peak and is declining in its relative importance. The Cotton Valley and Smackover of the upper Jurassic will increase in importance as more wells are drilled to the greater depths (Figure 8). The recent success ratio of wildcat wells drilled to Comanchean reservoirs in south Mississippi will contribute to the average depth to which wells are drilled in Mississippi, which is among the greatest in the Nation. The average annual depth of well penetration is progressively increasing and certainly the end of this increase is not yet in sight as long as prospective oil producing beds still lie unexplored at greater depths.

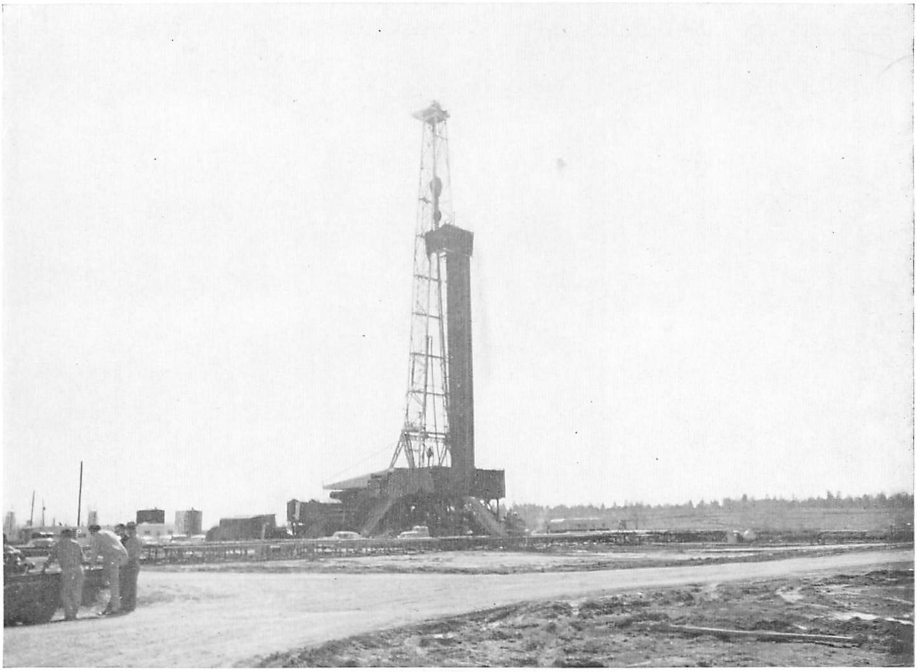


Figure 8.—Gulf Oil Corp. et al., Soso Field Unit Tract 28-7 Well No. 1-ZB, completed May 14, 1958, from Cotton Valley (perforated 15,247-56) and Hosston (perforated 12,598-617) formations. This well was drilled to 19, 040 feet, and the Cotton Valley (Jurrasic) completion makes it the deepest producing oil well in Mississippi. Photo by A. B. Wilson, 1958.

Mississippi has approximately 60,000 feet of sedimentary rocks known by well penetration and by projection of sediments. Nowhere in Mississippi has basement rock been penetrated. No part of the State can be considered to be "condemned" from the standpoint of possible oil production.

NATURAL GAS

In the production of natural gas, Mississippi ranks 8th among the states of the Nation. Cumulative production through 1958 was 2,343,562,755,000 cubic feet. The production of gas in Mississippi began in 1926 with the discovery of the Amory Gas Field in Monroe County in the Carter sandstone of Mississippian Chester age. In 1930 the Jackson Gas Field was discovered in the reef-type Jackson Gas Rock of upper Cretaceous age. This large, porous, reef-type limestone was developed over the top of a large volcanic island that ceased eruption during late upper Cretaceous time. Although neither the Amory Field nor the

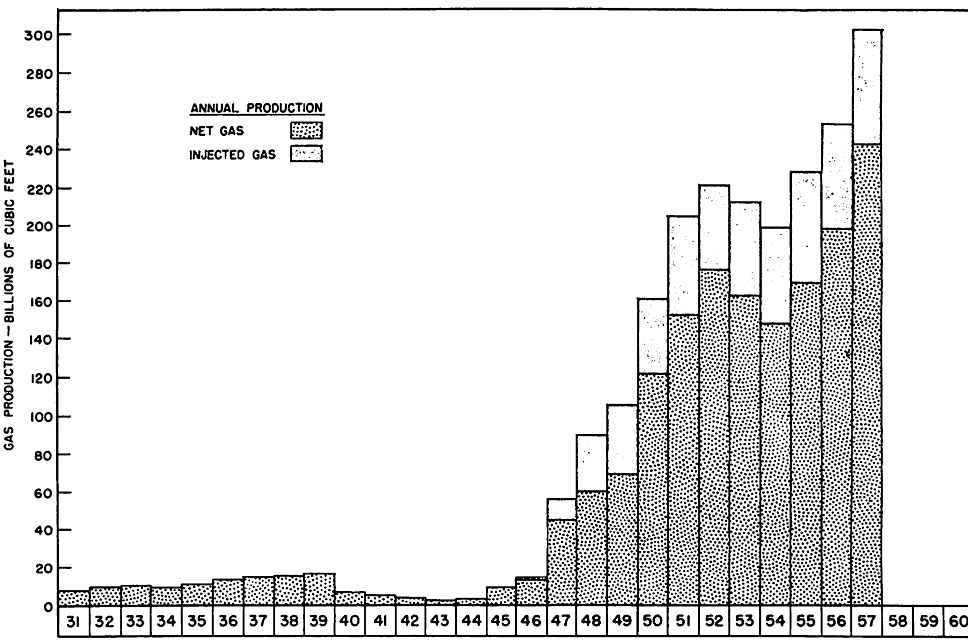


Figure 9

Jackson Field was large, their discovery and production provided incentive for additional drilling, which in time, led to the discovery of better and more profitable gas and oil fields in the State (Figure 9). Plate 2 shows the gas and oil fields of Mississippi and the great pipe line system transporting gas to points within and beyond the boundaries of Mississippi.

Natural gas is one of our most important and essential mineral products as in the providing of energy and heat and as a source of hydrogen for the manufacture of ammonia, hydrochloric acid and other products. In this last-named use it has been the basis of some of the large chemical plants within the State that are not adequately covered in this report. Natural gas is used increasingly as a fuel in firing brick and tile, cement and aggregate kilns and in the generation of electricity in a growing number of gas-fired steam turbine generating plants. The utilization of gas in the manufacture of brick, tile, cement, aggregates and other materials is a major factor in augmenting the permanent wealth of Mississippi, because these products are durable and useful in the advancement of culture and economics.

LIGNITE

Lignite is vegetal matter that has undergone diagenetic and metamorphic processes to the extent that it is intermediate between peat and bituminous coal. It is very dark-brown to black, firmly compacted, light in weight and contains hygroscopic moisture of 50 percent or more of its weight. Having accumulated in marshy environments, it commonly has an "underclay" and contains impurities of sand, silt and clay which contribute to its "ash" content. Some lignites, as do some coals, contain objectionable amounts of iron sulphide, pyrite, which is commonly associated with carbonaceous matter.

No state-wide study of lignite has been made since the publication in 1907 of Brown's "Lignite of Mississippi," Bulletin 3 of the State Survey, although many of the recent county reports contribute some additional specific information. Brown states (p. 24) that "beds beyond 3 feet in thickness are not very common and those beyond 5 feet are very unusual." The thickest lignite he observed was the "burning bed" 6 miles southwest of Lexington, Holmes County, where it is about 8 feet thick. There is little doubt that Dr. Brown's appraisal of the thicknesses was in some cases on the conservative side. The Drip Springs lignite of Winston County, estimated by him to be about 2 feet thick, was found by auger drilling to average 7.5 feet in thickness, and was reportedly thicker in nearby bored water wells (Bull. 38, pp. 81-82, 158-159). "The analysis shows this to be higher in fixed carbon than any other Mississippi lignite analyzed, and it is the best of the Winston County lignites examined" (p. 41). The record of the analyses (air-dried basis) of Brown's samples, under the direction of State Chemist W. F. Hand follows (pp. 51-52):

TABLE 1
ANALYSES OF MISSISSIPPI LIGNITES.

No.	Locality	Moisture	Volatile Matter	Fixed Carbon	Ash	Total	Sulphur	Calories	B.T.U.
2	Panola Co., 1 m. from Tocowa	13.93	44.65	35.17	6.25	100	.70	5,517	9,930
5	Itawamba Co., E. A. Palmer, II	12.51	36.55	38.44	12.50	100	3.27	4,928	8,870
6	Choctaw Co., W. A. Collins	11.44	36.57	38.56	13.43	100	2.05	5,115	9,207
7	Choctaw Co., Chester	11.39	39.79	38.72	10.10	100	2.83	5,236	9,425
8	Choctaw Co., Moses Bridges	14.29	38.90	37.71	9.10	100	.86	5,018	9,032
9	Choctaw Co., Patrick Ray	10.79	41.59	36.54	11.08	100	1.18	5,311	9,560
10	Choctaw Co., E. W. Oswalt	11.61	34.61	42.47	11.31	100	2.66	5,595	10,071
11	Choctaw Co., Snow's field	11.07	42.92	39.70	6.31	100	1.92	5,526	9,947
12	Winston Co., W. E. Huntley	9.91	37.08	36.42	16.59	100	2.95	4,987	8,977
13	Winston Co., Drip Spring	11.59	37.49	43.76	7.16	100	1.29	5,455	9,819
14	Winston Co., C. L. Taylor	14.20	35.24	41.80	8.76	100	.63	5,255	9,459
15	Kemper Co., DeKalb	11.40	32.61	37.00	18.99	100	1.80	5,112	9,201
16	Kemper Co., Pool's mill	13.61	37.14	42.10	7.15	100	2.64	5,439	9,790
17	Jasper Co., Garlandville	12.51	41.40	33.93	12.16	100	2.77	5,050	9,090
18	Scott Co., Pearl River	13.50	39.66	36.50	10.34	100	4.10	4,972	8,950
20	Holmes Co., G. F. Nixon	13.20	40.16	32.24	15.40	100	1.20	5,050	9,090
21	Holmes Co., Burning bed	13.87	36.32	34.46	15.36	100	1.39	4,681	8,426
22	Holmes Co., Tolarville	10.07	41.71	22.86	25.36	100	1.64	4,831	8,696
23	Holmes Co., Shenoah Hill	15.22	42.38	34.91	7.49	100	.91	5,112	9,201
25	Panola Co., Tocowa	11.84	38.96	29.36	19.84	100	.69	4,706	8,471
27	Tate Co., Sarah	12.01	38.51	25.88	23.60	100	1.40	4,457	8,022
30	Benton Co., J. C. Orman	14.29	47.38	30.73	7.60	100	1.26	4,769	8,584
35	Lafayette Co., near Caswell	9.60	30.54	28.86	31.00	100	.57	4,021	7,238
39	Webster Co., 3 m. from Alva	13.04	36.68	35.62	14.66	100	.48	4,582	8,247
40	Webster Co., Bellefontaine	14.90	39.21	35.57	10.32	100	.56	5,065	9,117
42	Calhoun Co., Pittsboro	13.96	39.97	38.58	7.49	100	.56	5,190	9,342
43	Calhoun Co., Camp Spring	12.20	46.27	30.86	10.67	100	.76	5,096	9,173
44	Calhoun Co., John McPhail	11.46	40.74	37.59	10.21	100	.78	5,486	9,875
45	Calhoun Co., near Slate Spring	12.26	37.43	41.94	6.37	100	.94	5,533	9,959
46	Yalobusha Co., J. J. Milton	12.62	40.85	39.94	6.59	100	2.05	5,392	9,706
47	Lafayette Co., W. J. Hogan	11.84	34.15	35.68	18.33	100	.48	4,598	8,276
48	Lafayette Co., near Delay	14.61	38.51	39.10	7.78	100	1.28	5,221	9,398
50	Lafayette Co., R. V. Edwards	14.60	38.59	35.21	11.60	100	1.83	4,878	8,780

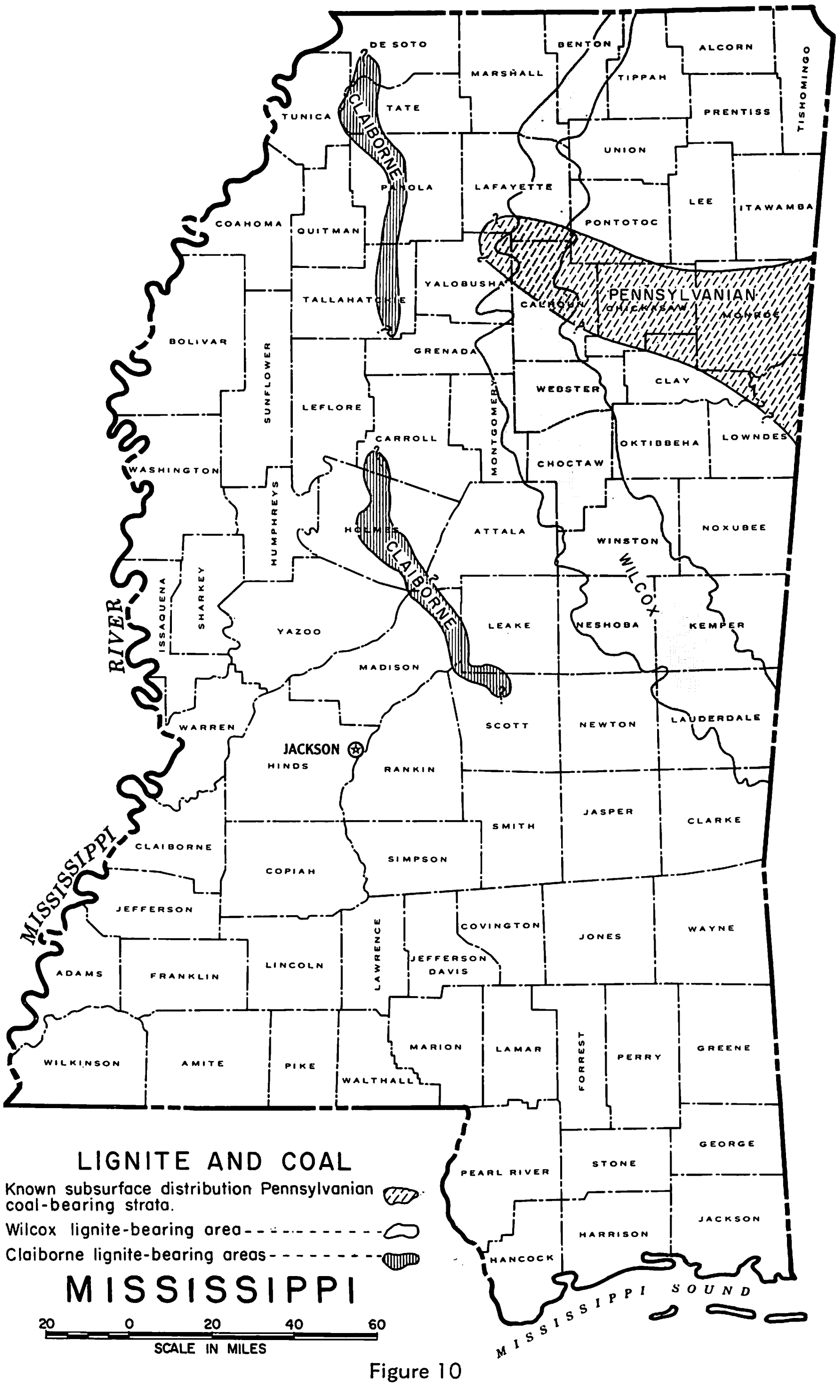

LIGNITE AND COAL
Known subsurface distribution Pennsylvanian coal-bearing strata.
Wilcox lignite-bearing area
Claiborne lignite-bearing areas
MISSISSIPPI
20 0 20 40 60
SCALE IN MILES
CLAIBORNE
CLAIBORNE
PENNSYLVANIAN
WILCOX
MISSISSIPPI RIVER
MISSISSIPPI SOUND
JACKSON
DE SOTO
MARSHALL
BENTON
TIPPAH
ALCORN
TISHOMINGO
TUNICA
TATE
PRENTISS
UNION
PANOLA
LAFAYETTE
LEE
ITAWAMBA
COAHOMA
QUITMAN
PONTOTOC
YALOBUSHA
CALHOUN
CHICKASAW
MONROE
TALLAHATCHIE
BOLIVAR
GRENADA
SUNFLOWER
WEBSTER
CLAY
LEFLORE
MONTGOMERY
CARROLL
OKTIBBEHA
LOWNDES
WASHINGTON
CHOCTAW
HUMPHREYS
HOLMES
ATTALA
WINSTON
NOXUBEE
ISSAQUENA
SHARKEY
YAZOO
LEAKE
NESHOBA
KEMPER
MADISON
WARREN
SCOTT
NEWTON
LAUDERDALE
HINDS
RANKIN
JASPER
SMITH
CLARKE
CLAIBORNE
COPIAH
SIMPSON
JEFFERSON
COVINGTON
JONES
WAYNE
LAWRENCE
LINCOLN
JEFFERSON DAVIS
ADAMS
FRANKLIN
WILKINSON
AMITE
PIKE
MARION
LAMAR
FORREST
PERRY
GREENE
WALTHALL
GEORGE
PEARL RIVER
STONE
HARRISON
JACKSON
HANCOCK

Figure 10

Lignite is found in Mississippi at the Tuscaloosa-Eutaw contact, at the Midway-Wilcox contact, throughout the Wilcox, in the middle Claiborne, in the Forest Hill and the Bucatunna (Figure 10). Only the Wilcox and Claiborne beds are considered to be economically important. From these sediments, millions of tons may be recovered by strip mining and many additional millions of tons may be recovered by underground mining, if markets can be developed.

The economic utilization of lignite is very limited in the Gulf Coastal Plain states. After World War I, several attempts to mine lignite in the Wilcox of Mississippi were not financially successful. Just prior to World War II, certain importers were anxious to exploit domestic sources of van dyke brown which is manufactured as a dark pigmenting material from certain grades of lignite. About that time a lignite development was started in Arkansas. It is reported that lignite is currently being used as a solid fuel additive to natural gas in a steam turbine electric generating plant in Texas.

Despite the abundance of lignite as an undeveloped mineral resource, its utilization must depend upon field sampling and mapping of the beds and upon thorough laboratory studies of the compositions and qualities of the material. It has never been and may never be a competitive fuel, but through laboratory experimentation many extremely valuable products may be extracted to render lignite mining and processing a profitable business. Simultaneous working of associated clays may locally aid in the financial success of lignite production.

COAL

Coal is not found near the surface in Mississippi, but is present at depths of 1000 feet or more in a few counties of north Mississippi. The beds, within the Pennsylvanian system, are in a subsurface westward extension of the Black Warrior Basin of Alabama where many large coal mines have been and are in operation. In the wells drilled in Mississippi which have penetrated coal, it is impossible to tell from available data the exact thicknesses of the seams. Some of them appear to be 24 inches or more in thickness, but, on the whole, the subsurface Pennsylvanian of Mississippi does not appear to carry as many workable seams of coal as do the equivalent surface and near-surface strata of Alabama. Coal has been noted in Monroe, Chickasaw, Calhoun and other nearby Counties from deep oil test well cuttings (Figure 10). The great problems of mining, together with lack of information on thicknesses and distribution of the seams, make this a resource of little present interest. Experimental work on underground semi-combustion of thin coal seams in Alabama and elsewhere may at some future date enable recovery of coal gases for fuel.

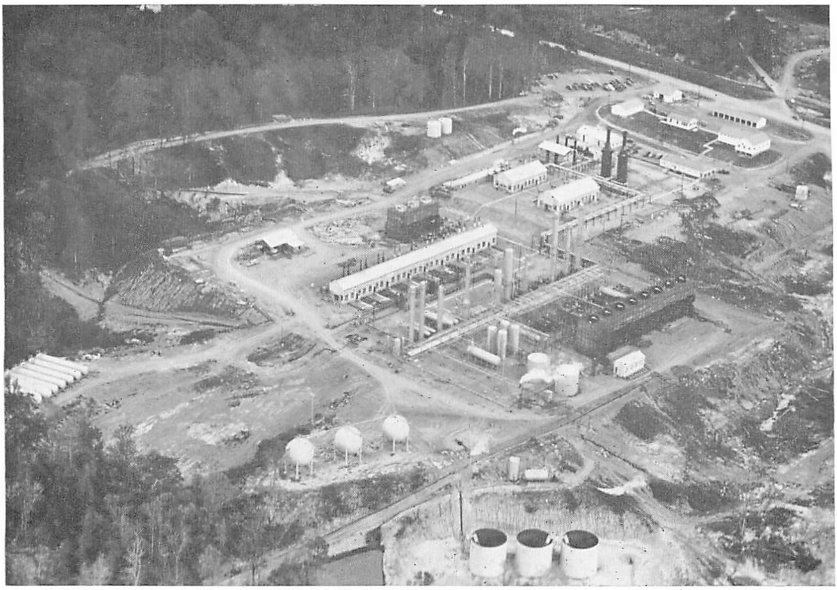


Figure 11.—The California Company's Cranfield Field Unit, Adams County, Mississippi, showing U. S. Highway 84 (right background), field offices, unit cycling plant and a few individual lease installations. The plant is designed to conserve reservoir energy in the primary recovery of Tuscaloosa oil, to recover the liquid hydrocarbons produced with the gas from the Tuscaloosa gas cap, and to return the stripped gas to the reservoir. Photo by Elwood M. Payne, October 24, 1947.

UNDERGROUND FUEL STORAGE

Two natural gas storage reservoirs and one LPG (liquified petroleum gases) storage project are in successful operation in Mississippi. The Mississippi Gas Company worked over the Amory Field and drilled two additional wells to convert it to the State's first natural gas storage project for "peak-shaving" and other emergencies. United Gas undertook the extremely expensive job of conditioning the Rankin County portion of the

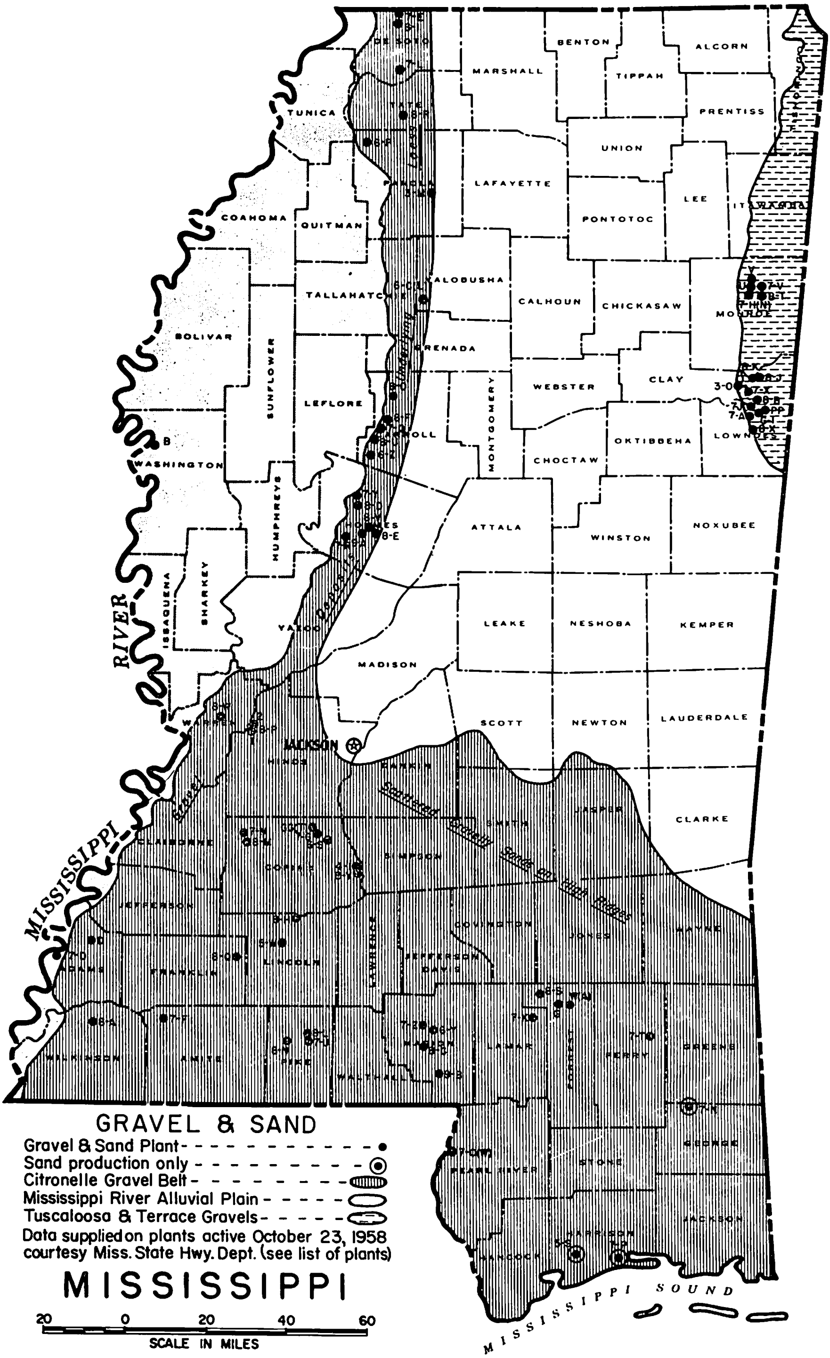

GRAVEL & SAND
Gravel & Sand Plant
Sand production only
Citronelle Gravel Belt
Mississippi River Alluvial Plain
Tuscaloosa & Terrace Gravels
Data supplied on plants active October 23, 1958 courtesy Miss. State Hwy. Dept. (see list of plants)
MISSISSIPPI
20 0 20 40 60
SCALE IN MILES
MISSISSIPPI
RIVER
MISSISSIPPI SOUND
JACKSON
DE SOTO
MARSHALL
BENTON
TIPPAH
ALCORN
TUNICA
TATE
PRENTISS
UNION
LAFAYETTE
LEE
COAHOMA
QUITMAN
PONTOTOC
TALLAHATCHIE
CALHOUN
CHICKASAW
BOLIVAR
SUNFLOWER
GRENADA
LEFLORE
WEBSTER
CLAY
MONTGOMERY
OKTIBBEHA
WASHINGTON
CHOCTAW
HUMPHREYS
ATTALA
WINSTON
NOXUBEE
SHARKEY
ISSAQUENA
LEAKE
NESHOBA
KEMPER
MADISON
SCOTT
NEWTON
LAUDERDALE
HINDS
CLARKE
CLAIBORNE
JEFFERSON
LAWRENCE
ADAMS
FRANKLIN
LINCOLN
WILKINSON
AMITE
PIKE
LAMAR
FORREST
PERRY
GREENE
PEARL RIVER
STONE
JACKSON
HANCOCK
HARRISON

Figure 12

Jackson Dome for similar storage. Both projects are in operation, the former having a working-gas capacity of 727,530,000 cubic feet and the later 2,569,305,000 cubic feet. The Petal salt dome near Hattiesburg in Forrest County is successfully operating as an LPG storage reservoir. An attempt to utilize the Edwards salt dome for LPG storage was unsuccessful. Fuel storage has become an increasingly important feature of our mineral economy. Therefore, the use of depleted reservoirs for fuels storage should be considered, as well as the use of excess natural gas for injection in pressure maintenance systems, as the California Company is doing at Brookhaven and Cranfield (Figure 11).

NON-METALLIC MINERALS

GRAVEL

Gravel deposits are widely distributed over Mississippi, many of them exceeding 40 to 50 feet in thickness. Figure 12 shows the locations of commercial gravel and sand aggregate plants over the State and the physical distributional relation of the deposits. The narrow belt along the Alabama line in northeastern Mississippi contains large deposits of gravel in the Tuscaloosa formation, as well as terrace and stream gravels derived chiefly from the Tuscaloosa, but in part from the Pottsville and in part from the basal Eutaw. The Tuscaloosa for many years supported large commercial operations in Tishomingo County and smaller plants in Itawamba County. At present, however, there are no commercial plants operating from the Tuscaloosa. The group of plants around Amory (Monroe County) are developing terrace gravels below the confluence of Tombigbee River

TABLE 2

ACTIVE GRAVEL & SAND PLANTS IN MISSISSIPPI (OCTOBER 23, 1958)

Plant Letter	*Producer*	*County*
B	Greenville Gravel Company	Washington
D	St. Catherine Gravel Company	Adams
G	American Sand & Gravel Company	Forrest
U	Amory Concrete Gravel Company	Monroe
V	Amory Sand & Gravel Company	Monroe
W(A)	American Sand & Gravel Company	Forrest
GG(T)	Traxler Gravel Company	Copiah
PP	Fleming Gravel Company	Lowndes

TABLE 2 (CONTINUED)

Plant Letter	*Producer*	*County*
3-M	Hotopohia Gravel Company	Panola
3-O	West Point Gravel Company	Clay
4-I	Green Bros. Gravel Company	Copiah
5-S	Gulfport Gravel Company (Sand Only)	Harrison
5-W	Lincoln Sand & Gravel Company	Lincoln
6-C(L)	Grenada Gravel Company	Yalobusha
6-I	Columbus Gravel Company	Lowndes
6-P	Crenshaw Gravel Co.	Panola
6-S	Green Bros. Gravel Company	Copiah
6-Y	Pearl River Sand & Gravel Company	Marion
6-Z	J. H. Farrish & Sons Gravel Company	Carroll
7-A	Ellis Sand & Gravel Company	Lowndes
7-D	St. Catherine Gravel Company	Adams
7-E	Memphis Stone & Gravel Company	DeSoto
7-F	John D. McCabe Gravel Company	Amite
7-G	Traxler Gravel Company	Copiah
7-H(N)	Nash Contracting Company	Monroe
7-J	Tombigbee Gravel Company	Lowndes
7-K	Allied Sand & Gravel Company	Lamar
7-L	Memphis Stone & Gravel Company	DeSoto
7-M	Traxler Gravel Company	Copiah
7-N	American Sand & Gravel Company (Sand Only)	George
7-O(W)	Williams Gravel Company	Pearl River
7-P	Leggett Sand & Gravel Company (Sand Only)	Harrison
7-Q	J. W. Rimmer Sand & Gravel Company	Carroll
7-R	Petermann Yazoo Ready-Mix	Holmes
7-T	Underwood Sand & Gravel Company	Perry
7-U	Green Bros. Gravel Company	Pike
7-V	Trace Road Sand & Gravel Company	Monroe
7-X	Smith Gravel Company #2	Lowndes
7-Y	Jack Ray Gravel Company, Lexington	Holmes
7-Z	Pearl River Sand & Gravel Company	Marion
8-A	McCabe Gravel Company	Wilkinson
8-B	C & P Gravel Company	Lowndes
8-C	Percy Whittom Gravel Company	Marion
8-D	Hammett Gravel Company	Holmes
8-E	Hammett Gravel Company	Holmes
8-F	J. J. Ferguson Sand & Gravel Company	Carroll
8-H	Hammett Gravel Company	Lincoln
8-I	Tennessee Gravel Company	DeSoto
8-J	Fleming Gravel Company #2	Lowndes
8-K	Columbus Gravel Company #2	Lowndes
8-L	Riverside Gravel Company	Pike
8-M	Traxler Gravel Company	Copiah
8-N	Green Bros., Inc.	Pike
8-O	J. W. Rimmer Sand & Gravel Company	Carroll
8-P	Cordova Sand & Gravel Company	Hinds

TABLE 2 (CONTINUED)

Plant Letter	*Producer*	*County*
8-Q	Mid-State Paving Company	Franklin
8-R	Northwest Miss. Sand & Gravel Company	Tate
8-S	Pittman Concrete Company	Forrest
8-T	D. N. Francis Sand & Gravel Company	Monroe
8-U	Farrish & Son Gravel Plant	Carroll
8-V	Yazoo Ready-Mix Company	Holmes
8-W	Lambert Gravel Company	Warren
8-X	C & P Gravel Company	Lowndes
8-Y	Green Bros. Gravel Company	Copiah
9-A	Hammett Gravel Company	Holmes
9-B	Wright Mud & Chemical Company	Marion

Figure 13.—Washing and screening plant. Crystal Springs Sand and Gravel Company (SW¼ Sec. 33, T. 6S., R. 9W.), 2 miles northeast of Crenshaw (M. G. S. Bull. 81, Fig. 45). Photo by F. E. Vestal, July 28, 1953.

and Bull Mountain Creek, and the group of plants around Columbus (Lowndes and Clay Counties) are working terrace sediments at the confluences of Tombigbee River and Buttahatchie and Luxapalila Rivers. The high water table commonly found in these stream terraces assures a water supply adequate for washing and screening the sands and gravels which are used in many types of concrete construction and as road material, or as aggregate in concrete or asphalt surfacing.

The great area in north-central and east-central Mississippi devoid of commercial gravel and sand plants depends largely on the Tuscaloosa-Terrace and the Citronelle belts for its coarse aggregates. Some thin layers in the Cretaceous and Tertiary have from time to time supplied limited quantities of material for local road surfacing. Some of the sediments in this area are pebble- and boulder-bearing but not sufficiently for commercial development.

The Citronelle gravel belt extends from the Tennessee line to the Louisiana line and from the Louisiana line to the Alabama line. Some of the gravel deposits, particularly some of the gravelliferous sands, are possibly Mio-Oligocene and therefore older than the Pliocene Citronelle, with which they are herein mapped for convenience. This belt maintains by far the greatest number of commercial aggregate plants (Figure 13).

The alluvial plain of the Mississippi River system has only two plants in operation at this time, one in Washington County and one at the mouth of St. Catherine Creek in Adams County. In periods of active construction within this belt, gravel plants are set up to dredge below stream level in Sunflower River and possibly other streams.

The production of the gravel and sand aggregate plants has been to a large extent periodic. Many commercial plants active during periods of construction find it necessary to shut down either temporarily or permanently, or to move to other locations when original contracts have been filled. Besides the plants now active (Figure 12, Table 2), hundreds of roadside pits and makeshift plants produce gravel for county road work and other local use. There is at present no way to estimate accurately the annual quantity and value of gravel and sand produced.

SAND

Other than sand excavated usually with gravel and used as aggregate, there is little commercial sand production in Mississippi.

In Tishomingo County a sand in the Eutaw contains a natural admixture of bonding clay and is shipped as a foundry sand throughout the Nation (Figures 14, 15).

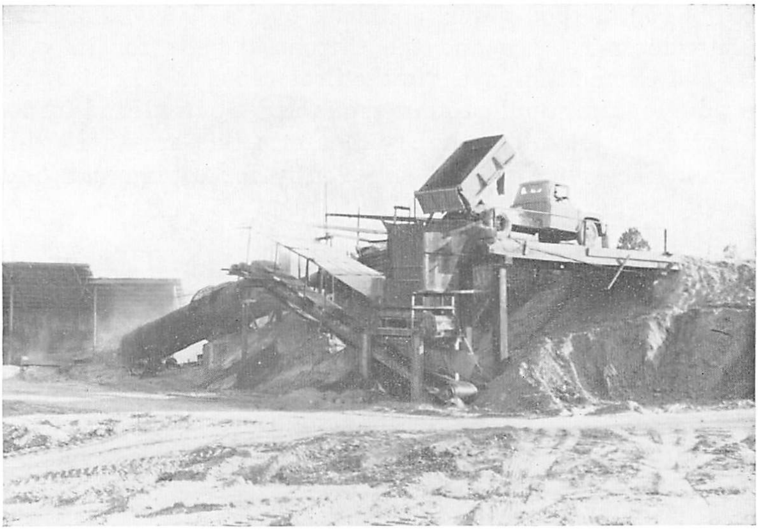


Figure 14.—Plant of Tri-State Sand Company, near Tishomingo City, Tishomingo County, Mississippi. Photo by W. S. Parks, April, 1959.

Figure 15.—A sand pit of Tri-State Sand Company, near Tishomingo City, Tishomingo County, Mississippi. Photo by W. S. Parks, February, 1959.

Quartz sands are one of the most abundant materials in Mississippi. They are present as surficial deposits along the Gulf coast, as river and coastal bars and terraces, and in many highly overloaded streams they produce a braided stream pattern similar to that developed in arid regions. Sands are abundant throughout post-Paleozoic deposits usually occupying a definite position in the basal portions of the many depositional cycles (cyclothems). Near the surface, sands are commonly stained yellow, brown or red with coatings of iron oxides, but below the zone of oxidation these same sands are clear and free of oxide films. Many sands are sufficiently high in silica content and free enough of other deleterious substances to be used in the manufacture of some grades of glass, and would be satisfactory for such use as to grain-size and other specifications. Sands of quality suitable for the manufacture of flint glass can easily be produced at various localities in the State, but it is not known whether or not their production would be competitive with sands imported for use by Knox Glass Bottle Company and General Electric Corporation.

CLAY

GENERAL

Clays and related materials comprise a very large group of mineral materials that is playing an increasingly important role in the economy of Mississippi. Thousands of products in common everyday use utilize clays in one way or another. The detailed classification of clays is difficult and highly technical, but that followed herein is somewhat simplified.

Clays and shales are produced from the weathering, assortment and deposition of pre-existing aluminous materials which may have been feldspathic rocks or may have been older clay or shale deposits or sedimentary deposits having a clay or shale content. In general, it is observed that clays subjected to the greatest leaching or lixiviation for prolonged periods of time and under specific climatic conditions tend to lose silica content and to increase in alumina content. In many cases, iron oxide content increases along with the alumina content. Under less severe conditions of leaching and sub-aerial weathering other types of clay are formed, having relatively high alumina content but without any loss of combined silica. Farther seaward in lagoons and estuaries, are other types of clays and shales; and still farther seaward, additional changes have taken place in the clays. Thus, something of the nature of the environment of deposition of a pure clay can be determined from its composition ranging from low silica and high alumina in the non-marine clays to low alumina and high silica in the clays deposited on the floor of the sea. Although this relationship may not always hold true, it is generally applicable to the clays of Mississippi. The bauxites and kaolins are in the northern parts of the State nearer the center of the old continental land mass, while lower alumina clays are the dominant types in southern Mississippi which was more frequently submerged by invasions of the Gulf of Mexico.

The uses of clays are so numerous and varied that research into the specific application would be necessary to answer all questions raised about Mississippi clays. Certain of these clays achieve fairly high degrees of purity and others are variously impure. Many commercially usable clay strata are only a few feet thick, while others may be hundreds of feet in thickness.

KAOLINITIC CLAYS

Kaolinitic clays are present at two horizons in Mississippi: at the surface of the Paleozoic below the Tuscaloosa formation in Tishomingo County and at the top of the Midway formation in a belt extending arcuately from northeastern Lauderdale County through Tippah County. The former deposits are known as the Little Bear residuum and the latter as the Betheden residuum. In both areas, the kaolinitic clays are associated with bauxitic clays and lateritic substances. The principal kaolin deposits are in the Betheden. The kaolin is commonly ten feet or more in thickness and in some cases grades into bauxitic materials. Analyses* in Table 3 are fairly representative of the quality of the kaolin or china clay. These clays are known to be present in millions of tons throughout the Betheden belt. They can be beneficiated for higher type ceramic products and are amenable to alumina extraction by sintering processes. They are useful in the manufacture of high alumina refractories and high alumina quick-setting and other specialty cements.

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*For convenience, a system of sample designation was worked out for the county minerals surveys (WPA-sponsored) as follows:

County (letter); hole, pit or location (number); type of sample (C, for confirmation, P, for primary, and S for statigraphic); sampled interval (number). Thus, sample A155P4 indicates the sample came from the County bearing the prefix "A", Tippah County; from test hole 155; that it is a "primary" sample, more or less representative of a sizable deposit, sampled in sufficient quantity for thorough laboratory testing; that it is the 4th interval sampled, which, by reference to the log in "Tippah County Mineral Resources" is found to be 8.9-14.0 feet.

Prefixes used are as follows:

Winston County (Bull. 38)	None
Tippah County (Bull. 42)	A
Lauderdale County (Bull. 41)	B
Yazoo County (Bull. 39)	C
Union County (Bull. 45)	D
Warren County (Bull. 43)	E
Forrest County (Bull. 44)	F
Adams County (Bull. 47)	G
Tallahatchie County (Bull. 50)	H
Scott County (Bull. 49)	J
Choctaw County (Bull. 52)	K
Montgomery County (Bull. 51)	L
Clay County (Bull. 53)	M
Pontotoc County (Bull. 54)	N
Monroe County (Bull. 57)	P
Itawamba County (Bull. 64)	R

The purpose of the designations is to establish a permanent index system relating the deposits to the test results and by which the test pieces and sample remainders can be stored systematically by the Mississippi Geological Survey for future reference.

TABLE 3

ANALYSES OF MISSISSIPPI CLAYS AND RELATED MATERIALS

Sample	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	ign-loss	n-vHF	H_2O*	Total
Bauxites								
S-97	57.68	0.14	15.36	1.68	25.22	0.30	0.60	100.98
S-66	36.63	26.27	14.18	1.60	14.83	1.84	3.25	98.60
S-76	30.35	32.65	15.02	1.60	16.10	1.26	2.95	99.93
S-1	47.75	2.15	27.24	2.40	19.76	0.42	0.78	100.50
X	34.91	1.19	32.70	1.19	12.35	15.98	1.75	100.07
Kaolins								
13-P1	38.51	1.61	41.76	1.65	14.34	2.01		99.88
A-87	39.05	0.40	41.73	3.00	13.52	2.09		99.79
D-186,3-4	43.15	0.85	38.91	2.10	15.08	.78		100.87
N-199,2-3	40.70	1.29	38.85	1.72	15.45	1.69		99.70
Ball Clays (Anauxite)								
153-P1	31.61	1.44	51.11	1.14	11.60	4.49		101.39
N-199,1	32.56	4.80	47.25	1.56	11.40	2.30		99.87
H-128,3-4	29.22	2.19	57.32	.81	9.69	.76		99.99
B-64,P1	34.24	0.84	51.77	1.17	10.43	1.87		100.32
Bentonite								
C-53-P1	24.97	5.15	57.89	.50	10.60	1.06		100.17
No. 6	17.47	5.38	60.60	----	9.83	7.70		100.98
No. 1	19.69	5.96	59.07	----	8.55	7.26		100.53
No. 3	23.29	5.92	59.53	----	8.14	3.16		100.04
Montmorillonitic Clays (Marine Clay-Shales)								
A-264,C1	17.64	1.67	72.58	0.25	6.95	1.72		100.81
53AP1	21.12	6.07	61.87	1.05	7.07	4.08		101.26
J4,5	22.96	5.16	51.65	0.78	14.80	3.68		99.03
C59,P1	20.00	6.70	56.84	0.65	9.79	7.22		101.20
C4,C1-3	17.50	7.70	48.99	0.80	13.25	11.90**		100.14
Loess								
C9,C1-8	16.20	3.35	66.27	0.75	8.10	6.14		100.81
C1,C1-3	16.05	3.37	67.62	0.60	7.53	4.62		99.79
Loessal Clays								
C23,C1-3	14.66	4.25	73.05	0.85	4.08	4.11		101.00
C24,C1-2	12.40	4.58	74.78	0.90	2.85	5.72		101.23
E144,C1-3	15.02	2.31	74.67	0.89	2.84	4.80		100.53

*Analyses other than bauxite are on dry basis.

**10.84% CaO.

BAUXITES

S-97 — J. R. Warren, 14.9′-17.0′, East Smoky Top, Pontotoc Co., Miss. (B. 19, p. 93.) *Betheden.*

S-66 — John Wiley Tutor, 4.1′-8.8′, Pontotoc Co., Miss. (B. 19, p. 136.) *Betheden.*

S-76 — J. V. Wallace, 4.6′-8.2′, Union Co., Miss. (B. 19, p. 143.) *Betheden.*

S-1 — I. V. James, 0-12′, Tippah Co., Miss. (B. 19, p. 155.) *Betheden.*

X — Sturgis, Oktibbeha Co., Miss. (B. 19, p. 171.) *Betheden.*

KAOLINS

13-P1 — E. P. Rainey, 11′-21′, Winston Co., Miss. (B. 38, p. 93.) *Betheden.*

A-87 — W. L. Roberson, 4.9′-12′, Tippah Co., Miss. (B. 42, p. 147.) *Betheden.*

D-186,3-4 — O. D. Gray, 13.0′-23.8′, Union Co., Miss. (B. 45, p. 126.) *Betheden.*

N-199,2-3 — W. C. Sledge, 6.1′-10.5′, Pontotoc Co., Miss. (B. 54, p. 115.) *Betheden.*

BALL CLAYS

153-P1 — J. W. Sullivan, Winston Co., Miss. (B. 38, p. 126, p. 133.) *Fearn Springs.*

N-199-1 — W. C. Sledge, 0-6.1′, Pontotoc Co., Miss. (Bull. 54, p. 96.) *Fearn Springs.*

H-128,3-4 — A. N. & S. R. Newman, 9.9′-20.1′, Tallahatchie Co., Miss. (B. 50, p. 112.) *upper Zilpha.*

B-64,P1 — Ed Cannady, 6.2′-11.4′, Lauderdale Co., Miss. (B. 41, p. 204.) *Fearn Springs.*

BENTONITES

C-53,P1 — W. E. & R. E. Selby, 1.75′, Yazoo Co., Miss. (B. 39, p. 99.) *Vicksburg.*

No. 6 — Attapulgus Clay Co. (Filtrol), Polkville, Smith Co., Miss. (W. F. Hand, 149, 937.) *Vicksburg.*

No. 1 — Watkins, Pontotoc Co., Miss. (W. F. Hand, 149, 932.) *Ripley.*

No. 3 — Mrs. B. E. Evans, Itawamba Co., Miss. (W. F. Hand, 149, 934.) *lower Eutaw.*

MONTMORILLONITIC CLAYS

A-264,C1 — Kate Davis, 0-25′, Tippah Co., Miss. (B. 42, p. 183.) *middle Porters Creek.*

53AP1 — C. J. Morehead, 2′-37′, Winston Co., Miss. (B. 38, p. 140.) *middle Porters Creek.*

J4,5 — Adams Edgar Lbr. Co., 6.9′-13.0′, Scott Co., Miss. (B. 49, p. 121.) *upper Yazoo.*

C59,P1 — Kate Smith, 18.7′-31.7′, Yazoo Co., Miss. (B. 39, p. 94.) *upper Yazoo.*

C4,C1-3 — Ed Cooper, 1.7′-34.6′, Yazoo Co., Miss. (B. 39, p. 81.) *lower Yazoo.*

LOESS

C-9, C1-8 — J. A. Brunner, 0.5′-63.7′, Yazoo Co., Miss. (Bull. 39, p. 109.)

C1, C1-3 — Jim Gibbs, 0.4′-31.4′, Yazoo Co., Miss. (Bull. 39, p. 109.)

LOESSAL CLAYS

C-23,C1-3 — C. F. Harris, 0.3′-18.6′, Yazoo Co., Miss. (Bull. 39, p. 109.)

C-24,C1-2 — State of Miss., 0.3′-15.6′, Yazoo Co., Miss. (Bull. 39, p. 109.)

E-144,C1-3 — O. L. Elder, 0-14.9′, Warren Co., Miss. (Bull. 43, p. 81.)

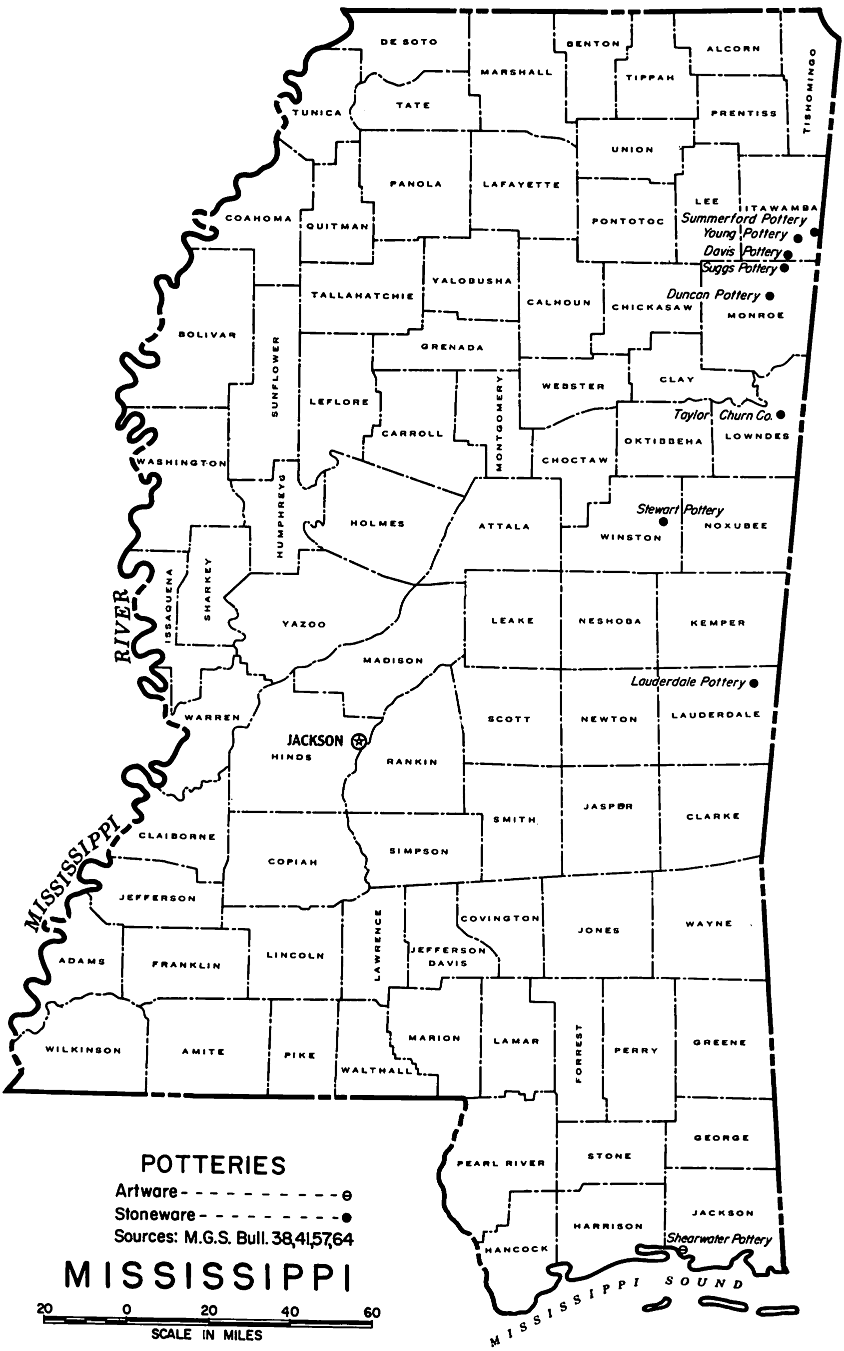
DE SOTO
MARSHALL
BENTON
TIPPAH
ALCORN
TISHOMINGO
TUNICA
TATE
PRENTISS
UNION
PANOLA
LAFAYETTE
LEE
ITAWAMBA
COAHOMA
QUITMAN
PONTOTOC
Summerford Pottery
Young Pottery
Davis Pottery
Suggs Pottery
YALOBUSHA
TALLAHATCHIE
CALHOUN
CHICKASAW
Duncan Pottery
MONROE
BOLIVAR
SUNFLOWER
GRENADA
LEFLORE
MONTGOMERY
WEBSTER
CLAY
Taylor Churn Co.
CARROLL
OKTIBBEHA
LOWNDES
WASHINGTON
HUMPHREYS
CHOCTAW
Stewart Pottery
HOLMES
ATTALA
WINSTON
NOXUBEE
ISSAQUENA
SHARKEY
YAZOO
LEAKE
NESHOBA
KEMPER
RIVER
MADISON
Lauderdale Pottery
SCOTT
NEWTON
LAUDERDALE
WARREN
JACKSON
HINDS
RANKIN
JASPER
CLARKE
SMITH
CLAIBORNE
SIMPSON
COPIAH
MISSISSIPPI
JEFFERSON
COVINGTON
JONES
WAYNE
LAWRENCE
JEFFERSON DAVIS
ADAMS
FRANKLIN
LINCOLN
WILKINSON
AMITE
PIKE
WALTHALL
MARION
LAMAR
FORREST
PERRY
GREENE
GEORGE
STONE
PEARL RIVER
JACKSON
HARRISON
HANCOCK
Shearwater Pottery
MISSISSIPPI SOUND
POTTERIES
Artware - - - - - - - - - - - ⊖
Stoneware - - - - - - - - - - ●
Sources: M.G.S. Bull. 38,41,57,64
MISSISSIPPI
20 0 20 40 60
SCALE IN MILES

Figure 16

ANAUXITIC OR BALL CLAYS AND STONEWARE CLAYS

The clays in this category, as shown by the four analyses (Table 3) are considerably lower in alumina and higher in silica than the kaolins. Some of these clays are extremely fine-grained, plastic, and tough and form excellent ceramic bond clays. They are found chiefly in the Fearn Springs (basal Wilcox) and in part of the Claiborne. Where clays of this type are silty or contain fine sand, they have been used for a great many years in the manufacture of pottery (Figure 16). The specific county mineral

Figure 17.—Commercial clay bed in the Kentucky-Tennessee Clay Company's pit (NW. 1/4, Sec. 21, T. 7 S., R. 9 W.), 3 miles southeast of Crenshaw (M. G. S. Bull. 81, Fig. 42). Photo by F. E. Vestal, May 9, 1956.

survey reports give descriptions of these clays (Figure 17), which appear to be considerably more abundant than the kaolins. These clays can be beneficiated through the reduction of iron oxide and titanium oxide for high grade ceramic use. They may eventually be considered raw materials for alumina extraction in sintering processes.

A relatively thin bed of ball clay underlying a lignite bed at the top of the Tuscaloosa is known in Monroe and Itawamba Counties. Clays of this type are not mentioned in the geologic

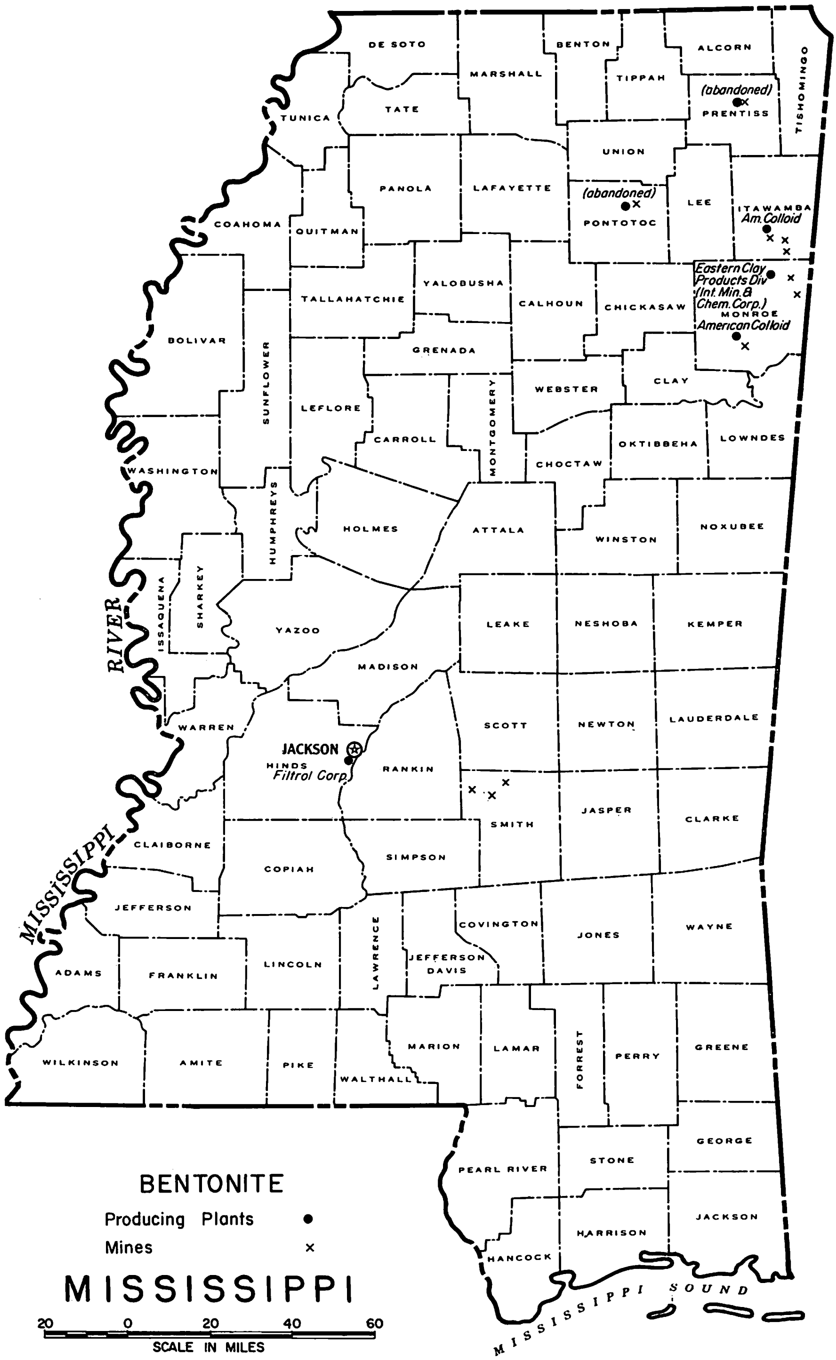
DE SOTO
MARSHALL
BENTON
TIPPAH
ALCORN
TISHOMINGO
TUNICA
TATE
(abandoned)
PRENTISS
UNION
PANOLA
LAFAYETTE
(abandoned)
PONTOTOC
LEE
ITAWAMBA
Am.Colloid
COAHOMA
QUITMAN
TALLAHATCHIE
YALOBUSHA
CALHOUN
CHICKASAW
Eastern Clay Products Div (Int. Min. & Chem. Corp.)
MONROE
American Colloid
BOLIVAR
SUNFLOWER
GRENADA
LEFLORE
WEBSTER
CLAY
MONTGOMERY
CARROLL
OKTIBBEHA
LOWNDES
WASHINGTON
CHOCTAW
HUMPHREYS
HOLMES
ATTALA
WINSTON
NOXUBEE
ISSAQUENA
SHARKEY
YAZOO
LEAKE
NESHOBA
KEMPER
RIVER
MADISON
SCOTT
NEWTON
LAUDERDALE
WARREN
JACKSON
HINDS
Filtrol Corp.
RANKIN
SMITH
JASPER
CLARKE
MISSISSIPPI
CLAIBORNE
COPIAH
SIMPSON
JEFFERSON
COVINGTON
JONES
WAYNE
LAWRENCE
JEFFERSON DAVIS
ADAMS
FRANKLIN
LINCOLN
WILKINSON
AMITE
PIKE
WALTHALL
MARION
LAMAR
FORREST
PERRY
GREENE
GEORGE
STONE
PEARL RIVER
BENTONITE
Producing Plants •
Mines ×
JACKSON
HARRISON
HANCOCK
MISSISSIPPI
MISSISSIPPI SOUND
20 0 20 40 60
SCALE IN MILES

Figure 18

literature from south Mississippi, although some of the clays from Adams County appear to have ceramic utility. High-grade light-colored face brick such as are being manufactured at the present time in Marshall County, can be manufactured from these clays in many of the counties of north Mississippi.

BENTONITE CLAYS

Bentonite is characteristically an extremely fine-grained, tough clay formed by the alteration of volcanic ash, evidence of which is presented in the form of unaltered shards of volcanic glass and biotite mica. The four analyses records (Table 3) indicate the approximate range in chemical composition of this im-

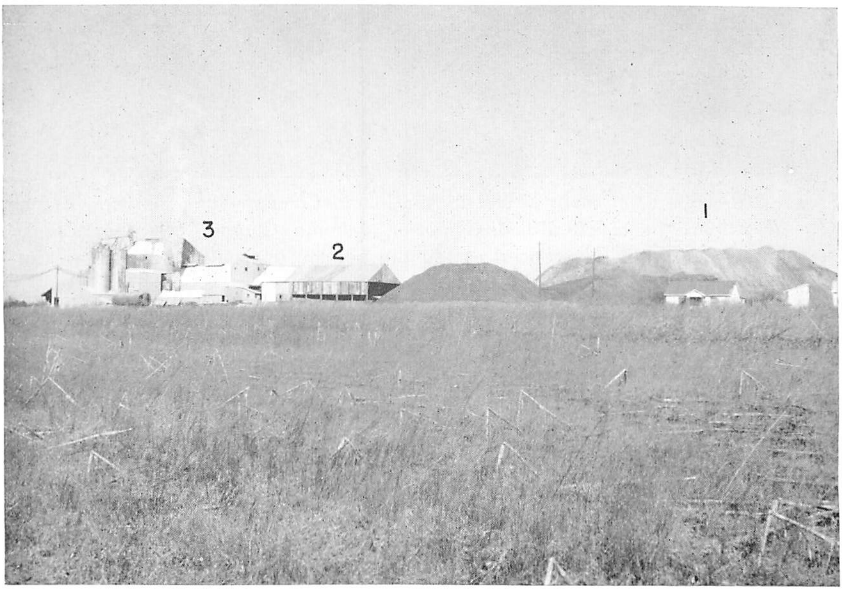

Figure 19.—Dixie Bond plant, Eastern Clay Products Department of International Mineral & Chemical Corporation at Smithville, Monroe County, Mississippi: (1) stockpile, approximately 65,000 tons of bentonite, (2) dry shed, (3) kiln, milling and storage housing. Photo Eastern Clay Products, January 21, 1959.

portant clay, the chief mineral component of which is montmorillonite. Impurities commonly found in bentonite are sand and silt, non-bentonite clay, lime in the form of marine shells, and less commonly lignite and pyrite. Bentonite clays usually have a waxy or a mealy texture, but in either case, a good bentonite is easily distinguished from other types of clay.

Figure 20.—Aberdeen plant of American Colloid Company on Aberdeen Branch of Illinois Central Railroad Company, Monroe County. "Panther Creek" Eutaw bentonite is produced as foundry bonding clay. Photo American Colloid Company, 1959.

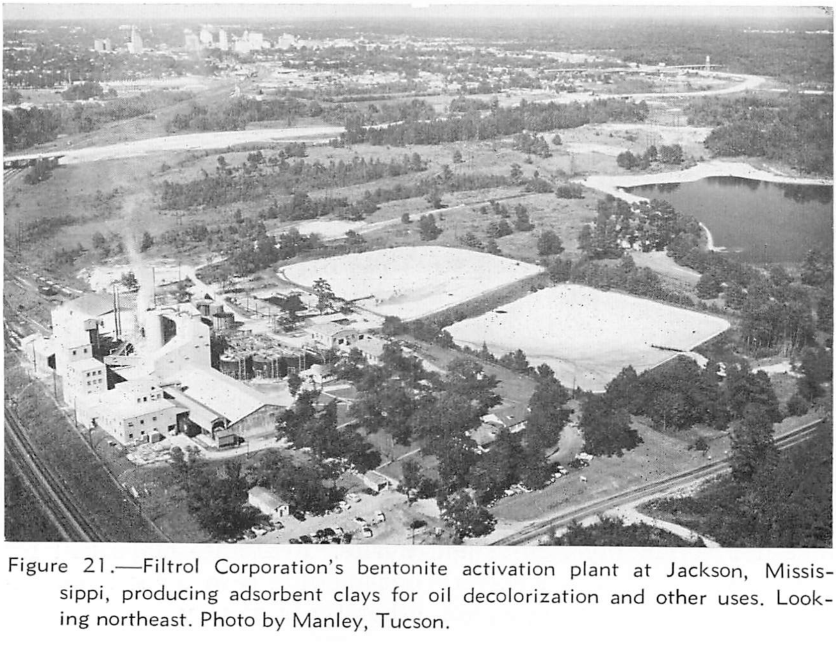

Figure 21.—Filtrol Corporation's bentonite activation plant at Jackson, Mississippi, producing adsorbent clays for oil decolorization and other uses. Looking northeast. Photo by Manley, Tucson.

The principal commercial deposits are in Smith, Itawamba and Monroe Counties (Figure 18). By far the thickest deposits are in the basal Eutaw formation in Itawamba and Monroe Counties, where millions of tons have been marketed by the three principal operating companies, Filtrol Corporation, Eastern Clay Products Division of International Minerals and Chemical Corporation and American Colloid Company (Figures 19, 20). Filtrol ships the raw bentonite from its northeast Mississippi mines and its Smith County mines to its activation plant (Figure 21) at Jackson, which produces bleaching clay used in the refining of oils and other materials that respond to the highly adsorbent properties of this clay. The other companies produce the bentonite chiefly for bonding clay for use in foundry molding sands. This industry has been active in Mississippi since 1939. The clays are mined, kiln dried to a low hygroscopic water content, ground extremely fine, and sacked in moisture-proof bags for shipment to foundries all over the Nation.

An admirable conservation practice has been worked out between the two industries which are competitive for the raw material but not for the market. The yellowish and brownish oxidized collar or fringe of the bentonite bed around the edges of the hills contains ferric iron hydroxide which is undesirable in the activation processes, but these weathered or incipiently weathered clays have increased bonding strength, which renders them more desirable as bonding clays. Accordingly, Filtrol Corporation has had an arrangement with at least one of the bonding clay companies to sell this so-called "skimmer" clay, which is transported to the stockpile of the bonding clay company and thus maximum utilization is made of these valuable bentonite deposits in this area.

Bentonites are also used as drilling muds, as suspending agents and for many other purposes. Tests run on Mississippi bentonites have indicated that the addition of alkalis will improve their suspending properties and render them equal in many respects to the better drilling muds on the market today.

Bentonite was first recognized in Mississippi in the late 1920's, and the production of this clay has grown rapidly to be one of the largest mineral industries of the State. Little is known about the reserve of commercial bentonite in the State. Data relating to the annual production are not available; however, there is reason to believe, in view of the large output of the plants now operating and of the limited areas in which commercial thicknesses of these clays are known, that the time has come for concern over the future supplies of raw material for the existing demand.

The small deposit in Prentiss County and the considerably larger deposit of bentonite in the Ripley formation in Pontotoc County were worked out in a very short time. In the Vicksburg limestone belt, a great deal of bentonite is known where its relative thinness and the fact of its being sandwiched between beds of hard limestone and marl militate against its exploitation. Thin or very local beds of bentonite have been reported at numerous horizons throughout the Cretaceous, in the Midway, in the basal Wilcox, in the Claiborne, in the Yazoo clay of the Jackson formation and in the Bucatunna clay member of the upper Vicksburg formation. It is possible that commercial thicknesses of bentonite may exist locally at the same horizons that these beds only a few inches in thickness are known. Further exploration over the State may discover such reserves, although such a discovery does not appear probable.

MONTMORILLONITIC AND MARLY CLAYS, ABSORBENT MATERIAL, LIGHTWEIGHT AGGREGATE

The clays comprising these groups are among the most abundant mineral substances in the State and are at many places hundreds of feet in thickness. It will be noted that they are somewhat similar to bentonite in chemical composition, in that they usually contain a relatively low alumina content, a relatively high iron oxide content and a high silica content (Table 3). Many of these clays have been determined to have montmorillonite as their chief mineral constituent. They are largely of marine origin and in many cases contain calcareous marine shells which would be objectionable in some clay products but would be desirable in others. From the pure clay, these deposits grade on the one hand into silty or finely sandy materials and on the other into highly marly, calcareous materials. The clays of this group, although extremely abundant in the State, have not been used to any great extent. Efforts to develop them as insulating material have been made, but the most successful commercial use to date has been in the preparation of absorbent substances and lightweight expanded clay aggregate for concrete. Two

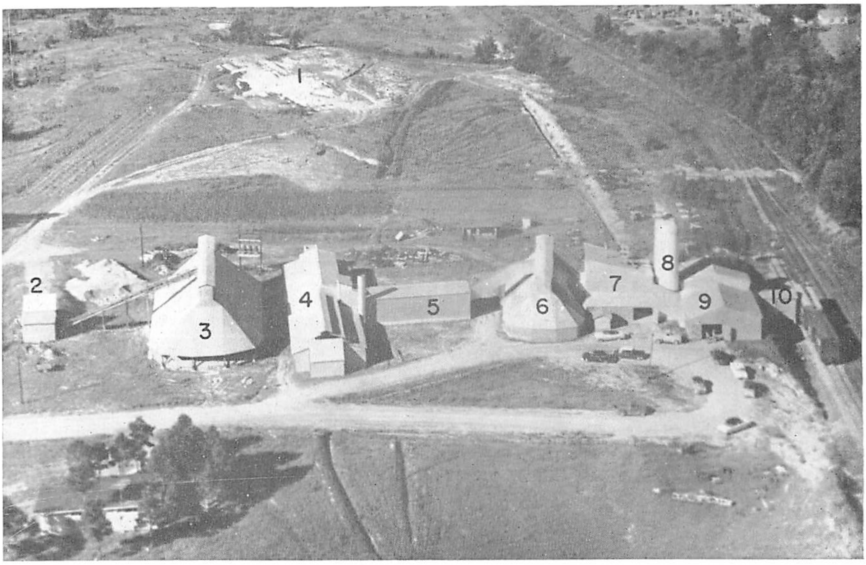

Figure 22.—Plant of Howell-Southern Products, Inc., Ripley, Tippah County, Mississippi, which produces fired clay aggregated for absorbent and deodorizing purposes: (1) clay pit-basal Porters Creek, (2) shredding shed, (3) dry shed, (4) kiln building, (5) cooler, (6) product storage, (7) screening and crushing, (8) silos, (9) bagging, and (10) loading. Photo by Richard Allin, December, 1958.

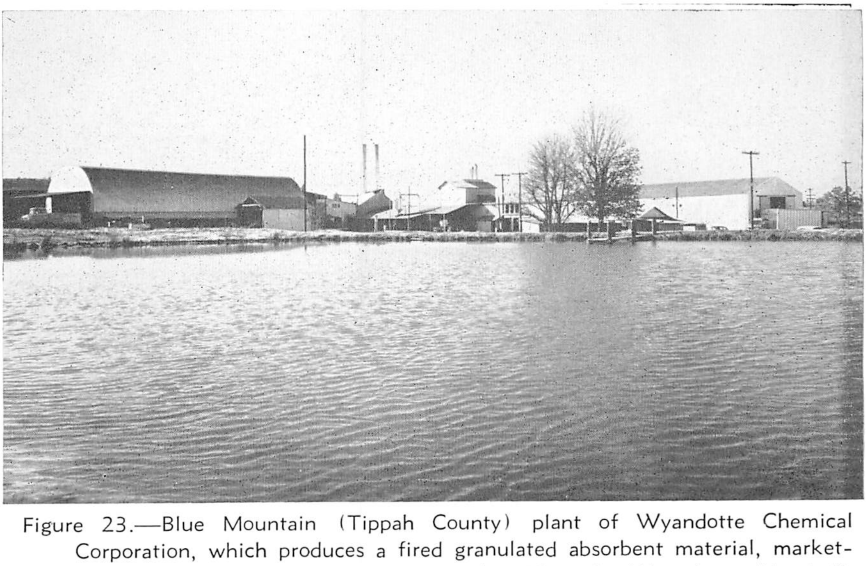

Figure 23.—Blue Mountain (Tippah County) plant of Wyandotte Chemical Corporation, which produces a fired granulated absorbent material, market-as "Zorball", from the Porters Creek clay. Photo by Wyandotte, March 7, 1959.

plants in Tippah County produce a fired granular aggregate used extensively as an industrial absorbent (Figures 22, 23). It is finding a growing market in the poultry industry as an absorbent, in brooder houses, cages and other places and later as a fertilizer or soil conditioner. The finely porous granules of different sizes resulting from the high temperature kiln firing of the Porters Creek clay in Tippah County have countless everyday uses that are being developed by Wyandotte Chemical Company and Howell-Southern Clay Products Company, Inc.

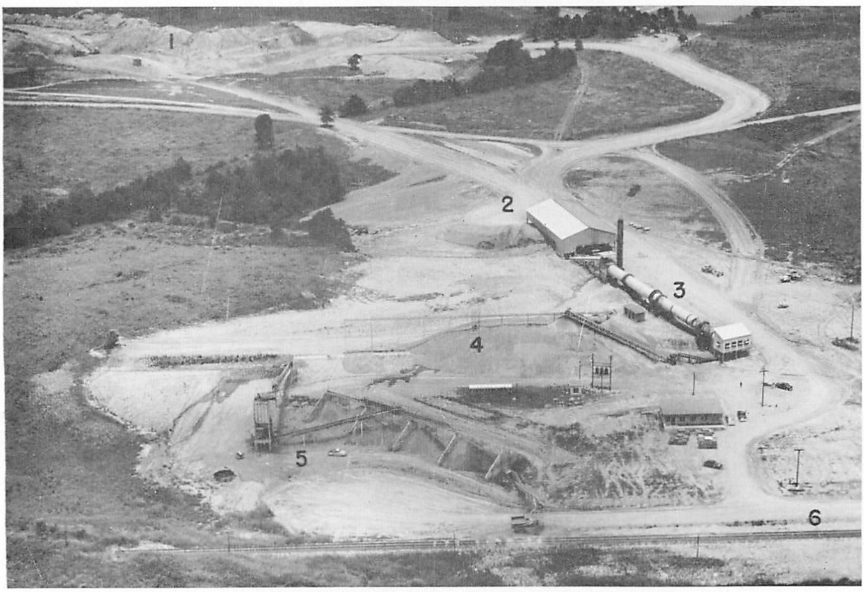

Figure 24.—Miss-Lite aggregate plant of Jackson Ready-Mix Concrete at Cynthia, Hinds County, Mississippi: (1) pits opened in the Yazoo clay, (2) clay dry shed, (3) rotary kiln, (4) clinker storage area, (5) grinding, screening and storage of graded aggregates, and rail or truck shipping facilities. Photo by Frank Noone, July 2, 1958.

At Cynthia, Hinds County, the Miss-Lite Division of Jackson Ready-Mix Concrete put into operation in 1958 the State's first large lightweight concrete aggregate plant producing a graded expanded clay aggregate for structural concrete out of the Yazoo clay marl. This plant is currently producing 300 tons of graded aggregate daily, principally for use by producers of concrete block throughout the State (Figure 24). Continuing research by the company has discovered other valuable commercial application

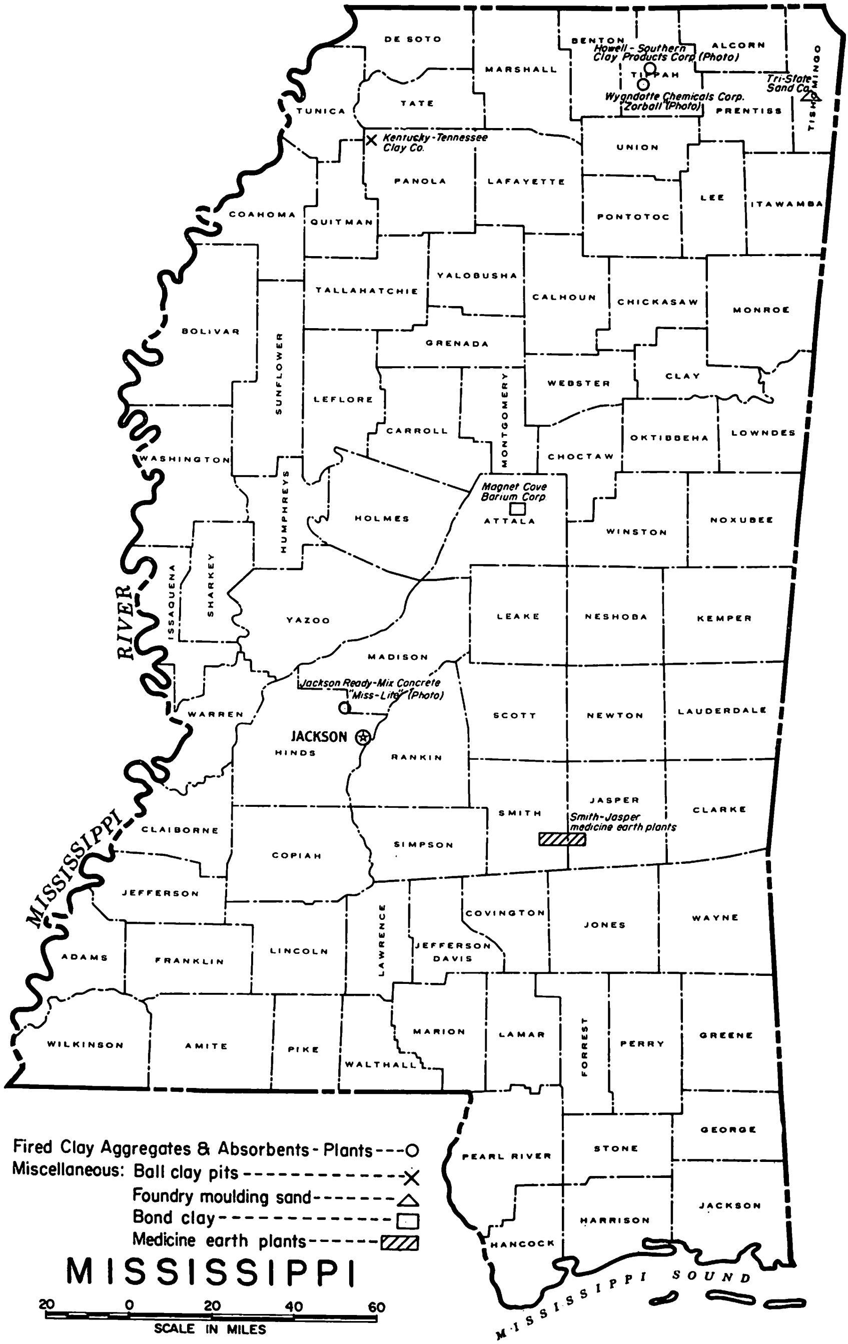
DE SOTO
MARSHALL
BENTON
Howell - Southern Clay Products Corp (Photo)
ALCORN
TIPPAH
Wyandotte Chemicals Corp. "Zorball" (Photo)
Tri-State Sand Co.
TISHOMINGO
PRENTISS
TUNICA
TATE
Kentucky-Tennessee Clay Co.
UNION
PANOLA
LAFAYETTE
LEE
ITAWAMBA
COAHOMA
QUITMAN
PONTOTOC
YALOBUSHA
TALLAHATCHIE
CALHOUN
CHICKASAW
MONROE
BOLIVAR
SUNFLOWER
GRENADA
CLAY
LEFLORE
WEBSTER
MONTGOMERY
CARROLL
OKTIBBEHA
LOWNDES
WASHINGTON
CHOCTAW
HUMPHREYS
Magnet Cove Barium Corp.
ATTALA
HOLMES
WINSTON
NOXUBEE
ISSAQUENA
SHARKEY
RIVER
YAZOO
LEAKE
NESHOBA
KEMPER
MADISON
Jackson Ready-Mix Concrete "Miss-Lite" (Photo)
WARREN
SCOTT
NEWTON
LAUDERDALE
JACKSON
HINDS
RANKIN
MISSISSIPPI
JASPER
SMITH
CLARKE
Smith-Jasper medicine earth plants
CLAIBORNE
SIMPSON
COPIAH
JEFFERSON
COVINGTON
JONES
WAYNE
ADAMS
FRANKLIN
LINCOLN
LAWRENCE
JEFFERSON DAVIS
WILKINSON
AMITE
PIKE
MARION
LAMAR
FORREST
PERRY
GREENE
WALTHALL
GEORGE
PEARL RIVER
STONE
Fired Clay Aggregates & Absorbents - Plants
Miscellaneous: Ball clay pits
Foundry moulding sand
Bond clay
Medicine earth plants
JACKSON
HARRISON
HANCOCK
MISSISSIPPI
MISSISSIPPI SOUND
20 0 20 40 60
SCALE IN MILES

Figure 25

for this aggregate. The plant is situated on a 670-acre tract of land under which the Yazoo clay reaches a maximum thickness of approximately 400 feet.

The great thicknesses of some of the marine clays in this group might make them attractive at some future date for the extraction of alumina through sintering processes. Their ceramic utility is limited because of the tendency of most of them to bloat and fuse at relatively low temperatures. Even so, there are many ceramic applications for the clays of this group.

At Kosciusko, Attala County, Magnet Cove Barium Corporation (Figure 25) began in 1958 producing the Zilpha marine clay-shale as a foundry bonding clay which is marketed as "bentonite."

One of the most promising uses of the montmorillonitic clays is for oil well drilling muds, of which many thousands of tons are used annually in the State at a price of about $50.00 per ton. A specifically favorable type of Porters Creek clay in Tippah County, investigated by McCutcheon, maintained its good weight and viscosity with increase in salt content. Such a mud would be unusually valuable in drilling in the Salt Basin of south Mississippi.

SHALES

The Paleozoic (Mississippian Chester) shales crop out only in Tishomingo County, where their distribution is very restricted. No representative chemical analysis or ceramic test is available. A mile east of the State line, in Colbert County, Alabama, Corinth Brick Company operated a pit from which Alsobrook shale was taken to Corinth for brick-making. Here the shale is approximately 80 feet in thickness.

SURFACE CLAYS AND SILTS

By far the most important group of clays suitable for the manufacture of brick and tile are the weathered surface clays and their silty intergrades. These clays furnish the principal materials used by the eighteen brick plants now operating in Mississippi (Figure 26). Fifty or sixty years ago there were many more brick plants than today, but it is probable that the combined capacity was much less then than now.

The clays of this group are (1) residual from the bedrock formations, (2) alluvial accumulations in the valleys of small

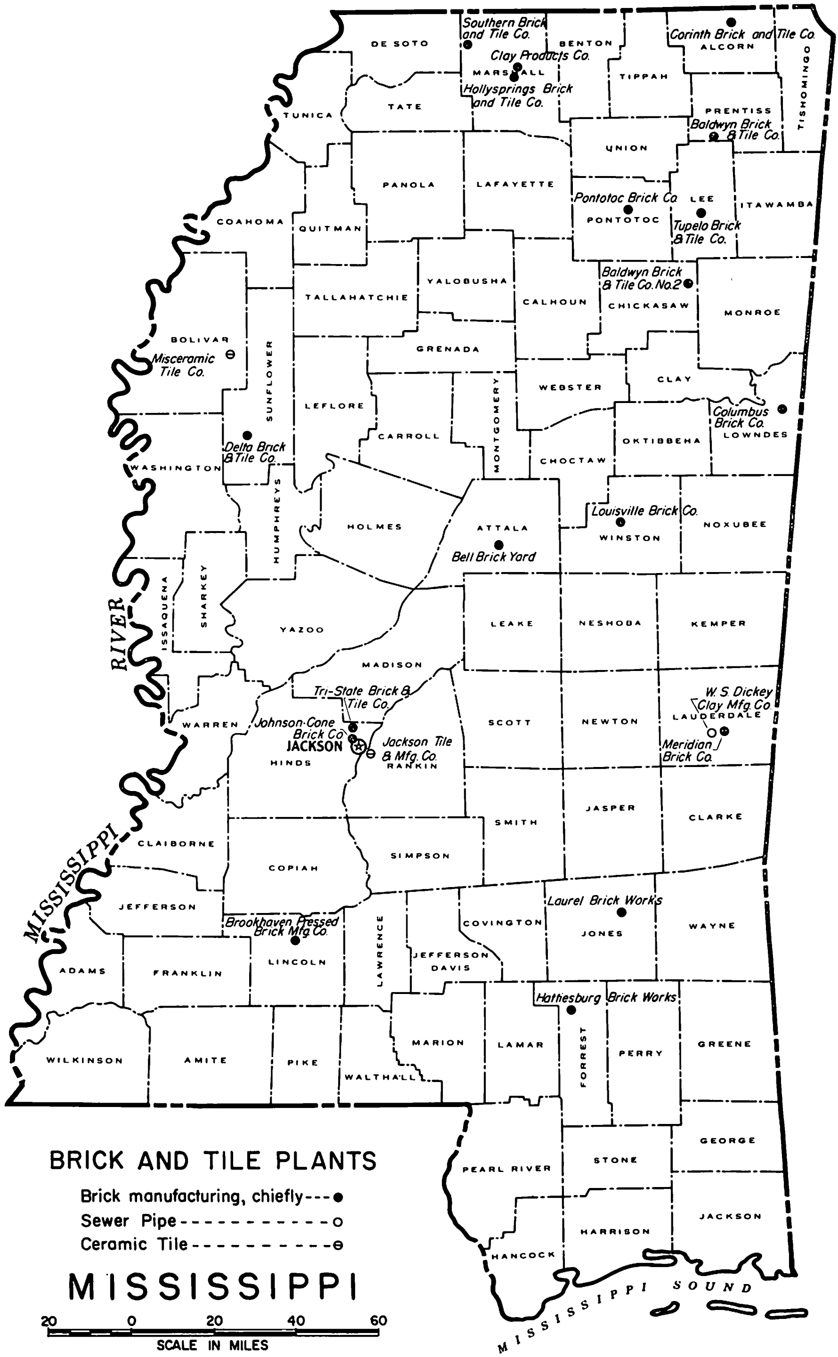
DE SOTO
Southern Brick and Tile Co.
BENTON
Clay Products Co.
MARSHALL
Hollysprings Brick and Tile Co.
TIPPAH
Corinth Brick and Tile Co.
ALCORN
TISHOMINGO
PRENTISS
Baldwyn Brick & Tile Co.
TUNICA
TATE
UNION
PANOLA
LAFAYETTE
Pontotoc Brick Co.
PONTOTOC
LEE
Tupelo Brick & Tile Co.
ITAWAMBA
COAHOMA
QUITMAN
Baldwyn Brick & Tile Co. No.2
YALOBUSHA
CALHOUN
CHICKASAW
MONROE
TALLAHATCHIE
BOLIVAR
Misceramic Tile Co.
SUNFLOWER
GRENADA
WEBSTER
CLAY
LEFLORE
MONTGOMERY
Columbus Brick Co.
LOWNDES
CARROLL
OKTIBBEHA
CHOCTAW
Delta Brick & Tile Co.
WASHINGTON
HUMPHREYS
HOLMES
ATTALA
Bell Brick Yard
Louisville Brick Co.
WINSTON
NOXUBEE
ISSAQUENA
SHARKEY
YAZOO
LEAKE
NESHOBA
KEMPER
RIVER
MADISON
Tri-State Brick & Tile Co.
W. S. Dickey Clay Mfg. Co.
WARREN
Johnson-Cone Brick Co.
JACKSON
HINDS
Jackson Tile & Mfg. Co.
RANKIN
SCOTT
NEWTON
LAUDERDALE
Meridian Brick Co.
SMITH
JASPER
CLARKE
MISSISSIPPI
CLAIBORNE
COPIAH
SIMPSON
JEFFERSON
Laurel Brick Works
COVINGTON
JONES
WAYNE
Brookhaven Pressed Brick Mfg. Co.
LINCOLN
LAWRENCE
JEFFERSON DAVIS
ADAMS
FRANKLIN
Hattiesburg Brick Works
MARION
LAMAR
FORREST
PERRY
GREENE
WILKINSON
AMITE
PIKE
WALTHALL
GEORGE
PEARL RIVER
STONE
JACKSON
HARRISON
HANCOCK
MISSISSIPPI SOUND
BRICK AND TILE PLANTS
Brick manufacturing, chiefly ---●
Sewer Pipe ------------o
Ceramic Tile -----------⊖
MISSISSIPPI
20 0 20 40 60
SCALE IN MILES

Figure 26

or large streams, or (3) loessal silt or silty clay of eolian (windblown) origin in part modified by weathering agents.

As in several other states of the Mississippi Valley, so in Mississippi, the loess and loessal clays (brown loam) are the most wide-spread and abundant ceramic material. Around 1900, perhaps a dozen or more plants manufactured deep-red fine-textured brick along the loess bluffs from the 4- to 6-foot blanket of brown loam. Logan reports some of these plants utilizing up to 20 percent of the underlying loess as an admixture. Two analyses each of loess and brown loam show the high silica, low alumina content (Table 3). Curiously, the brown loam, having greater plasticity, has a lower alumina content, but a higher iron oxide content. Perhaps much of the alumina in the loess is in the form of feldspar which would have no effect on plasticity.

The great thickness of the loess, 50 to 60 feet or more, its remarkable uniformity in grain size, texture and chemical composition, and its great distribution, in a belt from Louisiana to Tennessee, should encourage research into its use, either in the manufacture of brick or in other products.

NATURAL CLAY PIGMENTS

In Tishomingo County, thick deep-red and red-brown kaolinitic clays and bright yellow clays have been investigated as natural paint pigment; and in World War I, some clay was shipped for this purpose. In World War II, Eastern Clay Products, Inc. mined and shipped a few carloads of yellow ochre from the Betheden horizon in the Pinedale community of southwest Union County and western Pontotoc County. The clay was used as a pigment in camouflage paint. Yellow clays are known in several places in the State but are usually thin and of very restricted lateral extent. The deep-red iron-rich sandy clay-loams overlying some of the glauconitic units, particularly the Winona-Zilpha beds in Newton and Neshoba Counties, are worth investigation as a possible source of a cheap red pigment for paint, concrete or ceramic uses.

STONE

Mississippi contains little good building stone. The Catahoula (Miocene) sandstone has found limited use in building, as

Figure 27.—Cabin constructed of Highland Church sandstone in Tishomingo State Park, Tishomingo County, Mississippi. Photo by W. S. Parks, June, 1959.

Figure 28.—Gang mill at quarry of Mississippi Stone Company, Tishomingo County, Mississippi (NW.¼, NE.¼, Sec. 7, T. 6 S., R. 11 E.). Photo by W. S. Parks, April, 1959.

have the hard limestones of the Vicksburg formation (Oligocene). The soft "chimney rock" facies of the Vicksburg has been sawed into brick for local construction. On limited scales the dark-brown ferruginous sandstones common, but not abundant, in many parts of Mississippi have been used for rustic paving and veneered construction. At best this could be considered a specialty product because of its relatively limited quantities, usually

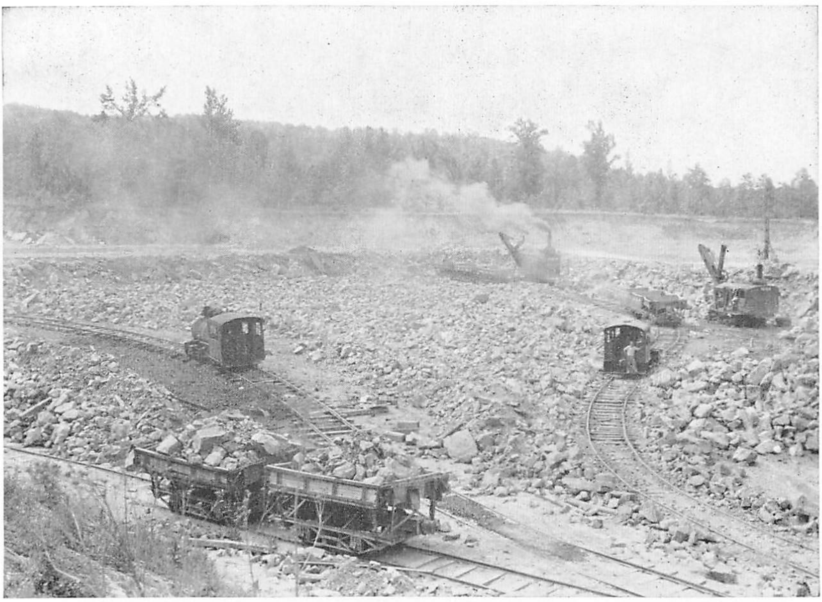

Figure 29.—Asphaltic oolitic limestone of Chester age, produced by Alabama Asphaltic Limestone Company as a natural rock asphalt paving material, south of Margerum, Colbert County, Alabama, (NE.¼, Sec. 12, T.4 S., R. 15 W.), 3-½ miles east of Tishomingo County line. May 26, 1941.

as sheets of stone only a few inches thick, developed near the surface at sand-clay contacts. Very locally, too, some of the hard bauxite at the Midway-Wilcox contact and the hard sandy limestone of the Chiwapa member of the Ripley formation have been used in rustic construction.

The chief possibilities for development of commercial building stone are the Paleozoic rocks of Tishomingo County. Limestones are present in suitable quantity, but the best possibilities are the sandstones of the Highland Church (Hartselle) member of the Forest Grove formation. Several quarries have been active in recent years in the vicinity of Tishomingo. The stone is a strong, durable, fine-grained, light-gray to light-tan sandstone, making a very pleasant appearance on construction. W. C. Morse, former State Geologist, has for many years encouraged the use and development of this lasting and attractive structural material (Figures 27, 28).

ASPHALTIC ROCK

In Tishomingo County, the Chester (upper Mississippian) limestones and sandstones are locally impregnated with asphalt or bitumen to the extent of being suitable for natural asphaltic paving material. The most usable rock, perhaps, is the Southward Pond limestone "A" (Gasper oolite) which is exposed chiefly along the west and north rims of Southward (or Cypress) Pond. This stratum has been worked commercially for many years just across the State Line, south of Margerum, Alabama (Figure 29). The asphaltic oolitic limestone stratum is normally 10 to 15 feet in thickness. Early experience with production and utilization of the asphaltic Chester sandstones in Alabama has indicated that the quartz sand grains contribute to rapid abrasion of the pavement surface in contrast to the better bonding characteristics of the limestone. None of the sandstones has been worked in Alabama for many years. Elsewhere in Mississippi are small amounts of grahamite and asphaltic impregnations in Mesozoic and Tertiary sediments, but they are insufficient for commercial interest.

LIMESTONE AND CHALK

CEMENT MATERIALS

Cement materials are widely distributed over Mississippi (Figure 30). Portland cement is made from a definite natural or artificial blend of calcareous, siliceous and aluminous components, fired to fusion (clinker), and ground to an impalpable flour (portland cement). When mixed with sand and gravel aggregates and water, the cement takes up the water in chemical combination, forming a tightly interlocking mass of minute crystals, cementing the aggregates together (concrete).

The two cement plants now in operation in Mississippi are Marquette Cement Manufacturing Company at Brandon, Rankin County, and the Mississippi Valley Portland Cement Company

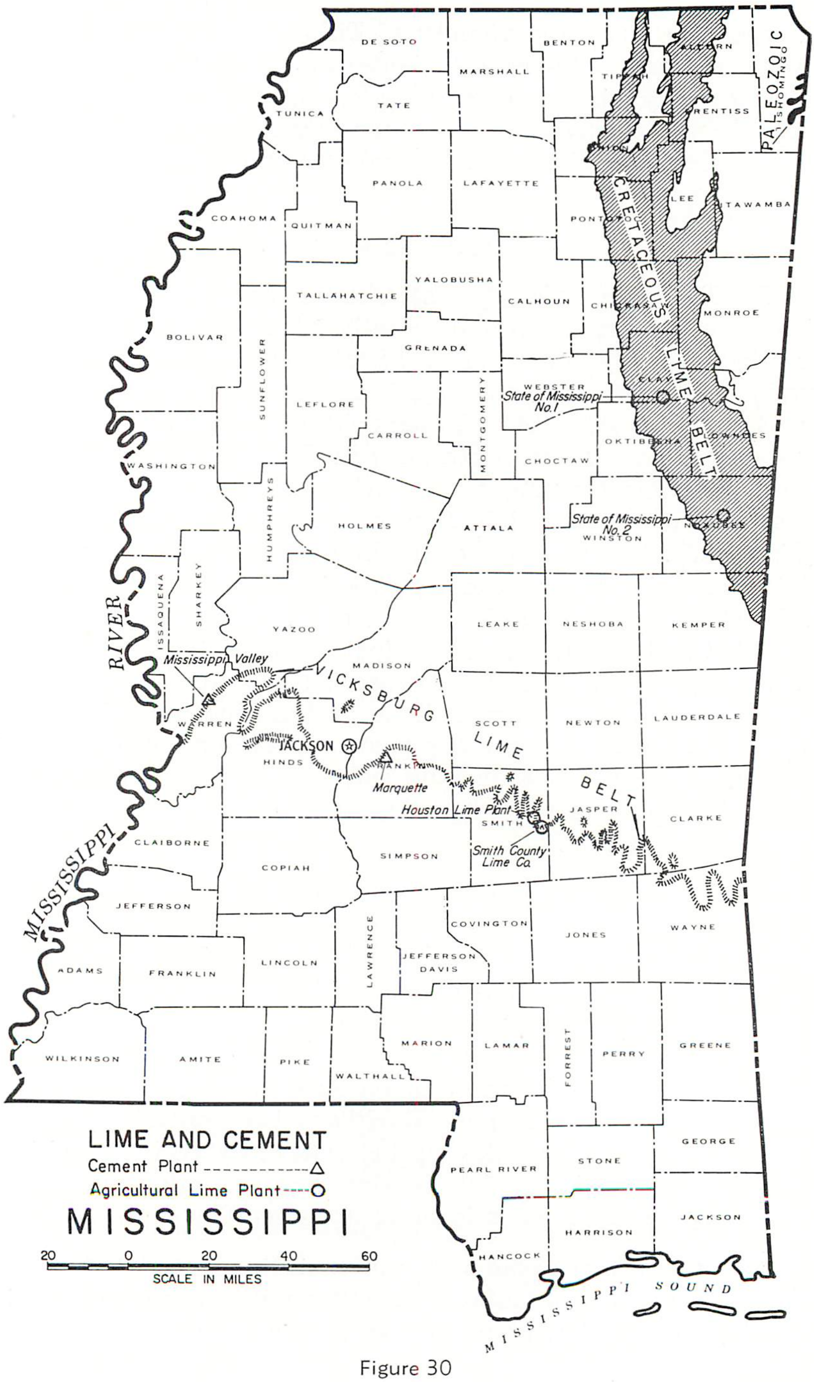
LIME AND CEMENT
Cement Plant
Agricultural Lime Plant
MISSISSIPPI
20 0 20 40 60
SCALE IN MILES
CRETACEOUS LIME BELT
VICKSBURG LIME BELT
PALEOZOIC
MISSISSIPPI RIVER
MISSISSIPPI SOUND
Mississippi Valley
JACKSON
Marquette
Houston Lime Plant
Smith County Lime Co.
State of Mississippi No. 1
State of Mississippi No. 2
DE SOTO
MARSHALL
BENTON
TUNICA
TATE
PRENTISS
PANOLA
LAFAYETTE
LEE
ITAWAMBA
COAHOMA
QUITMAN
YALOBUSHA
TALLAHATCHIE
CALHOUN
MONROE
BOLIVAR
SUNFLOWER
GRENADA
LEFLORE
WEBSTER
CARROLL
MONTGOMERY
WASHINGTON
CHOCTAW
HUMPHREYS
HOLMES
ATTALA
WINSTON
ISSAQUENA
SHARKEY
YAZOO
LEAKE
NESHOBA
KEMPER
MADISON
SCOTT
NEWTON
LAUDERDALE
HINDS
JASPER
SMITH
CLARKE
CLAIBORNE
COPIAH
SIMPSON
JEFFERSON
COVINGTON
JONES
WAYNE
LINCOLN
LAWRENCE
JEFFERSON DAVIS
ADAMS
FRANKLIN
MARION
LAMAR
FORREST
PERRY
GREENE
WILKINSON
AMITE
PIKE
WALTHALL
GEORGE
PEARL RIVER
STONE
JACKSON
HARRISON
HANCOCK

Figure 30

at Haynes Bluff, Warren County. The Marquette plant began producing cement from the Vicksburg limestone, marls and clays in 1950 (Figure 31). Its effective clinker capacity (Company's Annual Report, 1957) is 1,253,000 barrels per year. The writer was reliably informed that the 1958 production was 1,100,000 barrels (4 sacks per barrel) of portland cement and 100,000 barrels

Figure 31.—Marquette Cement Manufacturing Company plant at Brandon, Rankin County, Mississippi. This larger of the State's two cement plants has an annual capacity of more than 5,000,000 sacks of cement. Photo by Bob Hand.

of masonry cement. The production of this plant has had a beneficial effect upon the mineral economy of the State, supplying income directly and indirectly to many families, and reducing, to a large extent, the quantity of cement Mississippi had theretofore found it necessary to import from Alabama, Tennessee and elsewhere. The increased use of cement in road building, in construction, in the petroleum industry, in the greatly expanded concrete building-block and ready-mix concrete industries encouraged the successful establishment of a locally financed stock cement manufacturing company. Mississippi Valley Portland Cement Company began production in January, 1959, with a rated capacity of 750,000 barrels per year (Figure 32). This new plant was built at a cost of about $5,000,000, will have an annual payroll of $500,000, and employs 75 to 100 people.

The Paleozoic limestones of Tishomingo County are variously adaptable to the manufacture of cements. Water, rail and highway transportation favor the development of a large industry in this area, as do the availability of electricity, natural gas, real estate and labor, and the charges for them.

Figure 32.—Mississippi Valley Portland Cement Company plant at Haynes Bluff, Warren County, Mississippi: (1) quarry face, (2) primary crusher, (3) washing and screening, (4) overhead conveyor, (5) Mississippi State Highway 3, (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. Photo by Newton Advertising Agency, January 25, 1959.

Within the Selma chalk belt are the best opportunities for cheap utilization of raw materials for cement manufacture. Certain strata within the Selma are relatively thick (50 to 100 feet), contain 80 to 85 percent $CaCO_3$, and are covered by only a foot or two of overburden. Should sufficient market demand develop in the future, the Selma belt offers unexcelled potentialities for economical cement production.

AGRICULTURAL LIME

Mississippi is endowed with an ample supply of lime suitable for agricultural purposes. The lime deposits, in 18 counties, (Miss. Geol. Surv. Bull. 46, pp. 5 and 6) have fair distribution. As of many other items of our economy we are, nevertheless, importers of much of our agricultural lime.

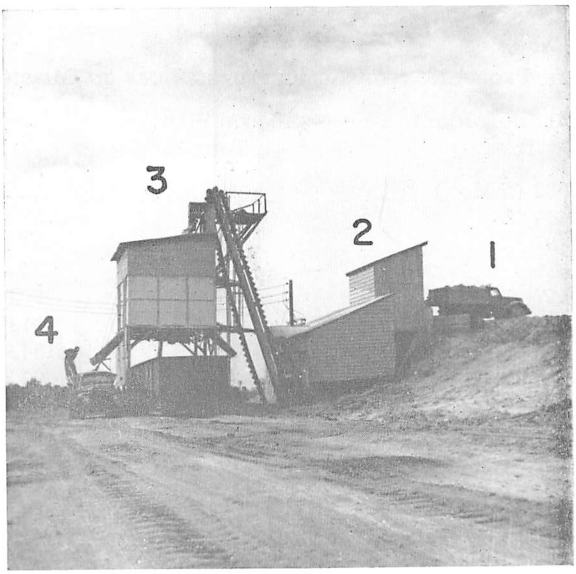

Figure 33.—Agricultural Lime Board's Cedar Bluff plant, Clay County, Mississippi: (1) truck unloading chalk lumps, (2) crusher shed, (3) storage and loading bin, (4) rail and highway transportation. December, 1958.

Liming materials may be classified as follows: (1) hard crystalline high-calcium Paleozoic limestone of Tishomingo County; (2) chalk of the Selma and Prairie Bluff, varying in impurities such as sand, clay, mica and pyrite; (3) marls of the Vicksburg formation, varying in impurities of sand, glauconite and clay; and (4) hard non-crystalline or semi-crystalline limestone, generally high-calcium, of the Vicksburg formation.

In 1945 the State of Mississippi, through its Department of Agriculture and Commerce, Division of Lime, put into operation the first successful agricultural lime plant in the State, at Cedar Bluff, Clay County, on the Demopolis member of the Selma chalk (Figure 33). The plant was the result of cooperative efforts of the State Agricultural Department, Mississippi State Chemical

Laboratory, Mississippi Extension Service, Mississippi Geological Survey and the U. S. Agricultural Adjustment Administration which sponsored a survey of the State's lime deposits. By 1951 profits from successful operation at Cedar Bluff permitted the construction of a second plant at Macon, Noxubee County, also on the Demopolis chalk. The production of the two plants is tabulated by years:

TABLE 4

ANNUAL PRODUCTION OF AGRICULTURAL LIME IN MISSISSIPPI

Year	Cedar Bluff Plant Tons	Macon Plant Tons	Total Tons
1945	22,022 (5 Mos.)		22,022 (5 Mos.)
1946	59,464		59,464
1947	35,467		35,467
1948	24,331		24,331
1949	29,057		29,057
1950	101,051		101,051
1951	105,556	29,439 (6 Mos.)	134,995
1952	56,510	33,886	90,396
1953	25,035	12,436	37,471
1954	57,523	33,694	91,217
1955	60,246	29,337	89,583
1956	90,095	50,388	140,483
1957	37,468	23,486	60,954
1958	66,078	35,037	101,115
Totals:	769,903	247,703	1,017,606

Officials of the Agricultural Stabilization and Conservation Committee of the U. S. Department of Agriculture advise that Mississippi has some 10,000,000 acres of lime-deficient pasture land and crop land, and they recommend the use on these lands of an average of one ton of lime per acre each five years, or the utilization of 2,000,000 tons annually. Figure 34 shows the annual production of the Division of Lime (all for use within the State), the total tonnage for which cost-sharing was paid through the Agricultural Conservation Program (closely approximating the total amount of lime used), and the net deficiency in use. Thus, the soils of Mississippi, except in the small non-deficient areas, have not for the first time reached the recommended lime balance, nor, at the present rate of liming, will they ever reach that balance. Important and profitable increases in yield of row crops and pastures have been reported from many farm applications of liming. Agronomist W. B. Andrews summarized (Miss. Geol. Surv. Bull. 46, p. 4) the efficacy of lime on soils as follows:

THE VALUE OF LIMING ACID SOILS

The use of ground limestone ($CaCO_3$) *has doubled the yield of lespedeza, soybeans, and winter legumes on some soils in Mississippi. In addition to supplying calcium for plant food, lime helps to keep phos-*

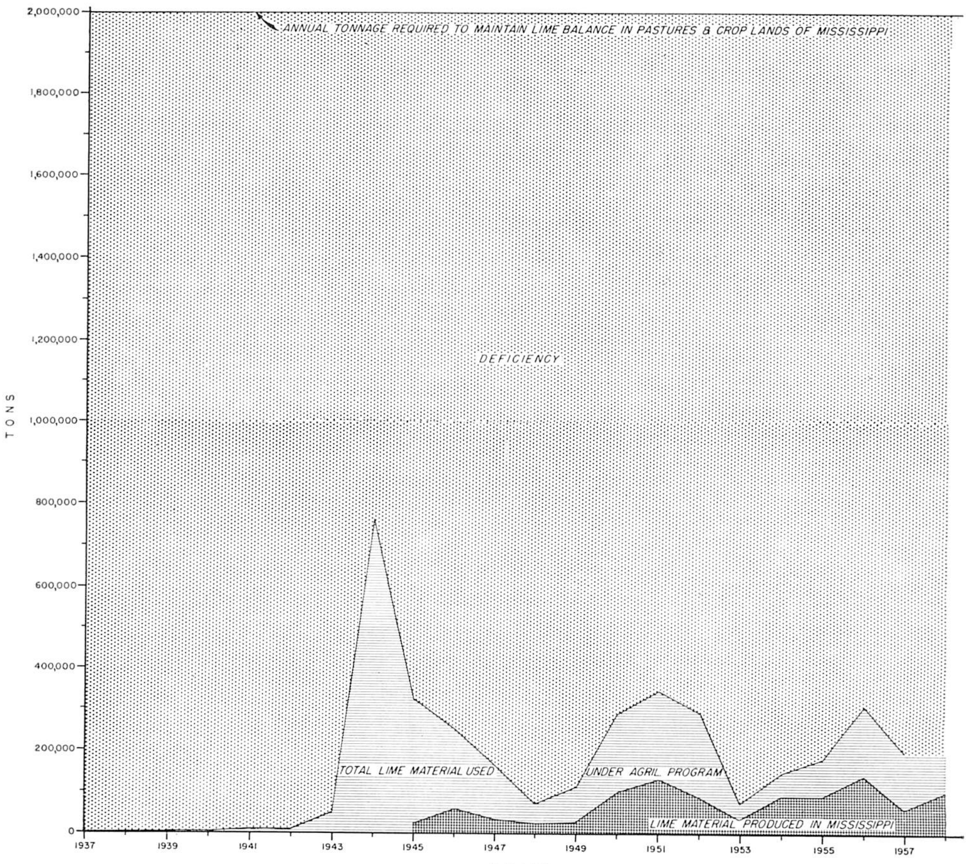

Figure 34

phorus in a form which is available to plants, and reduces the loss of potash by leaching. Consequently, over a period of years, less phosphorus and potash are required where a good supply of lime is maintained in the soil. The application of lime to strongly acid soils increases the calcium content of the grasses and legumes grown. When the calcium content of these plants is increased, they are more palatable to livestock, and they, in turn, produce more meat and milk.

In general, sandy soils are lower in lime than soils which contain more clay. The use of more than 1000 pounds of lime per acre often produces over-liming injury on sandy soils. Over-liming injury can be avoided and the lime needs of crops can be supplied by applying 750 to 1000 pounds of ground limestone per acre every three years. Decreased yields due to the use of too much lime can be corrected by the use of five pounds of borax per ton of lime used.

The distribution of natural liming materials is shown in Figure 30 which also shows the locations of the Cedar Bluff and Macon plants. The combined capacity of these two plants is about 100 tons per hour. It is immediately apparent that sources of commercial agricultural lime in the Vicksburg formation belt need to be developed. In eastern Smith County, near Sylvarena (NW.¼, Sec.9, T.2 N., R.9 E.), a start in the production of lime was made recently on a small scale by P. D. Houston, Bay Springs, Mississippi; also (NE.¼, SE.¼, Sec.22, T.2 N., R.9 E.) by Grady James of Sylvarena and Sam Bass, Sumrall, Mississippi, operating as The Smith County Lime Company, Bay Springs, Mississippi. It is reported (Feb. 17, 19, 1959) that the Houston plant has produced and marketed more than 1800 tons and the James and Bass Plant 1467 tons. The plants have reported hourly capacities of about 15 and 30 tons, respectively. Most of the sales have been to cash customers without A.C.P. assistance.

WOOL ROCK

Rock (mineral) wool is widely and principally used as an insulating material. Its manufacture is relatively inexpensive because of the simplicity of the process and the wide range of tolerance in composition of the wool rock. Impure chalk, or impure limestone or marl may be used. The deposits of limestone and chalk shown in Figure 30 can be utilized, after specific study of the material selected, in the process. In addition, Counties other than shown on the limestone belts contain marls that would not be suitable for cement or agricultural lime but are sufficiently high in lime to constitute a base for wool rock. The raw material, of proper composition, is melted and from a thin stream of the melt is blown into long silky fibers of opaque glass or into glassy pellets. Due to the light weight of the product and the relatively low cost of plant construction, the rock wool industry is a decentralized one.

All the rock or mineral wool used in Mississippi is imported from plants in other states. The use of insulating substances is a greatly expanding practice, integral with air-conditioning, heating and cooling systems, in homes and in places of business, in refrigeration systems and in systems requiring the confinement of heat and sound. Although no data are available on the requirements of the Mississippi rock wool market, the extent of the wool's use is suggested by the insulation advertisements on the yellow pages of the current Jackson, Mississippi, telephone directory. In 1945, T. E. McCutcheon, working with W. C. Morse, produced good quality rock wool in the Mississippi Geological Survey's laboratory from the basal Annona (Demopolis) member of the Selma chalk near Tupelo, Lee County. The results of the study were published as Survey Bulletin 62, "Rock Wool." The establishment of a rock wool industry in Mississippi is many years overdue.

CHERT AND TRIPOLI (SILICA)

Chert and tripoli (pulverulent chert or pulverulent silex) are found in the northern part of Tishomingo County in decalcified strata of Iowa (Mississippian) age, the Iuka chert. The characteristic steep-sided chert hills border the Pickwick Reservoir on lower Bear Creek, the Tennessee River valley and Indian and Yellow Creeks. Only in the area south of Eastport and north of Little Bear Creek are the tripoli deposits known in the Iuka chert. Spain (p. 3) points out that the tripoli deposits lie in a plane declined southwesterly in a 40 mile distance from an elevation of about 800 feet in the Waynesboro-Collinwood district in Tennessee to an average elevation of about 425 feet in Mississippi. This slope, less than half a degree, conforms to the structure of the Mississippian rocks and roughly conforms to the major Mesozoic unconformity about 100 feet higher. Although in this area the Little Bear residuum rests locally upon the cherts, it is quite evident that the principal decalcification and silicification of the Mississippian limestone took place prior to the advance of the Cretaceous sea, and that the chert gravels of the Tuscaloosa (Gordo) and of the Eutaw in this area were locally derived largely from the Mississippian cherts.

The Iuka chert has a thickness of over 100 feet and the tripoli a thickness of 15 to 20 feet, containing more or less chert. These beds, and the early attempt to produce the tripoli, are described by Morse (p. 91 ff.) and by Vestal (pp. 8-12).

The tripoli (Figure 35), more than 98 percent SiO_2, has been utilized experimentally as a pottery "flint," as the quartz ingredient of glass, and for abrasives and its other common uses.

The chert appears to offer exceptional possibilities for use in a number of fields. Local phases contain large, tough, durable

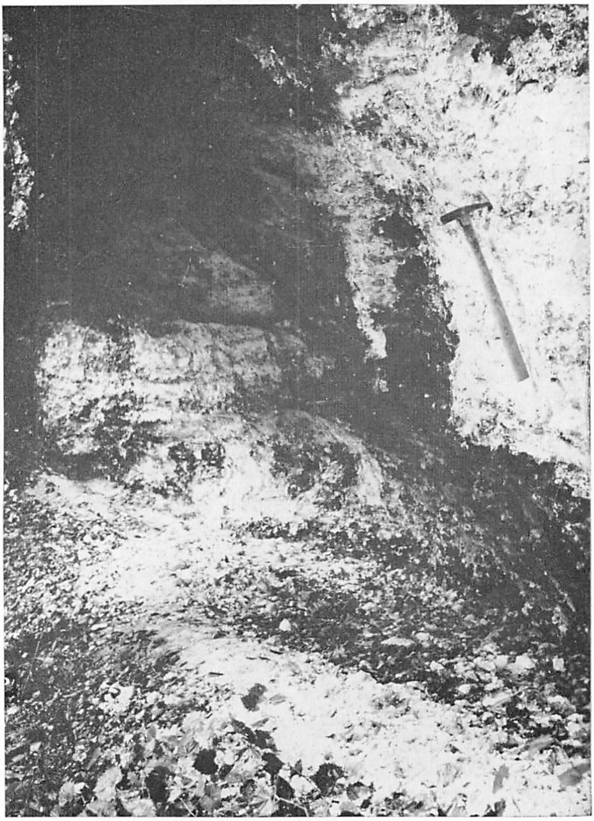

Figure 35.—Tripoli, A. W. Mangum property, Tishomingo County. Photo, 1936.

and insoluble rough blocks that would be well suited for rip-rap and that might be competitive with limestone, since drilling and blasting would not be required. Smaller blocks, because of their angularity and insolubility would be excellent lower course material for roadbeds and foundations for construction in areas where soil stabilization is required. Such uses of chert blocks are especially needed in many parts of Mississippi where expensive structures and pavements are deteriorating because of lack of foundation support. Much of the chert is coarse, porous, permeable and insoluble and might be utilized profitably in filter beds and for similar purposes. Another use for the larger blocks of chert is in ornamental rustic construction such as is common in the Ozark region. The finer chert can be used as a road metal on secondary roads, as a concrete aggregate or as roofing granules. The chert deposits lie, for the most part, fronting or close to the navigable Tennessee River System and would be available by water transportation along the western part of Mississippi and elsewhere. Should the Tennessee-Tombigbee Waterway become a reality, the cherts would be more economically available along the eastern side of Mississippi and the western side of Alabama. They may find profitable utilization as bedding for oysters along the Mississippi Gulf Coast.

The industrialization of Mississippi has greatly increased the use of high temperature refractories as linings for rotary, periodic and tunnel kilns and for fire boxes of many types. Silica refractories are in much demand because of their refractoriness at temperatures at which fireclay brick begin to soften and because of slight expansion instead of contraction when subjected to heat. Parmelee and Harman conducted experiments in Illinois with ground novaculite chert using tripoli as fines for improving density of the mix. The qualities of the cherts and tripoli of Tishomingo County are similar to those of Illinois chert on which the promising experimental work was done.

ROCK SALT, SOLUBLE SALTS SOLUTIONS, AND WATERS

ROCK SALT

A thick blanket of rock salt, the Louan salt, underlies approximately the south half of Mississippi at depth ranging from about 10,000 feet or less to possibly 25,000 feet or more (Figure 36). This evaporite sequence, possibly 4,000 to 6,000 feet in normal thickness, is composed principally of halite (sodium chloride or rock salt), lesser amounts of anhydrite (calcium sulfate) and probably numerous other more soluble and less soluble salts. It has been assumed, possibly without adequate supporting evidence, that the Louan evaporite basin was periodically invaded by the sea; that special conditions prevailed which permitted the deposition of sodium chloride, but that the brines in the land-locked Louan sea were never concentrated to the point of

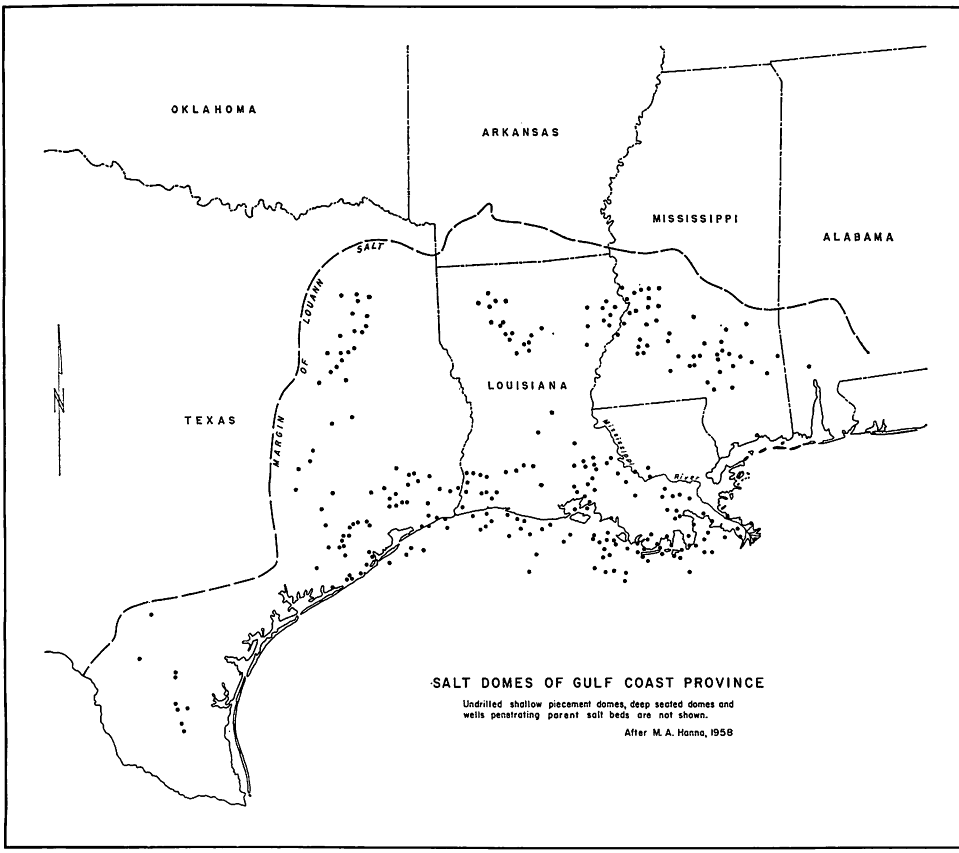

Figure 36

precipitating the more soluble salts such as are found in the Stassfurt district. Where critical conditions develop, the parent Louan salt bed flows under the weight of the heavier overburden and gives rise to rod-shaped or mushroom-shaped stocks of salt, rising vertically many thousands of feet into the covering sediments. When these stocks of salt penetrate under-saturated water-bearing strata, the sodium chloride or more soluble salts pass into solution, leaving the anhydrite and other less soluble materials as a residue. In this manner the cap rock which overlies all of our piercement domes had its origin.

Forty-eight of these relatively shallow piercement domes have been proved by drilling in the State (Figure 37). Many

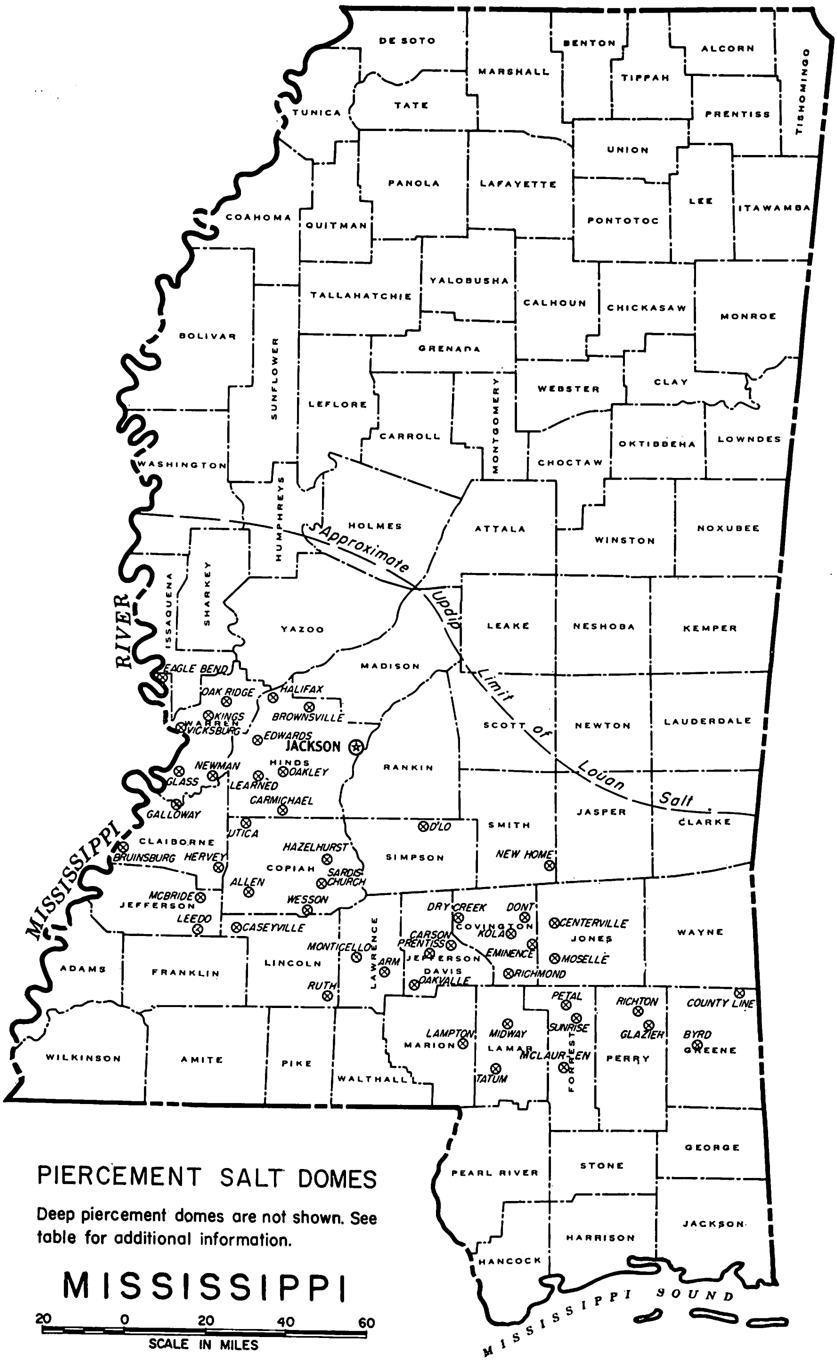
PIERCEMENT SALT DOMES
Deep piercement domes are not shown. See table for additional information.
MISSISSIPPI
20 0 20 40 60
SCALE IN MILES
MISSISSIPPI RIVER
MISSISSIPPI SOUND
Approximate Updip Limit of Louan Salt
DE SOTO
MARSHALL
BENTON
ALCORN
TIPPAH
TISHOMINGO
TUNICA
TATE
PRENTISS
UNION
PANOLA
LAFAYETTE
LEE
ITAWAMBA
COAHOMA
QUITMAN
PONTOTOC
YALOBUSHA
TALLAHATCHIE
CALHOUN
CHICKASAW
MONROE
BOLIVAR
GRENADA
SUNFLOWER
WEBSTER
CLAY
LEFLORE
MONTGOMERY
CARROLL
OKTIBBEHA
LOWNDES
WASHINGTON
CHOCTAW
HUMPHREYS
HOLMES
ATTALA
WINSTON
NOXUBEE
ISSAQUENA
SHARKEY
YAZOO
LEAKE
NESHOBA
KEMPER
MADISON
EAGLE BEND
OAK RIDGE
HALIFAX
KINGS
WARREN
VICKSBURG
BROWNSVILLE
EDWARDS
JACKSON
SCOTT
NEWTON
LAUDERDALE
NEWMAN
GLASS
HINDS
OAKLEY
LEARNED
RANKIN
CARMICHAEL
GALLOWAY
JASPER
CLARKE
UTICA
D'LO
SMITH
CLAIBORNE
BRUINSBURG
HERVEY
HAZELHURST
COPIAH
SIMPSON
NEW HOME
SARDIS CHURCH
ALLEN
MCBRIDE
JEFFERSON
WESSON
DRY CREEK
DONT
LEEDO
CASEYVILLE
COVINGTON
KOLA
CENTERVILLE
JONES
WAYNE
CARSON
PRENTISS
MONTICELLO
LAWRENCE
EMINENCE
ADAMS
FRANKLIN
LINCOLN
ARM
JEFFERSON DAVIS
MOSELLE
OAKVALE
RICHMOND
RUTH
PETAL
RICHTON
COUNTY LINE
LAMPTON
MIDWAY
SUNRISE
GLAZIER
BYRD
MARION
LAMAR
FORREST
MCLAURIN
PERRY
GREENE
WILKINSON
AMITE
PIKE
WALTHALL
TATUM
GEORGE
STONE
PEARL RIVER
JACKSON
HARRISON
HANCOCK

Figure 37

more have been indicated, more or less conclusively, by gravity and seismic exploration, in part supported by exploratory drilling. These shallower domes have not been rewarding to oil and gas exploration which was responsible for discovering them but they offer a great future in the production of salt and the many derivatives of salt chemistry.

The domes vary greatly in size and in depth below the surface (Table 5). Many of them are adaptable to recovery of concentrated salt solution simply by the circulation of cool fresh water. A few might lend themselves to underground mining on a large scale where the salt would be removed in solid form.

It is unfortunate that Mississippi is the only Gulf Coast state containing known salt domes that does not produce its own salt. Although the supplies in this State are practically unlimited, millions of dollars are spent annually for salt and salt products produced in other states. Aside from table salt and salt used in food preservation and in refrigeration, large amounts are used by Hooker Chemical Corporation at Columbus, and by the American Potash and Chemical Corporation at Hamilton, in the manufacture of sodium chlorate. The salt for these industries is shipped by rail from Louisiana. Similarly, soda ash, used as a flux in glass manufacture, is imported by Knox Glass Bottle Company and General Electric, both in Jackson. Caustic soda is used in large quantities as a gelling or suspending agent in drilling muds. Hydrochloric acid is used extensively in acidizing oil and gas wells to increase their potentials. Chlorinated hydrocarbons are used in nearly all insecticides and in many herbicides. Salt's chemical applications seem to be without end. Particularly with the recent and current advent of new and large chemical industries in the State it is desirable to develop the domestic salt deposits to supply the demand as far as possible.

TABLE 5

PIERCEMENT SALT DOME DISCOVERIES—MISSISSIPPI

Listed Chronologically

NR*—Salt not reached by well.
**—Depths are shallowest known on each dome, not always in discovery well.

No.	*Name*	*County*	*Location*	*Discovery Date*	*Discovery Well*	*Depth to Cap Rock*	*Depth** to Salt*
1	Midway	Lamar	28- 4N-15W	1-12-37	Sun Oil Co.-1-Scanlon-Semmes	1646	2555
2	Edwards	Hinds	35- 6N- 4W	12-15-37	Sou. Nat. Gas Co.-1-Angelo-Williams	2773	3124
3	Glass	Warren	6-14N- 3E	4- 1-40	W. O. Allen-1-Cully	3996	4025
4	Tatum	Lamar	14- 2N-16W	10-23-40	Tatum Lbr. Co.-1-Tatum	1456	1613
5	Dont	Covington	7- 8N-14W	10-24-40	Sun Oil Co.-D-1-Speed	2037	NR*
6	Oakvale	Jefferson Davis	32- 6N-19W	11- 6-40	Sun Oil Co.-1-Taylor	1870	2652
7	Newman	Warren	12-14N- 4E	11-23-40	Magnolia Petr. Co.-1-Paxton-Brown	4935	5114
8	Kings	Warren	39-17N- 4E	11-23-41	Magnolia Petr. Co.-1-Hall	3591	3845
9	Halifax	Hinds	1- 7N- 4W	12-28-41	Plains Prod. Co.-1-Gaddis	3890	3938
10	Ruth	Lincoln	15- 5N- 9E	7-28-42	Freeport Sul. Co.-2-Clarke	2176	NR*
11	D'Lo	Simpson	17- 2N- 4E	9- 5-42	Gulf Refg. Co.-1-Blalock-Nichols	2050	NR*
12	Sardis Church	Copiah	29-10N- 9E	5-14-43	Freeport Sul. Co.-1-Bell	1471	NR*
13	Lampton	Marion	20- 3N-17W	6-25-43	Gulf Refg. Co.-1-Bradshaw	1282	1344
14	Leedo	Jefferson	19- 8N- 4E	6-29-43	Gulf Refg. Co.-1-Cupit	1612	2065

TABLE 5—(CONTINUED)

No.	Name	County	Location	Discovery Date	Discovery Well	Depth to Cap Rock	Depth** to Salt
15	Byrd	Greene	16- 3N- 7W	7-21-43	Gulf Refg. Co.-1-Greene Cty. Sch.	1440	2054
16	New Home	Smith	5-10N-13W	8- 4-43	Gulf Refg. Co.-1-Dykes	1823	2570
17	Prentiss	Jefferson Davis	25- 7N-19W	8- 8-43	Gulf Refg. Co.-1-Blackmon	2546	NR*
18	Carson	Jefferson Davis	19- 7N-17W	9- 3-43	Gulf Refg. Co.-1-Price	2690	3093
19	Monticello	Lawrence	35- 7N-10E	9-25-43	Gulf Refg. Co.-1-Cox	2260	2750
20	Moselle	Jones	31- 7N-13W	11- 6-43	Gulf Refg. Co.-1-A-1-Lowery	2120	NR*
21	Bruinsburg	Claiborne	1-11N- 1W	3-10-44	Freeport Sul. Co.-2-Hammett	1981	2319
22	Allen	Copiah	5- 9N- 6E	3-15-44	Freeport Sul. Co.-2-Case Lbr. Co.	2517	2844
23	Richton	Perry	35- 5N-10W	10-15-44	Exploro Corp.-1-Carter	497	722
24	Richmond	Covington	17- 6N-15W	11-24-44	Freeport Sul. Co.-1-Beasley	1609	1945
25	Arm	Lawrence	8- 6N-20W	1- 7-45	Humble Oil & Refg. Co.-1-Nelson	1516	1931
26	Hervey	Claiborne	7-10N- 5E	6-22-45	Sun Oil Co.-1-Segrest	3326	3547
27	Galloway	Warren	43-13N- 3E	11- 7-45	C. H. Osmond-1-Anderson-Tully	3990	4196
28	Hazlehurst	Copiah	28- 1N- 1W	3-21-46	Stanolind-1-Huntington	1460	NR*
29	Utica	Copiah	8- 2N- 4W	5-29-46	Sun Oil Co.-1-Little	2830	3135
30	Dry Creek	Covington	21- 8N-17W	9-20-46	Sippiala Corp.-1-McRaney	1831	NR*
31	Petal	Forrest	25- 5N-13W	10-24-46	Sippiala Corp.-1-Wilson	1699	1739
32	McBride	Jefferson	10- 9N- 4E	12-25-46	Calif. Co.-2-Greer et al	2050	2250

TABLE 5—(CONTINUED)

No.	Name	County	Location	Discovery Date	Discovery Well	Depth to Cap Rock	Depth** to Salt
33	Eagle Bend	Warren	9-18N- 2E	6-15-47	Amerada Petr. Co.-1-Dabney-Bonelli	4292	4445
34	Brownsville	Hinds	15- 7N- 2W	11-18-47	Gulf Refg. Co.-1-Trotter	4511	4695
35	Eminence	Covington	5- 7N-14W	12- 7-47	Humble Oil & Refg. Co.-1-Rogers	1960	2442
36	Kola	Covington	28- 8N-15W	3-20-48	Humble Oil & Refg. Co.-1-Daughtry	2228	3048
37	County Line	Greene	1- 5N- 6W	4-10-48	Sun Oil Co.-1-Gaines	1290	2169
38	McLaurin	Forrest	10- 2N-13W	6- 1-48	Danciger Oil & Refg. Co.-1-Love Petr. Co.	1700	1969
39	Vicksburg	Warren	15-16N- 3E	9-14-48	Calif. Co.-1-Johnson	4362	4386
40	Carmichael	Hinds	27- 3N- 3W	4-19-49	Southeastern Drlg. Co.-1-Lewis-Ervin	2700	2966
41	Centerville	Jones	18- 8N-13W	5-14-49	Walter Sistrunk-1-Powell	2030	NR*
42	Oakley	Hinds	27- 5N- 3W	5-28-49	Sun Oil Co.-1-Shuff	2613	NR*
43	Learned	Hinds	35- 5N- 4W	11-11-49	Texas Co.-1-Noble (Min. Fee)	4429	4437
44	Sunrise	Forrest	8- 4N-12W	6-27-51	Calif. Co.-1-Berry	5632	5942
45	Glazier	Perry	19- 4N- 9W	12- 7-51	Union Prod. Co.-A-1-Stevens	7476	7835
46	Caseyville	Lincoln	23- 8N- 5E	12- 9-52	Gulf Refg. Co.-1-U.S.A.	2509	3035
47	Oak Ridge	Warren	16-17N- 5E	3- 3-55	Calif. Co.-3-1-Bd. of Supervisors	5060	5078
48	Wesson	Copiah	35- 9N- 8E	2- 4-56	Sun Oil Co.-1-McIntosh	3394	NR*

SOLUBLE SALTS

Several of the stratigraphic units in Mississippi contain soluble salts which upon natural leaching are removed by solution and carried downstream or are oxidized to form insoluble materials, which, in turn, in the case of certain iron compounds, are sources of limonite cement. As far as is known, the principal soluble salts are ferrous and ferric sulfates. Locally soluble iron salt is concentrated in near-surface clays to such an extent as to be commercially profitable to extract by leaching. A number of plants (Figure 25) are and have been for many years in operation in southeast Smith County, southwest Jasper County, and possibly in other parts of the State. Here the concentration of the iron sulfate is in the Bucatunna clay overlying the Vicksburg limestone. Local concentrations of this salt have been noted in the Bucatunna clay in Warren County at Vicksburg, in the Yazoo clay south of Satartia in Yazoo County, at horizons in the Wilcox and in some of the highly carbonaceous clays of the Cretaceous.

In the commercial operations the clays are dug from the pits and stored in drying sheds for a period of time allowing the minerals in the clays to undergo incipient oxidation and drying. The clays are then loaded into vats and saturated with water until the concentrated reddish-brown astringent solution has been drained from the clays into barrels for shipment to market. This material is used extensively in feeds and in various medical preparations.

It is not always clear whether the sulfates of iron as such are present in the fresh clays or whether they are derived in part from geochemical alteration of iron sulfide (probably marcasite). In any case, it is observed on the near-surface weathering of pyrite-bearing sediments that in the presence of calcareous materials, crystals of calcium sulfate or gypsum are commonly produced; and in the deficiency of iron and calcium, long, fibrous, white, astringent crystals of aluminum sulfate are produced through the decomposition of pyrite and interaction on the aluminum silicate composing the clay.

The fact that these "medicine" plants have been in operation in the Smith-Jasper County district over a period of about 50 years indicates that the raw material is present as a large reserve and that its development has not yet been fully attained. Geological and geochemical research on these deposits may render much needed assistance to these plants in expanding their operations, and in the possible utilization of their spent clays.

SALINE AND FRESH WATERS

The information derived from the drilling and logging of thousands of deep wells in the development of oil and gas in Mississippi has proved what had been known in a general way for many years, that Mississippi is one of the best watered areas of its size on the face of the earth. One has only to examine the ground water potential of another area to realize how much more fortunate Mississippi is in its fresh water supply. Parts of the State are underlain by artesian aquifers totaling 1000 feet or more in thickness, and extending over many square miles. Some of these areas can support industries that require enormous daily volumes of fresh water having low mineral content. Other parts of the State do not have enough ground water to supply large municipal or industrial withdrawal, but there is scarcely any part that cannot furnish its present demand for fresh ground water. In some parts of Mississippi, too, the interface of fresh water and salt water lies at 3000 feet below the surface or even as deep as 3500 feet below the surface. Such a deep fresh water-salt water interface is greatly beneficial to the State because it increases the reserve of fresh water, but, at the same time the relatively deep fresh water-salt water interface means that it is necessary to drill to greater depths for reserves of oil and gas and for recovery of salt water solutions.

In the production of oil and gas in Mississippi, the salt water is many times the volume of oil produced (Figure 38). The analyses of salt waters have been largely neglected and very few such analyses are available. Many millions of tons of soluble salts, mostly sodium chloride, have been drawn from the oil fields of Mississippi and returned to underground reservoirs or are allowed to escape into the soils or into the fresh water streams.* Some of the oil field waters have very high concentrations of sodium chloride, possibly sufficient for industrial use. It is not known what lesser salts or chemical compounds and elements might exist in these waters. A study of this kind would be a continuing

*The State, through police powers vested in its Oil and Gas Board, Board of Health and Game and Fish Commission has made commendable progress in the control of pollution.

investigation which should be profitable both to the petroleum industry and to the chemical industry that might utilize the substances discovered. The writer has made a practice of collecting waters whenever the opportunity presented itself and in so doing has been able to accumulate a few dozen water analyses from various formations. Table 6 is a compilation of Paleozoic water analyses from Pontotoc County, and by no means does it represent all the ingredients in these particular waters nor does it represent the maximum concentrations of the ions reported in the area. The salinity of water is to some degree a function of depth, because the more solids in aqueous solution, the greater the specific gravity of the solution. It follows that waters from the deepest reservoirs would likely carry the greatest amounts of dissolved solids.

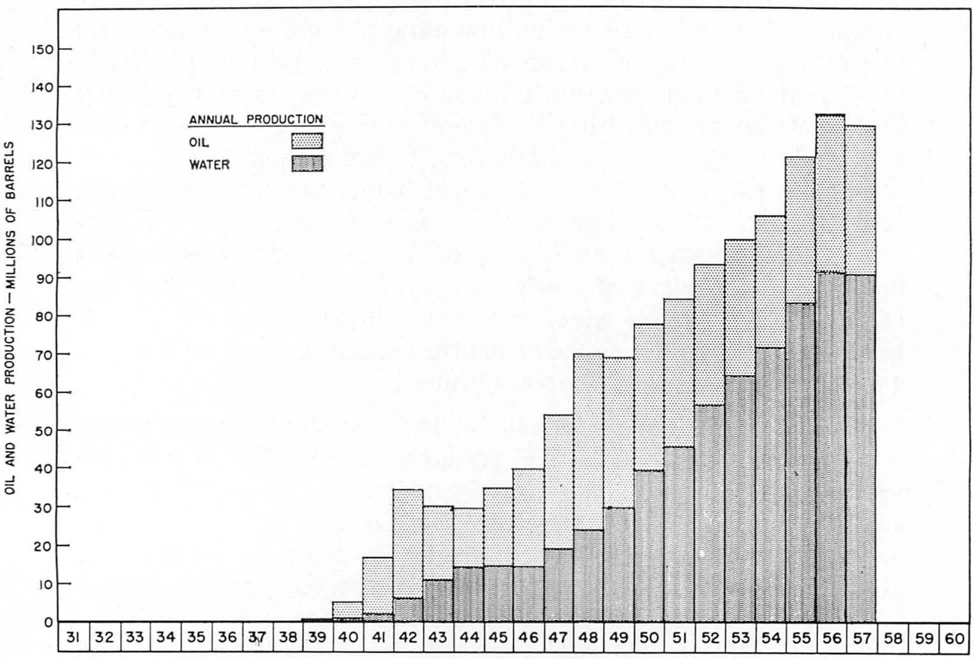

Figure 38

As discussed in the section on salt domes, it is not known definitely that there are no potassium salts in the evaporite sequence of Louan salt deposition. Careful sampling of waters and adequate analyses of these waters might show the presence of potassium salts in concentration sufficient for commercial

TABLE 6

PALEOZOIC FORMATION WATER ANALYSES
Pontotoc County, Mississippi
(radicles in parts per million)
(All samples are from drill stem tests and may reflect some dilution.)

	Chester		Devonian		Ordovician		Knox					
Reference No.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Radicle												
Sodium	13,749	5,716	13,521	4,509	9,711	10,630	10,190	11,991	12,091	23,030	10,491	8,650
Calcium	2,483	467	2,454	552	1,541	1,795	1,148	1,772	2,020	7,745	2,120	1,310
Magnesium	332	102	713	324	737	773	505	795	870	2,635	773	561
Iron	8									5		43
Sulfate	163	453	71	315	225	136	45	149	48	210	44	4
Chloride	26,240	9,574	26,950	8,420	19,432	21,453	18,795	23,404	24,290	56,660	21,985	17,021
Carbonate	18											
Bicarbonate	281	41	433	373	415	409	646	665	714	165		476
Total Solids	43,274	16,353	44,142	14,493	32,061	35,196	31,329	38,776	40,033	90,450	35,718	28,065
pH value	7.8	7.3	7.10	7.4	6.82	6.88	7.1	7.10	7.10	7.15	6.22	6.25
Sp. Grav.	1.0296	1.012	1.0311	1.011	1.0226	1.0267	1.023	1.0267	1.0280	1.0676	1.027	

1. Salmon No. 1 Patterson, Evans sand 3858-3903
2. Salmon No. 1 Naugher, Evans sand 1880-1960
3. Salmon No. 1 Wilson, 1st porous Devonian chert & dolomite 2040-80
4. Salmon No. 1 Naugher, 2nd porous Devonian chert 2775-2820
5. Salmon No. 1 Wilson, Patterson sand 2800-60
6. Salmon No. 1 Wilson, Wilson dolomite, 2946-65
7. Salmon No. 1 Naugher, Snow zone of Knox 3790-3855
8. Salmon No. 1 Wilson, Knox dolomite, 4040-4110
9. Salmon No. 1 Wilson, Knox dolomite 4110-4280
10. Magnolia No. 1 Warren, lower Knox dolomite 7210-7340
11. Salmon No. 1 Henderson, Knox dolomite, 2748-2958
12. Salmon No. 1 Graddy, Knox dolomite, 2510-2720

exploitation and might indicate an origin in the Louan sequence. Many of the laboratories which have analyzed Mississippi waters have not reported potassium. The extraction of solid chemicals from the deep mineral waters of Mississippi offers a great possibility for future development of the chemical industries of the State. It is necessary to know what radicles should be determined in analyses and how well a sample so analyzed is representative of the fluid content of the formation from which it came.

Electrical resistivity measurements which are determined by well logging have furnished a vast reserve of data that is useful in locating saturated or near-saturated saline solutions. Some of these data were used by Hawkins and Jones in a technical study of oil field brines in Mississippi and southwest Alabama Although the methods used indicate the total electrolytic potentials of the reservoir fluids, it is still necessary to obtain true samples of formation waters and to analyze them in detail in order to determine the type or types of mineral salts present. Here, again, because sodium chloride is the most abundant salt, the data are reported as sodium chloride equivalents.

GLAUCONITE

Glauconite or greensand is a common or abundant constituent of many marine sediments in Mississippi. It is described by F. W. Clarke: "In oceanic sediments, and chiefly near the 'mud line' surrounding the continental shores, the important mineral glauconite is found in actual process of formation. This green, granular silicate of potassium and iron occurs in rock of nearly all geologic ages, from the Cambrian down to the most recent horizons, and there has been much discussion over its nature and origin. In composition it is exceedingly variable, for the definite compound is never found in a state of purity, but is always contaminated by alteration products and other extraneous substances. . . . According to the best analyses, glauconite probably has, when pure, the composition represented by the formula $Fe''' K Si_2 O_6$ aq., in which some iron is replaced by aluminum, and other bases partly replace potassium."

The chief glauconite-bearing formations of Mississippi are the Eutaw, the Winona, and the Moodys Branch. Lesser amounts of glauconite are present in the Devonian limestone, the basal Mississippian shale and limestone, at intervals through the Cre-

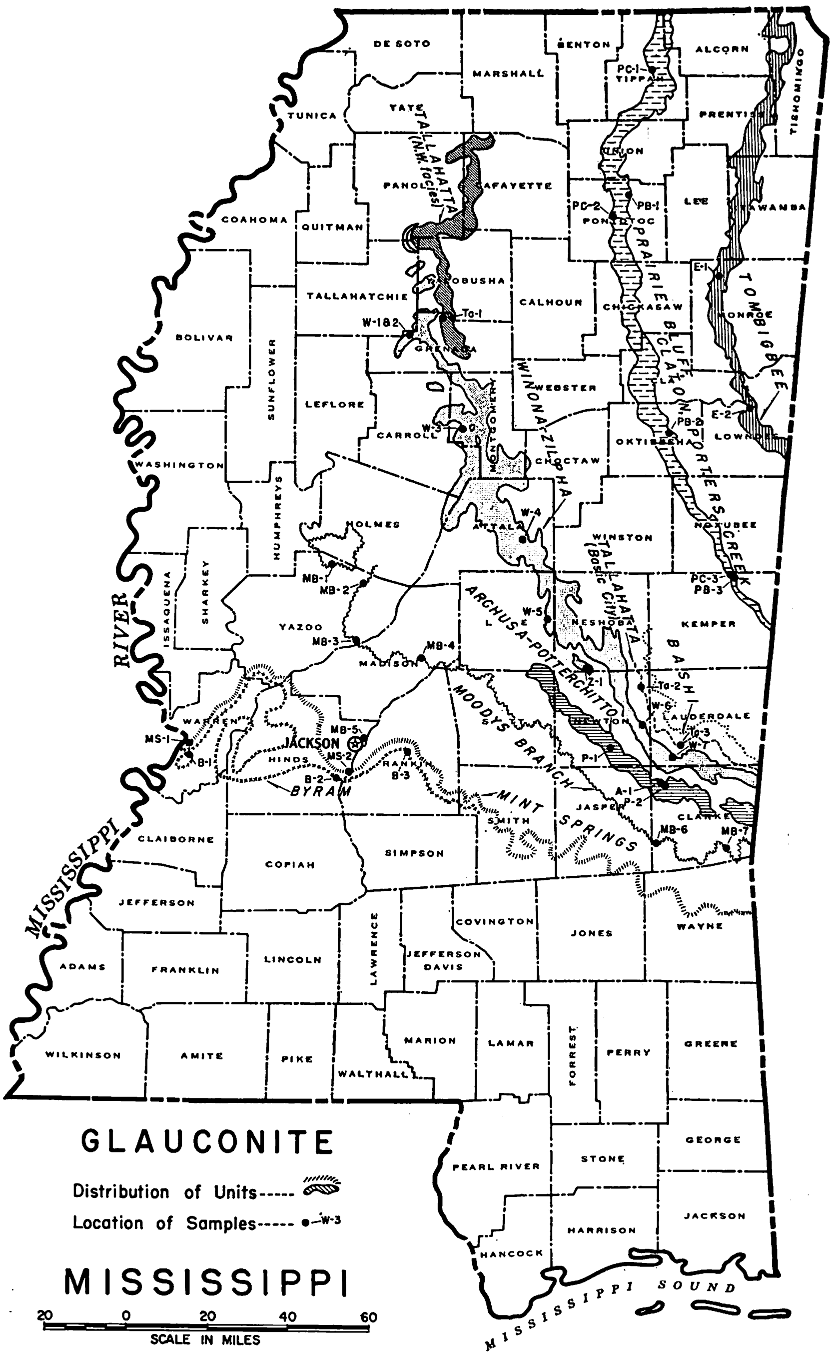
GLAUCONITE
Distribution of Units
Location of Samples
W-3
MISSISSIPPI
20 0 20 40 60
SCALE IN MILES
MISSISSIPPI RIVER
MISSISSIPPI SOUND
TALLAHATTA (N.W. facies)
WINONA-ZILPHA
TALLAHATTA (Basic City)
PRAIRIE BLUFF
CLAYTON
PORTERS CREEK
TOMBIGBEE
ARCHUSA-POTTERCHITTO
BASHI
MOODYS BRANCH
MINT SPRINGS
BYRAM
JACKSON
DE SOTO
MARSHALL
BENTON
ALCORN
TISHOMINGO
TUNICA
TATE
TIPPAH
PRENTISS
UNION
PANOLA
LAFAYETTE
PONTOTOC
LEE
ITAWAMBA
COAHOMA
QUITMAN
YALOBUSHA
CALHOUN
CHICKASAW
MONROE
TALLAHATCHIE
BOLIVAR
GRENADA
WEBSTER
SUNFLOWER
LEFLORE
CARROLL
MONTGOMERY
CHOCTAW
OKTIBBEHA
LOWNDES
WASHINGTON
HUMPHREYS
HOLMES
ATTALA
WINSTON
NOXUBEE
SHARKEY
ISSAQUENA
YAZOO
LEAKE
NESHOBA
KEMPER
MADISON
WARREN
HINDS
RANKIN
SCOTT
NEWTON
LAUDERDALE
SMITH
JASPER
CLARKE
CLAIBORNE
COPIAH
SIMPSON
JEFFERSON
COVINGTON
JONES
WAYNE
ADAMS
FRANKLIN
LINCOLN
LAWRENCE
JEFFERSON DAVIS
WILKINSON
AMITE
PIKE
WALTHALL
MARION
LAMAR
FORREST
PERRY
GREENE
PEARL RIVER
STONE
GEORGE
HARRISON
JACKSON
HANCOCK
PC-1
PC-2
PB-1
E-1
Ta-1
W-1&2
E-2
PB-2
W-3
W-4
PC-3
PB-3
MB-1
MB-2
W-5
MB-3
MB-4
Z-1
Ta-2
W-6
Ta-3
W-7
MB-5
MS-1
B-1
MS-2
B-2
B-3
P-1
A-1
P-2
MB-6
MB-7

Figure 39

TABLE 7

ANALYSES OF SOME MISSISSIPPI GLAUCONITES

	Stratigraphic Order	Sample Number	Grain Size in Mesh	H_2O- by Ignition	% SiO_2	% CaO	% MgO	% Fe_2O_3 & FeO	% Al_2O_3	% TiO_2	% MnO	Total in Percent
By-1					40.00	2.00	2.00	16.00	13.00			
	22	MS-1		17.34	40.85	9.21	1.52	14.00	15.78	0.25	0.001	98.95
MB-1	21	MB-1	60	14.62	44.60	1.68	2.02	15.90	19.58	0.35	0.001	98.75
	20	MB-1	80	13.44	43.49	0.88	3.04	16.92	21.65	0.36	0.001	99.77
	19	MB-3	40	16.09	40.91	0.63	2.50	14.13	25.01	0.28	0.001	99.55
MB-3	18	MB-3	60	19.66	38.16	2.33	2.39	13.33	23.82	0.22	0.002	99.91
	17	MB-4		14.08	33.41	3.28	2.25	17.87	29.04	0.25	0.002	100.18
MB-5	16	MB-5	60	15.71	45.96	3.95	1.49	15.32	17.27	0.27	0.001	99.97
	15	MB-5	100	14.33	45.93	0.15	0.65	14.68	27.05	0.36	0.001	103.15
MB-7	14	MB-7	60	13.20	41.75	0.56	2.22	17.73	22.48	0.26	0.001	98.20
	13	P-1	30	13.31	36.99	1.14	2.46	17.63	28.26	0.31	0.001	100.10
P-1	12	P-1	40	13.98	44.43	0.48	1.75	16.17	23.33	0.25	0.001	100.39
	11	P-2	20	13.63	38.91	1.42	2.04	22.05	20.71	0.25	0.002	99.01
	10	P-2	30	13.10	37.21	0.27	0.03	22.73	25.23	0.27	0.002	98.84
	9	P-2	40	11.93	44.60	1.44		20.01	18.75	0.21	0.001	96.94
P-2	8	P-2	60	14.21	43.05	0.74	0.05	16.16	24.90	0.31	0.001	99.43
	7	P-2	magnetic	12.31	44.81	1.12	3.60	29.38	7.99	0.27	0.001	99.48
Z-1	6	Z-1	60	14.49	48.44	3.20	0.22	13.70	21.71	0.26	0.001	102.02
W-1	5	W-1		14.80	39.28	1.82	1.90	14.11	29.57	0.20	0.002	101.68
	4	W-2	60	13.88	45.81	2.09	2.62	15.07	19.02	0.31	0.001	98.80
W-3	3	W-5	40	15.59	36.44	2.72	1.88	13.36	29.02	0.22	0.001	99.23
	2	W-5	40	15.79	41.92	2.78	1.94	13.51	23.76	0.18	0.002	99.88
W-7	1	W-7	40	13.29	44.28	0.02	1.96	21.10	18.12	0.32	0.001	99.09
(Ta_2 data from clay)					56.00	1.00	4.00	16.00	3.00		.01	

taceous, in the Midway, and at several horizons in the Wilcox, the Tallahatta, the Archusa and Potterchitto, the Mint Spring marl and the Byram marl. The distribution of the more important glauconite units and the locations of analyzed samples are shown in Figure 39. The glauconite-bearing strata are relatively thin, varying from a feather edge to a maximum of around 50 feet.

In 1946, Carnegie Foundation granted research funds to Millsaps College. A portion of the funds was allotted to the Chemistry, Physics and Geology Departments for a joint study of the glauconitic sands of Mississippi. Although the data are unpublished, they have been roughly compiled and made available to the writer by R. R. Priddy. Should demand arise, this work could easily be expanded into a separate bulletin on the glauconite resources of Mississippi. The 24 analyses (Table 7) do not include the alkalis which were "apparently lost as volatile material during loss-on-ignition procedures." The oxides of potassium and sodium (Table 8) were calculated by flame photometer. Unfortunately, the analyses given are of the glauconite concentrates, and the data showing ratios of the concentrates to impurities (sand, clay, shells, etc.) are not in readily usable form. In some samples the glauconite concentrate exceeded 50 percent of the total sample.

Glauconite is used as a zeolitic water softener and as a source of potassium for fertilizers. Minerals Yearbook reports the processing of glauconite limited to two plants, one in New Jersey and one in Maryland, producing annually less than a 6,000 ton average total glauconite concentrate. The analyses indicate all glauconite to have a high percentage of iron oxide. Under certain conditions of weathering, the combined silica and many of the other materials are dissolved leaving limonitic iron ores as an end product. The ores of East Texas originated in this manner from strata equivalent to our Zilpha and Winona. Some of the limonite ores of Alabama and Georgia undoubtedly had their origin in similar processes, as have small quantities of brown ore in a few places in Mississippi.

Deep, red sandy soils characterize the weathered surface of glauconitic sands, and such soils are generally fertile and easily tilled. The depth of weathering of most glauconitic sands contribute to usual thick overburden to the unoxidized glauconite strata.

TABLE 8

POTASSIUM OXIDE, SODIUM OXIDE AND IGNITION LOSSES OF SOME GLAUCONITE SAMPLES.

	Grain size in mesh	% K_2O	% Na_2O	% loss on ignition
* MB-7	60	2.93	0.28	13.20
* P-2		3.27		
* Z-1		3.09	0.69	14.49
* W-1		2.51	0.15	14.80
W-3		3.71	0.71	
* W-7	40	4.08	0.37	13.29
Ta-2		3.36	0.34	
(Antrim from Clarke)		8.00	2.00	7.00
(Italy-Clarke)		7.00	2.00	6.00

In fact, unweathered or unoxidized glauconite is rare along some of the outcrop belts, except in fresh excavations where the glauconite is recognized by its bright green color.

RARER SUBSTANCES

It is well to be on constant lookout for evidences of rare minerals that might, unexpectedly, lead to discovery of unsuspected resources. A few of these rarer or less known minerals have been found in the State and may, in time, lead to commercial exploitation of substances which are now unpromising.

Rare small crystals of purplish fluorspar, for example, were found in Tippah County in a sample of Knox dolomite at 1,835-45 feet in the Memphis Equipment Company's No. 1 W. E. Melton, drilled in 1956.

Native sulphur is reliably reported to have been found in amounts considered sub-commercial on some of the salt domes of south Mississippi. Elemental sulphur might profitably be extracted from well gases (see section on unusual gases) or from flue gases from kilns firing products high in sulphur compounds. Sulfuric acid is extensively used in the manufacture of fertilizer, in the activation of bentonite, and in the manufacture of hydrochloric acid by reaction with salt.

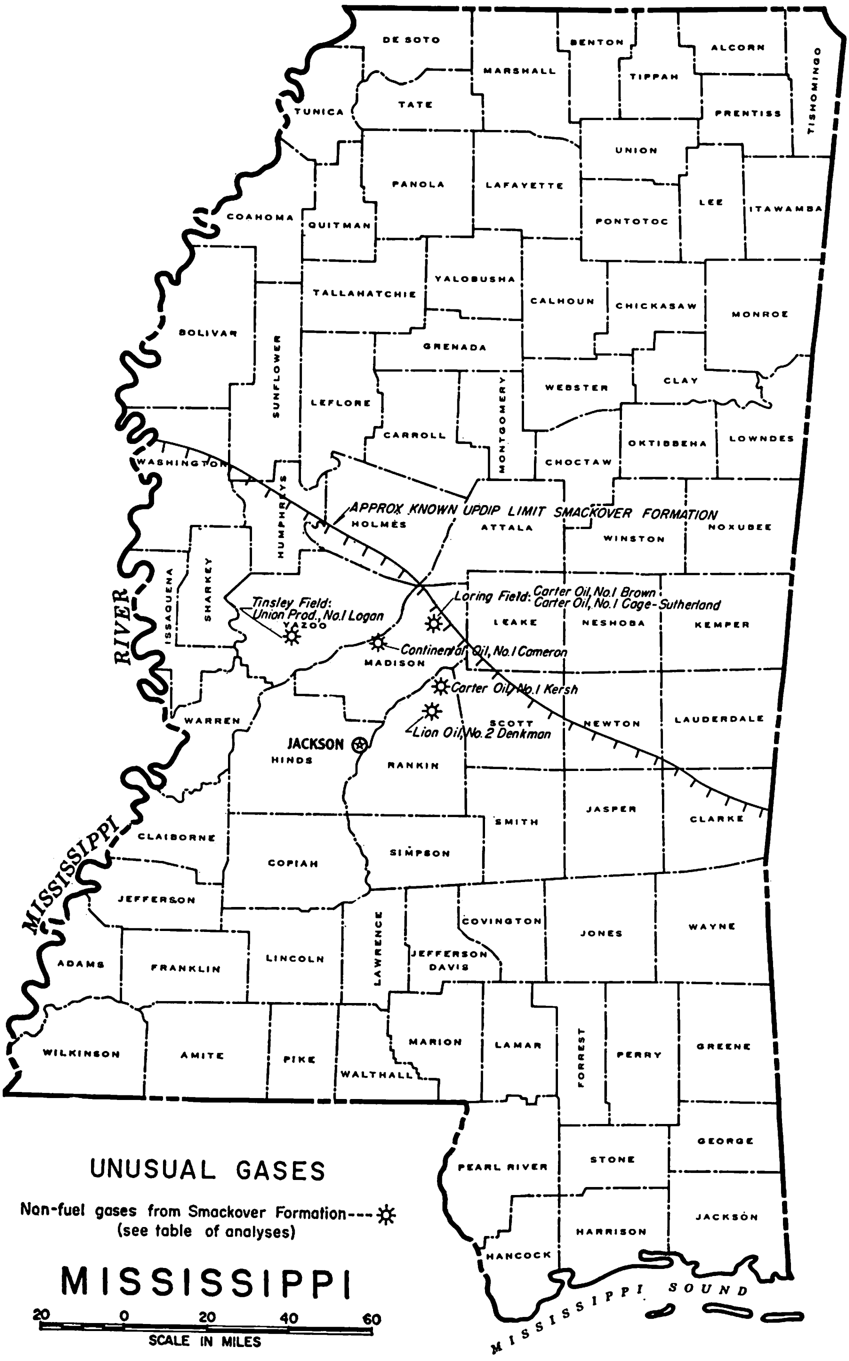
DE SOTO
MARSHALL
BENTON
TIPPAH
ALCORN
TISHOMINGO
TUNICA
TATE
PRENTISS
UNION
PANOLA
LAFAYETTE
LEE
ITAWAMBA
COAHOMA
QUITMAN
PONTOTOC
YALOBUSHA
TALLAHATCHIE
CALHOUN
CHICKASAW
MONROE
BOLIVAR
GRENADA
SUNFLOWER
LEFLORE
MONTGOMERY
WEBSTER
CLAY
CARROLL
OKTIBBEHA
LOWNDES
WASHINGTON
CHOCTAW
HUMPHREYS
APPROX. KNOWN UPDIP LIMIT SMACKOVER FORMATION
HOLMES
ATTALA
WINSTON
NOXUBEE
ISSAQUENA
SHARKEY
RIVER
Tinsley Field: Union Prod., No.1 Logan
YAZOO
Loring Field: Carter Oil, No.1 Brown
Carter Oil, No.1 Cage-Sutherland
LEAKE
NESHOBA
KEMPER
Continental Oil, No.1 Cameron
MADISON
Carter Oil No.1 Kersh
WARREN
SCOTT
NEWTON
LAUDERDALE
Lion Oil No.2 Denkman
JACKSON
HINDS
RANKIN
SMITH
JASPER
CLARKE
MISSISSIPPI
CLAIBORNE
COPIAH
SIMPSON
JEFFERSON
COVINGTON
JONES
WAYNE
ADAMS
FRANKLIN
LINCOLN
LAWRENCE
JEFFERSON DAVIS
WILKINSON
AMITE
PIKE
WALTHALL
MARION
LAMAR
FORREST
PERRY
GREENE
GEORGE
PEARL RIVER
STONE
JACKSON
HARRISON
HANCOCK
MISSISSIPPI SOUND
UNUSUAL GASES
Non-fuel gases from Smackover Formation
(see table of analyses)
MISSISSIPPI
20 0 20 40 60
SCALE IN MILES

Figure 40

UNUSUAL GASES

In west-central Mississippi wells drilled as oil tests of the Smackover formation have encountered large volumes of non-inflammable gases in both sandstone and carbonate facies of the formation (Figure 40). The cores from these tests commonly show large open or crystal-lined vugs, calcite and anhydrite veins, and other evidences of strong chemical corrosion of the Smackover sediments. The action of sulfurous gases in the presence of water or water vapor on lime-bearing rocks would produce the secondary phenomena described, giving sulfates and carbon dioxide as end products.

Conversely, it may be inferred that these reactions are incomplete where substantial percentages of sulferous gases (principally H_2S) remain, as at Tinsley in Yazoo County and at Loring in Madison County. Commercial processes are in operation in other states for the extraction of elemental sulfur or sulfuric acid from sulfur-rich gases, and it is probable that such processes can be applied to Smackover gases in Mississippi. Both sulfur and sulfuric acid are used extensively in the State in the manufacture of fertilizer, and the acid is used by Filtrol Corporation in the activation of bentonite. The few available analyses of these gases indicate high sulfur content in a westerly direction and nearly pure carbon dioxide in an easterly direction (Table 9).

Carbon dioxide as the gas and as carbonic acid is not only essential to life on earth, but is extremely important in many of the physical geologic processes. While in nature its acidic reactions are profound, industry, for the most part, has had to utilize stronger and faster-acting reagents. Carbon dioxide is

TABLE 9

ANALYSES OF SMACKOVER (JURASSIC) GASES

Well	CO_2	H	N_2	O_2	H_2S	CxHy	He	A	Undet.	Total
1(a)	95.2			0.4					4.4*	100%
1(b)	98.0								2.0	100%
2	95.63	0.05	0.53	0.08		3.16	0.24	0.01	0.3	100%
3	70.60		2.82		7.10	19.48				100%
4	74.38		0.24		6.37	19.01				100%
5	99.60								0.40**	100%
6	(Analysis not available)									

1. Lion Oil Co. No. 2 Denkman, Rankin County, Mississippi (22-7N-4E);
   (a) 15,088-15,140';
   (b) open hole DST to 16,276' TD; both tests flowed large volumes of non-inflammable gas. D&A 7/11/52.

2. Continental Oil Co. No. 1 Cameron, Madison County, Mississippi (36-10N-1E), 13,783′ to 13,970′: 2400 MCF/day on 3/8″ T.C. @ 700#, BHP 6577#, SITP 2343#; Completed as Hosston oil well, 7/8/51.

3. Carter Oil Co. No. 1 Brown, Madison County, Mississippi (31-11N-4E), Loring Field, 12,133′ to 12,487′: 4589 MCF/day plus 223 bbl. condensate on 5/8″ T.C. @ 1000# TP, BHFP 3025-4550#, completed as producer, 7/19/54.

4. Average flow stream compositions, Loring Field, Madison County, Mississippi, Carter Oil Co. No. 1 Brown (31-11N-4E) and Carter Oil Co. No. 1 Cage-Sutherland (6-10N-4E).

5. Carter Oil Co. No. 1 Kersh, Rankin County, Mississippi (18-8N-5E), average flow stream compositions: 14,524-14,789 on 3/8″ T.C. flowed at rate 6,000 MCF/day @ 1800#, BHFP 5820-6330#, SIBHP 7610#; 14,442-14,480 on 3/8″ T.C. flowed at rate 6200 MCF/day @ 1935#, BHFP 6705-6765#, SIBHP 7317# (approx. 160′ total porosity by microlog.)

6. Union Producing Co. & Jones-O'Brien No. 1 Logan, Yazoo County, Mississippi (23-10N-3W), Tinsley Field, a highly corrosive gas from the Smackover limestone. Prior to plugging, for safety, the well, on production test 13,985-14,427, flowed at rate 2439 MCF sour gas plus 68 bbl. 55.8° condensate per day on 7/16″ choke, flowing pressure 652 psi.

* Indicated N_2&H.

** O_2 & N_2; trace hydrocarbon (contamination ?).

used, however, in many chemical processes such as the Solvay process, the lime-sinter process of alumina extraction, and it is widely used in beverages and in the manufacture of "dry ice" for refrigeration. These gases are obtainable in large volumes as, for example, in Loring Field where approximately 400,000,000 cubic feet are vented monthly from the two wells in the production of about 11,000 barrels of oil.

METALLIC MINERALS

IRON ORES

Iron, in its various combined forms, is one of the common chemical elements in the rocks of Mississippi. It is present in many clays as soluble salts. It is the coloring agent of the red, brown and yellow sands and clays that lie mostly within the "zone of oxidation" at the earth's surface. It is particularly abundant in glauconite, ranging from 13 percent to 30 percent iron oxide in the Mississippi samples analyzed (Table 7).

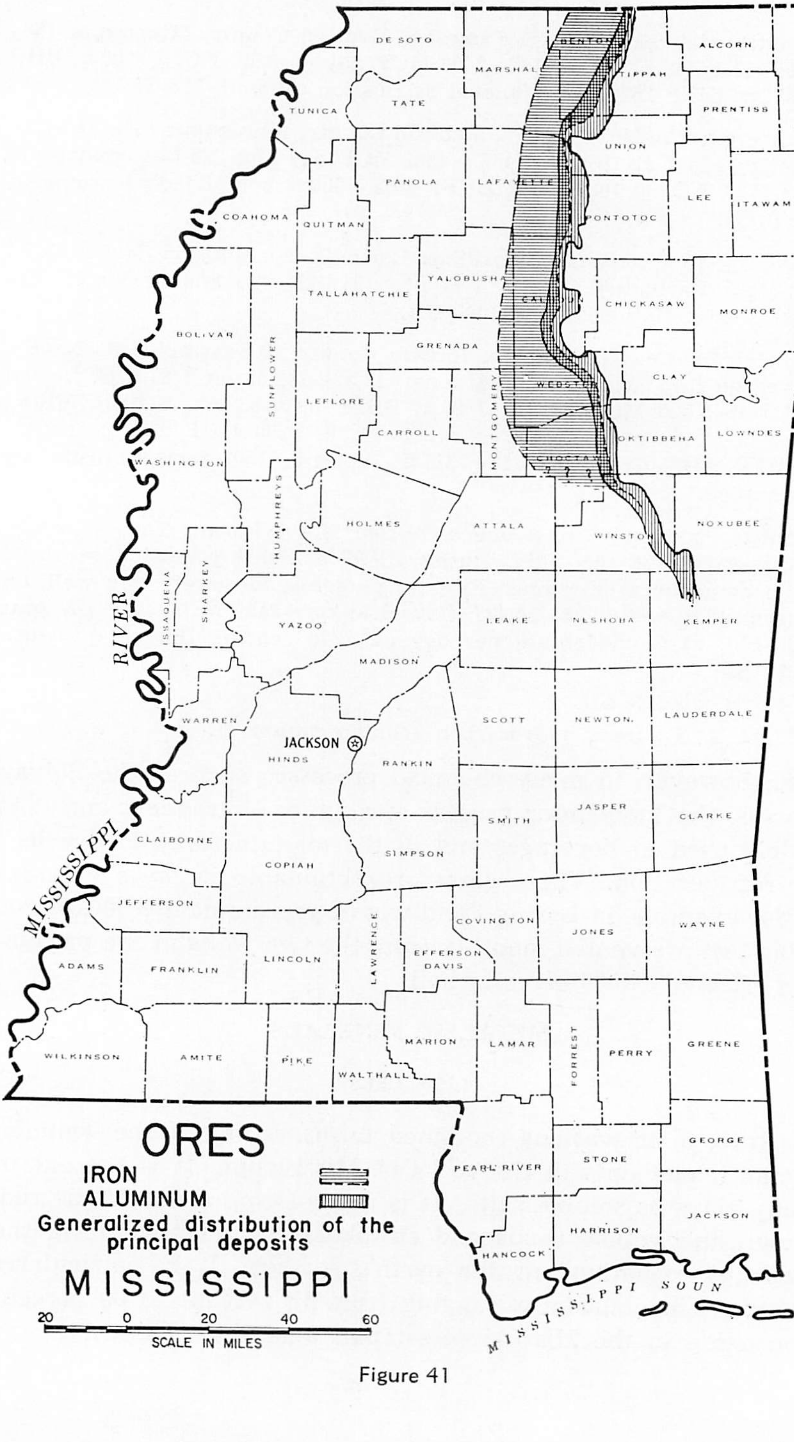
ORES
IRON
ALUMINUM
Generalized distribution of the principal deposits
MISSISSIPPI
20 0 20 40 60
SCALE IN MILES
MISSISSIPPI RIVER
JACKSON
DE SOTO
MARSHALL
BENTON
TIPPAH
ALCORN
TISHOMINGO
TUNICA
TATE
PRENTISS
UNION
PANOLA
LAFAYETTE
LEE
ITAWAMBA
COAHOMA
QUITMAN
PONTOTOC
YALOBUSHA
TALLAHATCHIE
CHICKASAW
MONROE
BOLIVAR
GRENADA
SUNFLOWER
LEFLORE
MONTGOMERY
WEBSTER
CLAY
CARROLL
OKTIBBEHA
LOWNDES
WASHINGTON
CHOCTAW
HUMPHREYS
HOLMES
ATTALA
WINSTON
NOXUBEE
ISSAQUENA
SHARKEY
YAZOO
LEAKE
NESHOBA
KEMPER
MADISON
SCOTT
NEWTON
LAUDERDALE
WARREN
HINDS
RANKIN
SMITH
JASPER
CLARKE
CLAIBORNE
SIMPSON
COPIAH
JEFFERSON
COVINGTON
JONES
WAYNE
ADAMS
FRANKLIN
LINCOLN
LAWRENCE
JEFFERSON DAVIS
MARION
LAMAR
FORREST
PERRY
GREENE
WILKINSON
AMITE
PIKE
WALTHALL
PEARL RIVER
STONE
GEORGE
HANCOCK
HARRISON
JACKSON
MISSISSIPPI SOUN

Figure 41

The principal iron ore deposits are in the Wilcox of north-central Mississippi (Figure 41). At and near the surface the ore is the hydrated oxide, limonite. At Winborn, Benton County, a charcoal blast furnace turned out 125 tons of pig iron about the beginning of World War I (Figure 42). The ores used were limonite and gray iron carbonate, siderite, both low in sulphur and phosphorous. At Flat Rock Church, Benton County, George S. Mepham Paint Company operated an open cut iron carbonate mine for many years, shipping the ore to the Company's factory at East St. Louis for roasting to the red oxide.

Intermittently, over the past 25 years, a few railroad cars of ore and ore concentrate have been shipped to Birmingham for smelting. Freight rates have been the largest single item of expense and thus far no producer of ore appears to have made a profit. The concentrates, in cases running 50 percent or more metallic iron, are reportedly of a desirable quality. The ores of iron are discussed in a number of bulletins of the Mississippi Geological Survey, by Lowe (Bull. 10, Bull. 12, Bull. 14), by Attaya (Bull. 71, Bull. 74), by Vestal (Bull. 73, Bull. 75), and by Lusk (Bull. 80) (Figure 43). Many millions of tons of mineable ore of high quality are estimated in the northern Wilcox belt. Smelting of these ores within the State may be economically feasible, now or in the near future.

ALUMINUM ORES

Bauxite, the principal ore of aluminum, is present at the top of the Midway formation (Figure 41) as part of the Betheden residuum in Tippah, Benton, Union, Pontotoc, Calhoun, Webster, Oktibbeha, Noxubee, Winston and Kemper Counties (Bull. 19). Bauxitic clays are present in Tishomingo County. In the weathering alteration of clays or other aluminous rock beyond the mineral kaolinite, combined silica is replaced by combined water to form a hydroxide of aluminum. The analyses of some Mississippi bauxite samples illustrate the high combined water (loss on ignition) and the decreased silica content of the bauxite over the clays (Table 3). In some of the bauxite samples, the hydrated oxide of iron has increased simultaneously with the hydrated oxide of aluminum. As compared with the Arkansas bauxite deposits of the same age, but which were formed from feldspar-rich nepheline syenite, the Mississippi bauxite is vastly inferior.

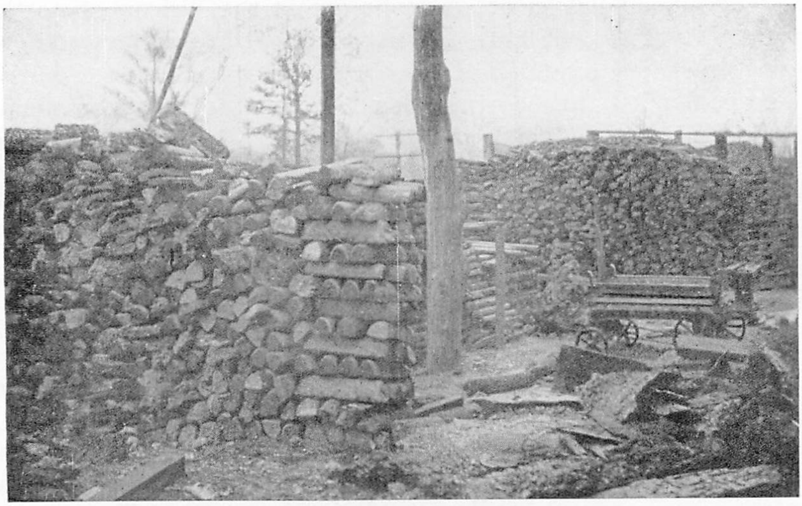

Figure 42.—Pig iron (125 tons) smelted by the furnace at Winborn. (M. G. S. Bull. 12, Fig. 13) (M. G. S. Bull. 80, Fig. 28).

Figure 43.—Iron ore concretion in road ditch (NW.¼, NW.¼, Sec. 12, T.5 S., R. 1 W.) about 2.5 miles north of Winborn (M. G. S. Bull. 80, Fig. 29). Photo by Tracy W. Lusk, June 4, 1956.

It is in thin lenticular beds, is lower in alumina, generally higher in iron and silica, and much more widely scattered areally.

The known Mississippi deposits of bauxite and bauxitic clay are intimately associated with much larger tonnages of kaolin and anauxite and the utilization of these materials concurrently in alumina extraction by sintering processes may be feasible. These ores have been considered in the manufacture of quick-setting cement and ferro-silicon.

OTHER METALLIC MINERALS

URANIUM

Commercially usable concentrations of uranium salts are not known to exist in Mississippi. Nevertheless, the State's scientists should continually be abreast of research on fissionable raw materials in other areas and alert to exploit such materials when found here in paying quantities. Radioactive logging of oil test wells have indicated some zones of unusual radioactivity, and surface prospecting has found evidences of uranium in black shales and lignitic beds. Heinrich reports radioactive minerals in sedimentary formations that have equivalents in Mississippi: (1) "... near Mauch Chunk (now Jim Thorpe), Pa., in the Pottsville conglomerate and Pocono sandstone (Pennsylvanian and Mississippian)"; (2) "In Texas at Tordilla Hill, Karnes County, in the upper Jackson formation (Eocene); in the Catahoula formation (Miocene) near Sample, Gonzales County; and in the Gueydan formation (Miocene) near Freer, Duvall County."; (3) the Chattanooga shale which, in Alabama and Tennessee: "Of the radioactive shales in the United States it is the most favorable possible future low-grade uranium source, because it is relatively radioactive, widespread, relatively thick, and is generally not deeply buried."; and (4) in the Tuscaloosa and younger sediments of Georgia. Burton and Sullivan report uranium concentrations in the Upper Cretaceous of Mississippi, of 6.5 to 12 parts per million and in the Upper Cretaceous of East Texas of 3.3 to 6.7 parts per million. Experiences in other areas are teaching us the natural methods of secondary enrichment of uranium compounds and the necessary environments of deposition and accumulation in sedimentary deposits.

Uranium concentration in sediments has been found to vary positively with increase in colloidal material, with organic material, with phosphatic material, and with subaerial laterization, and negatively with increase in quartz and with certain other conditions. These conditions will be understood more and more as the search for uranium continues. Priddy points out the highly lignitic nature of a facies of the Fearn Springs clay in Pontotoc County and elsewhere along this belt. The possibilities of this particular horizon would appear to be enhanced by its superjacent relationship to the Betheden residuum of bauxite, bauxitic clays and kaolin.

HEAVY MINERALS

Exploitation of natural concentrations of heavy mineral sands in Florida is a relatively new and vital industry that might be extended into Mississippi. R. D. Foxworth completed in 1958 an excellent masters thesis on the heavy minerals from the beaches and islands of the Mississippi Gulf Coast. The ultimate source of these twenty-six minerals is considered to be the southern Appalachian mountains. Foxworth considers that these sands are drifting westerly near shore and that local concentrations of the minerals are due to specific gravity, grain size and wave action. The processes of concentration are perhaps little different today than they have been at various times in the past in Mississippi. Therefore, similar or greater concentrations of these minerals might be found in the coastal terraces or within the older stratigraphic column. Foxworth's summary table gives these minerals in the following abundance:

TABLE 10

AVERAGE HEAVY MINERAL COMPOSITION OF THE BEACH OF EACH AREA AND THE TOTAL AREA

Minerals	Average Frequency for Total Area	Mainland	Deer Island	Round Island	Cat Island	Ship Island	Horn Island	Petit Bois Island
Andalusite	x	x	----	----	x	x	----	x
Apatite		x	----	----	----	----	----	----
Augite & Diopside		x	----	----	----	x	----	----
Dolo. & Sid	x	x	----	----	----	x	0.1	----
Epidote	----	----	----	----	x	----	----	----
Garnet	x	x	----	----	x	x	x	----
Hornblende (Brn)	0.1	0.1	x	x	x	0.2	0.2	x
Hypersthene		----	----	----	----	x	----	----
Ilmenite	13.4	13.1	3.1	6.1	8.9	24.8	10.8	11.4
Kyanite	27.4	26.3	25.5	32.9	30.5	22.1	31.3	26.7
Leucoxene	2.5	3.5	3.5	2.2	3.3	1.7	1.5	0.1
Lim. & Hem.	3.2	5.3	3.7	3.3	2.2	2.1	2.4	1.0
Mineral X	0.2	x	x	x	0.5	x	x	0.7
Pigonite		----	----	----	x	x	0.1	x
Pyrite & Marc.	0.2	0.2	0.3	0.2	0.2	0.4	----	0.1
Rutile	1.8	1.4	2.2	0.4	1.2	6.0	0.2	0.3
Sillimanite	1.2	1.5	0.5	0.7	1.2	0.3	1.6	1.5
Spinel	x	x	----	----	x	x	----	----
Staurolite	26.2	24.6	20.5	22.5	28.7	25.2	31.0	30.8
Titanite	x	x	x	----	x	x	----	x
Tourmaline (Brn)	18.9	18.2	27.4	28.2	19.8	8.6	17.9	24.2
Blue	0.2	0.3	----	0.1	x	0.2	0.1	0.5
Green	0.9	1.4	1.2	1.7	0.6	0.7	0.7	1.1
Colorless	0.4	0.3	0.5	1.2	0.6	0.1	0.6	0.4
Zircon	1.6	1.6	0.9	0.2	0.5	6.3	0.1	0.4

GOLD, LEAD AND SILVER

The valuable metals, gold, silver, lead and even zinc have been widely reported over the State, seemingly always in a legendary fashion. None of these metals is known authoritatively to be indigenous to the rocks of the State, but erratic specimens of their ores are sometimes found.

REQUIREMENTS FOR A USABLE MINERAL DEPOSIT

The requirements for the successful and profitable development of mineral deposits are many and variable. All the factors are economic and may be listed, generally in order of importance, as follows:

1. Demand
2. Size of deposit
3. Uniformity of material
4. Transportation
5. Drainage and mining costs
6. Fuel and water supply
7. Labor supply

Demand, being synonymous with market, must exist in actuality or potentially prior to the establishment of the industry. Demand may be obvious, or it may require a lengthy and expensive market survey in order to be felt. Capital to develop the new mineral industry is, of course, absolutely necessary, but has not been listed above because where there is demand and market people have always come up with money and resources to do the work required.

A mineral deposit must be large enough in itself or in combination with other deposits to sustain the new industry through its amortization period and for a reasonable life expectancy thereafter. This assumes the new industry to have no title or other ownership problems in the deposit.

A mineral deposit must be uniform within the limits prescribed by its market and by the facilities to produce the mineral product. This uniformity, or the lack of it, must be known before there is any production, particularly if the new industry is a stock company. Variations from uniformity require adjustments and deviations in processing which increase costs of production and reduce margins of profit.

Transportation is a broad term applicable to the movement of raw materials, machinery, labor and finished products. Converted to costs, it cannot occupy too great a percentage of the receipts of the finished product. Many of our mineral products are carried to market over roads and highways or through pipelines; most products, at one stage or another, utilize rail transportation from mine to processing plant and from plant to market; and some of the mineral products are benefited by the availability of water transportation. The accessibility by air for supervisory personnel and for emergency parts and supplies is also included in this term.

Unusual expenses in mining cannot be sustained in the ordinary mineral industry, because they reduce the competitive position of the company. Excessive water commonly determines the economic limit of a mining operation, for example, when a

Figure 44.—Misceramic Tile Company's Cleveland, Mississippi, 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. Photo by Sawyer, 1959.

deposit is worked to the point where it passes below the water table. In cases, the life of the deposit can be extended by pumping, but pumping, as compared to natural drainage, reduces the margin of profit. The removal of excessive overburden and underground mining likewise reduce the margin of profit.

Fuels in ample supply at established rates are necessary to the successful exploitation of mineral deposits. Electricity is now almost always an essential. Natural gas and fuel oil, coal and coke are common fuels, each having its own advantages and its own limitations in use and price. In some mineral industries large volumes of water are required; lack of water may retard development of some deposits indefinitely.

The availability of labor is a local situation varying from time to time. In broader perspective the availability of labor is related to general economics. The working of a mineral deposit does not often bring great wealth to the owner of the land or even to the operating company. Mineral production and processing is a competitive business where all the factors enumerated, and many more, besides, contribute to whether the industry will make or lose money. The great part of the income from mineral production goes directly to labor, and indirectly to labor which produced the machinery, materials, housing and equipment purchased or leased by the new mineral industry (Figure 44).

CONCLUSIONS

Mississippi has risen rapidly from 47th place in the 50 reporting political units of the Nation, in 1930, to 24th place in 1957. Development of extensive oil and gas fields have been largely responsible for this increase. Most of the mineral substances produced, including the crude oil and gas are exported for processing or utilization elsewhere; although there is an accelerating trend toward industrialization for the use of local raw materials.

All the mineral products require continuing study in their optimum utilization. Improved analytical techniques and the dissemination of knowledge of Mississippi's mineral raw materials will aid in the wise use of their products to the creation of greater and more permanent wealth.

New highways and a close network of railroads over the State, enormous volumes of surface water and ground water, an abundant supply of natural gas and petroleum, and an adequate supply of electricity, all provide an unusual opportunity in Mississippi for the development of new industries utilizing, within the State, the mineral resources.

The following expansions appear desirable in the best interest of the economy of the State:

1. To increase many times the output and farm use of agricultural lime, thereby helping to stop the rapid depletion of

the mineral content of the soils, improving the yield, and improving the quality of the yield of cropland and pastureland.

2. To increase capacity or secure additional capacity for refining a greater percentage of the crude oil produced in Mississippi.

3. To use and to encourage the use of Mississippi mineral products, brick, tile, portland cement, pottery, concrete aggregate, and all others.

The following industries appear to afford opportunity for immediate establishment within Mississippi:

1. Development of rock salt or salt brine for the manufacture of sodium chloride and chemicals derived therefrom, such as sodium chlorate, caustic soda, chlorine, hydrochloric acid and countless other chemical products.

2. Development of a rock wool industry, utilizing local wool rock and natural gas to supply the domestic market with insulating material.

3. Development of a competitive drilling mud in the State.

The following mineral materials, among others, are worthy of further study toward possible industrial use:

1. Glass sand
2. Lignite
3. Carbon dioxide gases
4. Sulfur gases
5. Iron ores
6. Glauconite
7. Heavy minerals
8. Clays for alumina extraction
9. Tripoli and chert
10. Oil refining and petrochemicals.

AFTERWORD AND ACKNOWLEDGMENTS

The writer feels that he was signally honored to be called upon by the Mississippi Geological Survey to prepare this short report on the State's mineral resources. Aside from the timeliness and merit of the subject, it is one which he long had cherished ambitions to develop. After acceptance of the assignment, he quickly realized that the subject was almost limitless and that his qualifications were dwarfed by the magnitude and number of the considerations involved, practical and technical: social, economic, chemical, physical, as well as geological. Inasmuch as the time was limited, the writer has attempted to do his best to portray the mineral resources of the State in a realistic light; to try to be as specific as a report, general by its very nature, would permit; to place properly proportioned emphases upon the diverse mineral substances; and to shift to generalities when approaching areas of his ignorance. For in the social and economic aspects of the subject one needs to be a mineral economist; in the chemical, a geochemist; in the physical, a mining engineer or a geophysicist; in none of which fields does the writer pretend efficiency. Mineral-wise, Mississippi is a rapidly advancing Commonwealth whose economic potentialities are tremendously greater than the imaginations of most of us can grasp, and if this picture has been created in the minds of the readers, the writer's acceptance of this assignment will not have been amiss.

The writer is particularly grateful for the confidence, encouragement and assistance of the State Geologist and the members of the Mississippi Geological Survey Board. The officials and employees of many mineral producing companies have contributed generously to the data herein, as have numerous other public officials and individuals.

Lastly, the credit for Mississippi's present position in the mineral world should go to the outstanding geologists who have directed the work of the Mississippi Geological Survey, nearly always without adequate funds for immediate needs—never with funds sufficient to finance necessary exploration and research on undeveloped resources: to Hilgard, who a hundred years ago, in the year (1859) Colonel Drake drilled his first oil well, described the Jackson Dome (p. 129), 70 years before it was discovered to contain natural gas, and who, in the same report vividly described bauxite in northeast Mississippi, years before

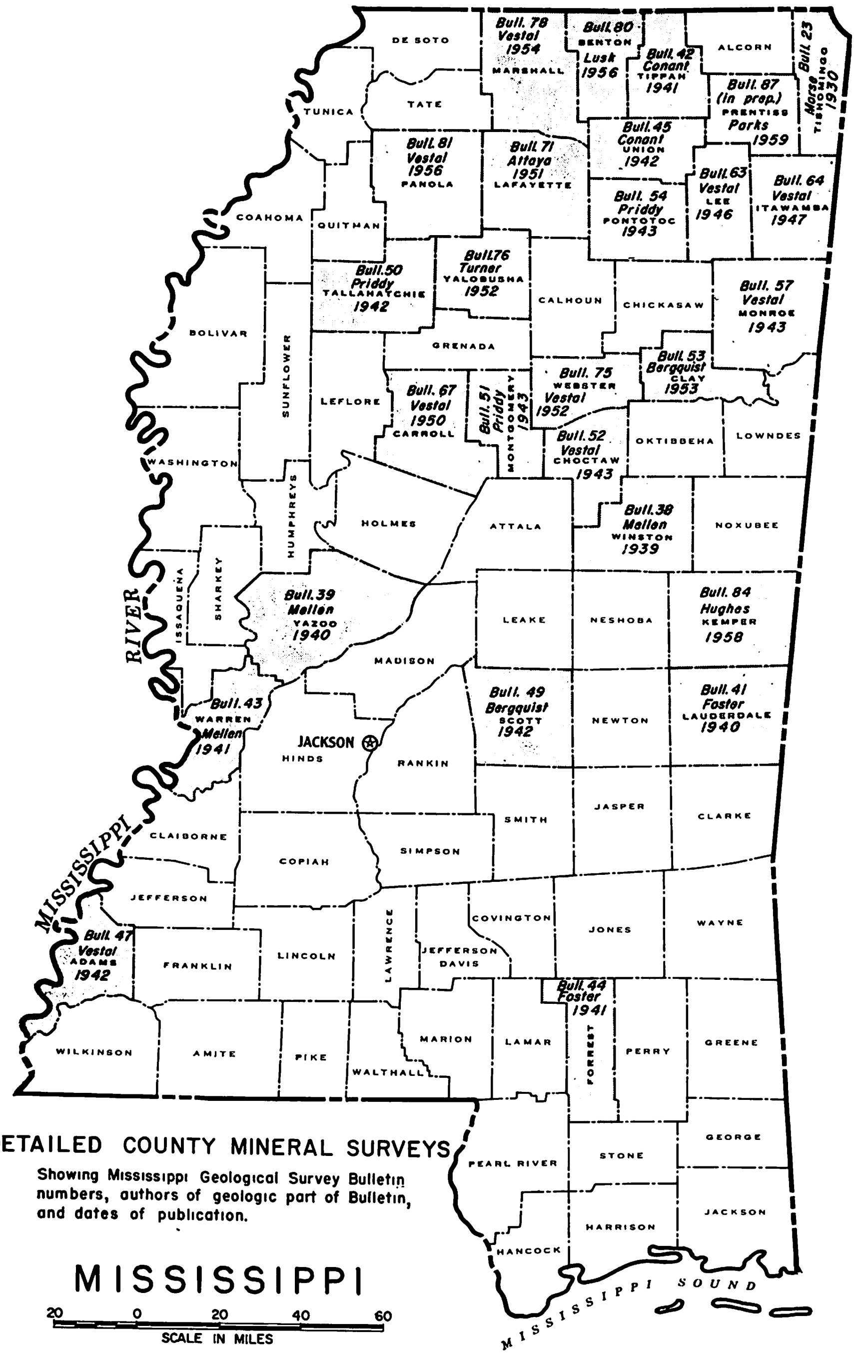
DETAILED COUNTY MINERAL SURVEYS
Showing Mississippi Geological Survey Bulletin numbers, authors of geologic part of Bulletin, and dates of publication.
MISSISSIPPI
20 0 20 40 60
SCALE IN MILES
DE SOTO
Bull. 78 Vestal 1954 MARSHALL
Bull. 80 BENTON Lusk 1956
Bull. 42 Conant TIPPAH 1941
ALCORN
Bull. 23 Morse TISHOMINGO 1930
TUNICA
TATE
Bull. 87 (In prep.) PRENTISS Parks 1959
Bull. 81 Vestal 1956 PANOLA
Bull. 71 Attaya 1951 LAFAYETTE
Bull. 45 Conant UNION 1942
Bull. 63 Vestal LEE 1946
Bull. 64 Vestal ITAWAMBA 1947
COAHOMA
QUITMAN
Bull. 54 Priddy PONTOTOC 1943
Bull. 50 Priddy TALLAHATCHIE 1942
Bull. 76 Turner YALOBUSHA 1952
CALHOUN
CHICKASAW
Bull. 57 Vestal MONROE 1943
BOLIVAR
SUNFLOWER
GRENADA
Bull. 53 Bergquist CLAY 1953
LEFLORE
Bull. 67 Vestal 1950 CARROLL
Bull. 51 Priddy MONTGOMERY 1943
Bull. 75 WEBSTER Vestal 1952
OKTIBBEHA
LOWNDES
WASHINGTON
Bull. 52 Vestal CHOCTAW 1943
HUMPHREYS
HOLMES
ATTALA
Bull. 38 Mellen WINSTON 1939
NOXUBEE
ISSAQUENA
SHARKEY
Bull. 39 Mellen YAZOO 1940
LEAKE
NESHOBA
Bull. 84 Hughes KEMPER 1958
RIVER
MADISON
Bull. 43 WARREN Mellen 1941
Bull. 49 Bergquist SCOTT 1942
NEWTON
Bull. 41 Foster LAUDERDALE 1940
JACKSON
HINDS
RANKIN
SMITH
JASPER
CLARKE
MISSISSIPPI
CLAIBORNE
COPIAH
SIMPSON
JEFFERSON
COVINGTON
JONES
WAYNE
Bull. 47 Vestal ADAMS 1942
FRANKLIN
LINCOLN
LAWRENCE
JEFFERSON DAVIS
Bull. 44 Foster 1941
WILKINSON
AMITE
PIKE
WALTHALL
MARION
LAMAR
FORREST
PERRY
GREENE
GEORGE
PEARL RIVER
STONE
JACKSON
HARRISON
HANCOCK
MISSISSIPPI SOUND

Figure 45

it was known to be the ore of aluminum; to Crider, who, at the beginning of the 20th century reorganized and set in motion the present Mississippi Geological Survey, developing surface stratigraphy and economic knowledge of clays, limestones, lignites and other mineral resources; to Lowe, who above all else held the Survey together through the many lean years when our annual mineral production rarely exceeded $2,000,000, and who dedicated himself to the belief that "this, in view of the abundance of our mineral resources, should have been twenty times as much"; and to Morse, who insisted upon high quality professional endeavor, county by county surveying the State for its mineral resources (Figure 45), and who led the development of the Mississippi mineral resources to the present beginning of a golden economic era.

The writer is very grateful to those ably assisting in the preparation of this report: to Mrs. Mary Alice Webb for the typing and secretarial assistance; to Mr. Charles Gordon for most of the drafting; to Engineering Service for contribution of the excellent county outline base map of Mississippi; to Dr. M. P. Etheredge, State Chemist, for several consultations on chemical processes and for reading the manuscript.

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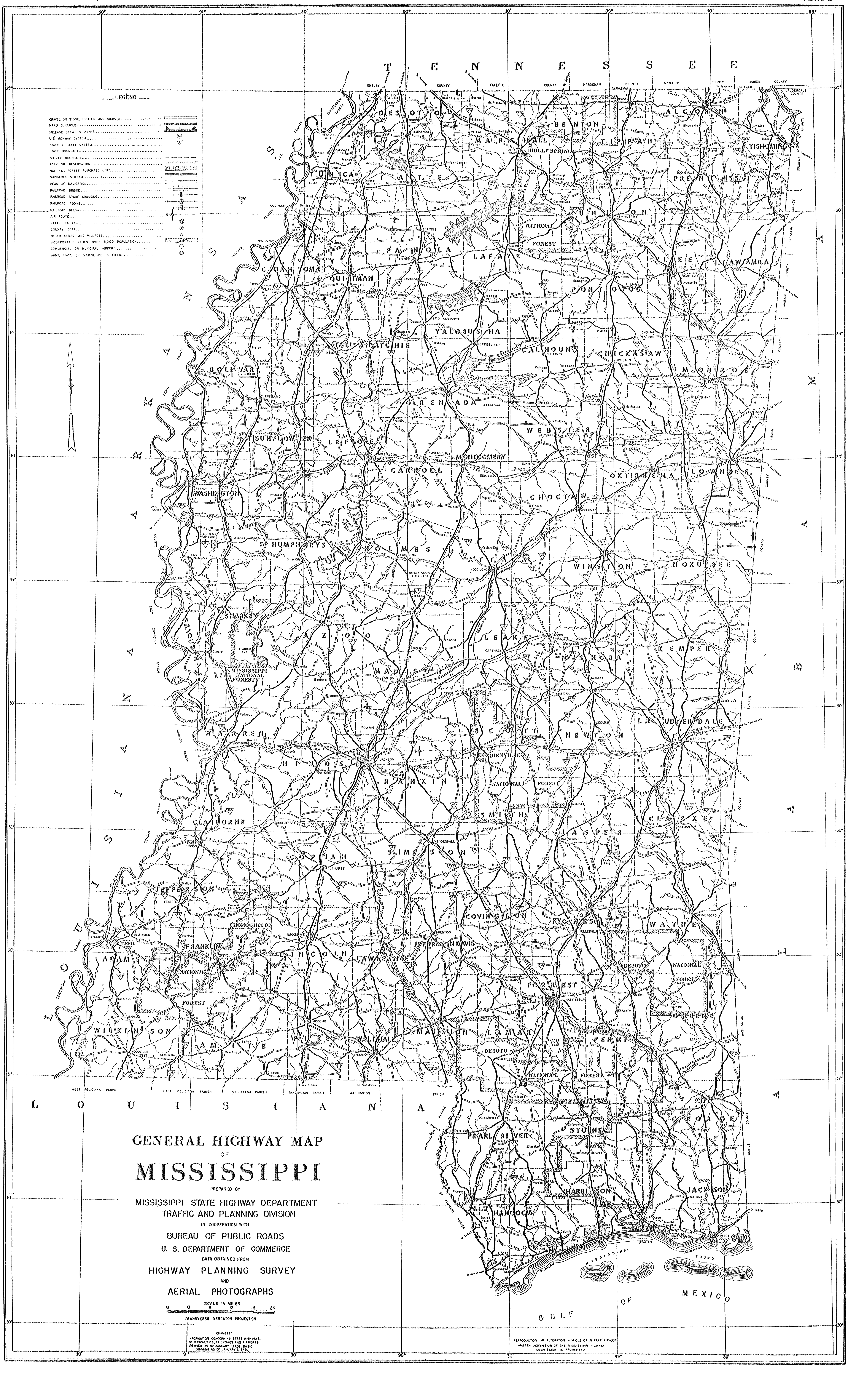
GENERAL HIGHWAY MAP
OF
MISSISSIPPI
PREPARED BY
MISSISSIPPI STATE HIGHWAY DEPARTMENT
TRAFFIC AND PLANNING DIVISION
IN COOPERATION WITH
BUREAU OF PUBLIC ROADS
U. S. DEPARTMENT OF COMMERCE
DATA OBTAINED FROM
HIGHWAY PLANNING SURVEY
AND
AERIAL PHOTOGRAPHS
SCALE IN MILES
TRANSVERSE MERCATOR PROJECTION
LEGEND
TENNESSEE
ARKANSAS
LOUISIANA
ALABAMA
GULF OF MEXICO
MISSISSIPPI SOUND