GEOLOGIC MAPPING IN MISSISSIPPI: PROCEEDINGS OF THE 1989 MISGEOMAP CONFERENCE

edited by

Michael B. E. Bograd
David T. Dockery III

CIRCULAR 3

**MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY
BUREAU OF GEOLOGY**

Conrad A. Gazzier
Bureau Director

Jackson, Mississippi

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PREFACE

The MISGEOMAP Conference was held February 21, 1989, in Jackson, Mississippi. It was co-hosted by the Mississippi Bureau of Geology and the U. S. Geological Survey.

GEOLOGIC MAPPING IN MISSISSIPPI: PROCEEDINGS OF THE 1989 MISGEOMAP CONFERENCE

INTRODUCTION

The Mississippi Bureau of Geology (formerly the Mississippi Geological Survey) has been the major producer of geologic maps for Mississippi during this century. Geologic mapping and mineral resource studies were the major tasks of this agency in its early years. With rising concerns over pollution in the 70's, the Bureau's emphasis shifted to the environment. New sections were formed for environmental geology, ground water, and regulation of surface mining. Geologic mapping and the construction of shallow subsurface cross sections were continued under the Surface Geology Section. Deeper stratigraphic cross sections and other studies concerning petroleum geology were done by the Subsurface Geology Section. Recently, the needs of environmental research have refocused attention on the importance of good geologic map coverage. Geologic maps are also vital for development of economic minerals. This industry contributes over $100 million annually to the Mississippi economy, exclusive of oil and gas. For these reasons, the MISGEOMAP Conference was held in Jackson on February 21, 1989, to discuss geologic mapping needs among the map makers and users. This conference included representatives from a diversity of federal and state agencies as well as academic institutions and was funded by the U. S. Geological Survey (USGS) as part of the COGEOMAP program. A list of attendees and their affiliations is given in Appendix A.

The MISGEOMAP Conference provided a dialogue between the Mississippi Bureau of Geology and various agencies that use geologic maps as to their needs for geologic map products. It also provided an opportunity to explore cooperative mapping projects between the Bureau and the U. S. Geological Survey along with other map producers. The conference program consisted of presentations by geologists from the Mississippi Bureau of Geology, U. S. Geological Survey, U. S. Waterways Experiment Station, Mississippi Mineral Resources Institute, and state universities who were involved in geologic mapping. After these presentations, map users from a number of agencies discussed the kinds of geologic map resources that they needed. A plan to revise the state geologic map was presented and various scales for this map were discussed.

Many of those who made presentations of their geologic mapping work provided manuscripts that are included in this report. These contributed papers follow a brief summary of the meeting's presentations and discussions. The interchange of ideas and the documentation of recent or ongoing geologic mapping projects as recorded form a basis for evaluating the direction of future mapping programs in the state.

CONFERENCE PROCEEDINGS

The MISGEOMAP Conference was opened with a welcome to the conferees by David Dockery of the Mississippi Bureau of Geology (MBG) and with an orientation to the packet of conference materials. This was followed by the conferees introducing themselves and giving their affiliations. Conrad Gazzier, the Bureau director and State Geologist, discussed the purpose of the conference and the impact it would have in the development of the agency's 5-year plan. He pointed out that the primary, traditional role of the Bureau is to produce geologic maps. Better maps are needed for application to environmental problems and development of economic mineral resources. The Bureau is developing a 5-year plan to direct the course of geologic mapping, including revision of the 20-year-old state geologic map.

David Dockery served as conference chairman and introduced the following speakers.

Wayne Newell of the U. S. Geological Survey COGEOMAP program explained the Survey's interest and possible involvement in geologic mapping in Mississippi. He pointed out new mapping techniques and the importance of digital maps. There are many ways that USGS can cooperate with state geological surveys, from projects in small areas to entire state geologic maps. Michael Bograd (MBG) gave a brief history of geologic mapping in Mississippi and discussed the Bureau's contribution to this history. He noted the unequal qualities of various geologic maps within the state and the recent improvements in map quality with the move to color maps. Robert Merrill (MBG) presented the Bureau's most recently completed geologic mapping project for the Tishomingo County geology bulletin. This presentation included slides of interesting outcrops as well as maps and cross sections. The stratigraphic nomenclature for the Paleozoic rocks was changed from that previously used by the agency to that more widely accepted by the surrounding states.

James May of the U. S. Army Engineer Waterways Experiment Station discussed the age of high level terrace deposits in southern Mississippi that have conventionally been placed in the Citronelle Formation. He argued that these deposits varied in age and were the updip graveliferous facies of various Miocene units. Gravels are present in the subsurface Miocene, but are mapped as terrace deposits where they crop out and are oxidized. May pointed out that the depositional environments of these deposits must be considered, as alluvial sediments of central and southern Mississippi grade into deltaic sands at the coast. Ernest Russell added that there is no way to date the gravels absolutely and that they are all reworked from the Tuscaloosa Formation (Cretaceous).

David Patrick of the University of Southern Mississippi identified mapping problems in southern Mississippi with the Citronelle Formation and the Miocene sediments. Here a detailed subsurface study is needed to define formations. He then presented his study of terrace surfaces and illustrated four to five terraces of presumed Quaternary age associated with the Pearl, Bowie, and Leaf rivers in southern Mississippi.

These terraces are underlain by Miocene rather than Quaternary deposits and are erosional, not depositional, surfaces. Patrick suggested that a distinction should be made on geologic maps between Quaternary terrace surfaces and Quaternary alluvium. Richard Bowen of the University of Southern Mississippi pointed out the difficulty of defining boundaries between the Miocene formations of southern Mississippi and argued for lithologic mapping in this area without regard for the usual Miocene stratigraphic nomenclature. He said that terraces in southern Mississippi are thin veneers and that the old term "high terrace" is erroneous. He stated that it is possible to make detailed maps in southern Mississippi at 1/24,000, but not of lithostratigraphic, chronostratigraphic, or biostratigraphic units. Basic mapping must be accompanied by a planned program of drilling to gain a three-dimensional understanding.

James Owens of the U. S. Geological Survey discussed the work on the Cape Fear Geologic Map at a scale of 1/250,000. This map of a section of New Jersey utilized 400 drill holes and was based on both rock stratigraphic and biostratigraphic research by the USGS. They approached the problem of dating sands and gravels by studying weathering profiles and clay mineralogy; mineralogy of sands was intensely studied, looking for dispersal patterns coming from the Piedmont. Owens also described the New Jersey COGEOMAP project, where a series of maps of the state will be produced at 1/100,000. This was a 50-50 co-op, which the state funded with a $500 million water bond issue; it is in its fifth and final year. Three holes were cored to 1000 feet. This mapping and the deep cross sections produced will be the legal standard in New Jersey for definition of aquifers, confining beds, and water quality studies. This study also demonstrated that water quality was controlled by the clay mineralogy of the aquifer system.

Ervin G. Otvos of the Gulf Coast Research Laboratory noted that the state geologic map for Mississippi showed the coastal zone as one Holocene deposit. He pointed out that this simple division includes seven stratigraphic units that range from Pliocene to Holocene in age, and that the Citronelle Formation is a special problem. Otvos agreed with May, Bowen, and Patrick about problems with the current Miocene stratigraphy. He has identified pre-Quaternary coastal deposits as Miocene, or even as undifferentiated non-marine Neogene clastics and argued that a better understanding of the units beneath the coastal Quaternary is needed. Otvos also pointed out that the coast is an area of rapid change, and a geologic map is needed so that environmental maps can be made.

Ernest Russell, formerly with Mississippi State University, discussed his work in the Cretaceous Selma Group sequence. Detailed composite sections through this sequence in conjunction with biostratigraphic control allow for the correlation of Selma units with other Upper Cretaceous deposits. Russell has mapped the Cretaceous in western Tennessee on 7½-minute quadrangles, and has worked with Don Keady around Mississippi State, Tupelo, Yellow Creek, and along the Tennessee-Tombigbee Waterway as projects came along to support the mapping. Problems exist in the definitions of rock units; for example, the Selma Chalk is not chalk but marl with a thick sequence of chalk within it. What is needed in the Cretaceous section is development of a stratigraphic framework on which to hang biostratigraphic units. Their field mapping allows them to have an understanding of the lithologic units, but corehole information is needed.

Charles Swann of the Mississippi Mineral Resources Institute reported on the various mapping projects of the MMRI; he and Henry Johnson are mapping 7½-minute quadrangles in northern Mississippi. This is part of an ongoing project of developing mineral data bases. The completed maps show geology, structure, pits, and oil well locations. By mapping at 1/24,000 they are finding previously unknown faults, displacements, and other features. Swann suggested that the present stratigraphic nomenclature of some areas needed to be reevaluated before additional geologic mapping is done, and that mapping of lithologic units be done with strict adherence to the stratigraphic code.

Robert Larson of the Waterways Experiment Station reported that the agency's Geologic Environments Analysis Section of the Geosciences Division had completed the geological engineering mapping of approximately 50 quadrangles in west-central Mississippi. These maps are available to the public while supplies last. They develop a geomorphological framework for cultural evaluations, and have a database system that includes soils, habitats, and fauna. Roger Saucier of the Waterways Experiment Station elaborated on the agency's mapping work in the Mississippi River alluvial valley. He explained that the classification scheme used in this mapping focused on depositional environments and emphasized lithology and geotechnical properties of units (to satisfy the engineers). However, important "by-products" of this mapping effort included new data and interpretations of Quaternary stratigraphy and chronology. These new data indicate that Harold Fisk's classic 1944 treatise on the Lower Mississippi Valley is out of date and in need of revision.

After a break for lunch, Roger Saucier showed three slides of Quaternary maps of the Mississippi River alluvial plain and the Yazoo River Basin.

David Dockery (MBG) discussed the Midway-Wilcox group boundary in Mississippi and showed that the Fearn Springs-Ackerman contact as mapped in Lauderdale County, Mississippi, was equivalent to the Naheola-Nanafalia contact as mapped in the neighboring county, Sumter County, Alabama. He suggested that Midway and Wilcox units of the type sections in Alabama should be mapped northward into Mississippi in order to revise the state geologic map. Dockery pointed out that the 1969 state geologic map is good in those areas with marine beds containing fossils, and that the map is less adequate in northwestern and southern Mississippi where non-marine clastics are present.

Charles Copeland of the Geological Survey of Alabama presented the new state geologic maps for Alabama. One map was at a scale of 1/250,000 or 1 inch to 4 miles and consisted of four sheets, with the legend on a fifth sheet. The other map was at a scale of 1/500,000, the same scale as the state map of

Mississippi, and consisted of a single sheet. Copeland stated that the 1/250,000 scale was useful for site-specific geologic determinations while the other was good only for hanging on the wall. The new map has 156 geologic units, whereas the 1926 map had 66 units. They find it is important to show alluvium, even though that covers up much of the bedrock mapping. While the maps were commended by most, one conferee suggested that the 1/250,000 map was still too small for site-specific work and that this map was neither good for the wall or site-specific determinations. Henry Johnson of the Mississippi Mineral Resources Institute asked why Alabama was not mapped on the USGS 1 by 2 degree topographic sheets. Copeland replied that this would require too many sheets to be practical for a state map, and that these maps were old and did not show reservoirs and interstates. The Geological Survey of Alabama is still mapping. They are mapping $7^{1}/_{2}$-minute quadrangles in the urban area near Birmingham and also in the Piedmont. Edward Luther of the Tennessee Division of Geology argued that the $7^{1}/_{2}$-minute quadrangle was the best scale for geologic mapping and stated that Tennessee had been producing 10 to 20 quadrangle geologic maps a year since they began this program in 1960.

Jack Medlin of the USGS reminded the conferees that a geologic map was never a final product but was only the beginning or a progress report to be revised with new data. As a geologic map is only a snapshot of knowledge at a particular time, digitized mapping is the direction of the future. Digital maps are easily updated as new data are gathered. These maps can be computer printed as needed with a notation showing the date of last revision. Harry Tourtelot of the USGS commented on how the resources for geologic mapping have improved over the years. Today we have better base maps and more abundant well data including both water wells and oil wells. It is now possible to see geology in three dimensions with better resolution. This better resolution often complicates the situation in areas of varied facies. Updip and downdip facies relationships are difficult to fit into the stratigraphic code. New concepts are needed in the mapping and correlation of fluviatile and coastal units.

Conrad Gazzier led a discussion session and called on the map users for their comments about the kinds of map products they need. Nancy Bethune of the U. S. Environmental Protection Agency gave a long list of geologic factors that the EPA would find useful on a geologic map as they deal with the problem of ground-water contamination. Many of these factors concerned aquifer characteristics, recharge and discharge areas, and geologic hazards such as faults, sinkholes, and soil stability (swelling clays). When asked how to sell the EPA on geologic maps, Bethune replied that the best way was for the agency to use them successfully. However, the EPA turnover was so large that those who had successfully used geologic maps didn't stay long enough to affect the agency's procedures. Many of the EPA staff are chemical engineers who are not geologically oriented. Roger Saucier questioned if time was best spent on interpretive maps such as hazard maps instead of on basic geologic mapping.

Ernest Russell pointed out the mapping problems with heterogeneous units and recommended lithostratigraphic maps. Norman Sohl of the USGS said that lithostratigraphic units needed to be placed in a chronostratigraphic framework. For the Miocene of southern Mississippi where this is a problem, Sohl suggested that palynology might provide such a framework. He further suggested that petrified wood from Tertiary units could be used to study climatic cycles, as the size of the wood cells indicates the amount of rainfall.

Christopher Cameron of the University of Southern Mississippi said in reference to the Mississippi Miocene section that correlations cannot be made within units where there are no horizons to be correlated. Cameron suggested that what is needed are continuous cores of the Miocene section and a study of magnetic polarity reversals. He then asked who paid for the core from New Jersey that James Owens had discussed earlier. Norman Sohl replied that the State of New Jersey paid for the core and the USGS supplied the expertise. Cameron then discussed the need for seismic surveys to map shallow subsurface units, pointing out that surface geophysics was underutilized in Mississippi. He also mentioned the utility of surface geochemistry, with the example of radon halos around salt domes. Dockery reported that specialists have said there are no useful pollen boundaries in the Miocene; Danny Harrelson of the U. S. Army Corps of Engineers said that in their experience pollen studies of Neogene units in Mississippi produced conflicting results.

Boyd Haley of the Arkansas Geological Commission, in discussing derivative maps, said that it would be impossible to put all the special interests of the EPA as cited by Bethune on geologic maps. Gazzier explained the Mississippi Bureau of Geology's plan to produce a new state geologic map and said that this map could be used as a basis for statewide derivative maps. Roger Saucier said that geologic maps are our first priority but that it is the derivative maps that bring in the money. Haley said that the $7^{1}/_{2}$-minute geologic maps are the best sellers (and most useful). Arkansas has mapped every $7^{1}/_{2}$-minute quadrangle in the state; they are available in black and white. He recommended mapping the state in $7^{1}/_{2}$-minute quadrangles before the effort to revise the state map. Tracy Lusk of the Mississippi Mineral Resources Institute also recommended that the Mississippi Bureau of Geology begin mapping the state in $7^{1}/_{2}$-minute quadrangles.

Richard Bowen agreed with Russell's earlier statement concerning the mapping of lithic units. Bowen said that the Miocene lithologies can be mapped without stratigraphic or biostratigraphic control. He said that he could produce thirty $7^{1}/_{2}$-minute quadrangle geologic maps in two years in the Mississippi Miocene by mapping lithic units, but that these units would not fit into a state geologic map. Dockery mentioned that the Mississippi Bureau of Geology was working on the Miocene biostratigraphy of offshore wells and hoped to be able to tie this stratigraphy with the land-based section. Otvos of the Gulf Coast Research Laboratory told of his work along the same lines.

Gazzier asked several map users to address their specific interests in geologic maps and received predictable responses. Jamie Crawford of the Mississippi Bureau of Land and Water Resources was interested in aquifer recharge and discharge areas for water resources investigations. Charlie Clevenger, responsible for dam inspections for the same agency, was interested in the units upon which dams were sited. Charles Smith of the Mississippi Bureau of Pollution Control expressed interest in 7½-minute geologic maps from which derivative maps could be made. Bill Lucas of the U. S. Bureau of Land Management needed site-specific information and to be able to determine the natural resources on U. S. government lands.

Richard McCulloh of the Louisiana Geological Survey said that he was glad to see that the Mississippi Bureau of Geology had a full-time geologic mapper. He noted the dwindling supply of geologic mappers and suggested that the production of a geologic map be used to satisfy the requirements of a master's thesis. McCulloh also noted that the Louisiana Geological Survey was founded in 1934 to map the state, parish by parish. This job at present is only one-third complete; with the downward shift of geologic mapping in priority only two parishes have been mapped in the last thirty years, both by non-Survey employees.

Gazzier continued in asking map users about their special interests in geologic maps. Edwin Miller of the U. S. Forest Service was interested in 7½-minute quadrangle geologic maps for environmental documents, siting roads, mineral resources, and hydrology. Robert Hinton of the USDA Soil Conservation Service also needed 7½-minute quadrangle geologic maps for soil surveys. Merrill pointed out that nine 7½-minute quadrangle geologic maps of Tishomingo County were being circulated by the Mississippi Bureau of Geology as open file reports. Alvin Bicker, former director of the Mississippi Bureau of Geology, explained that all county mapping at the agency since at least 1964 has been done on 7½-minute quadrangles, though the information has not been made available in that format. (Two 7½-minute quadrangle geologic maps have been published in color, with accompanying booklets on geology, mineral resources, and water resources. Little interest has been shown in these maps, and few have been sold.)

The most lively discussion of the conference followed as Gazzier asked the geology department chairmen present, Delbert Gann (Millsaps) and David Patrick (USM), about having geologic mapping as a project for a master's thesis. Gann left the question unanswered in replying that Millsaps College did not have graduate students in geology. He went on to bring up the geologic mapping concerns most commonly brought to him by the public — "is there Yazoo clay or a flood plain at this site where I am planning to buy or build a house?" Williams of the Arkansas Geological Commission suggested that the public ask those questions to a consultant. Such site-specific studies are what consultants are paid for and these questions should not encumber state agencies. Returning to Gazzier's original question, Patrick said that McCulloh's earlier comment on using graduate students to map geology was well taken. A graduate thesis could consist of a geologic map and some x-ray analysis of clays to make it into a research work. Christopher Cameron, also of the University of Southern Mississippi, added that a thesis could consist of the integration of a surface geologic map with a subsurface map. He said that many students don't like surface mapping and there is difficulty finding funding for these assistantships.

Russell pointed out that university geology departments had become so specialized that they had specialized themselves out of geologic mapping and were involved in black box geology. Haley of the Arkansas Geological Commission then pressed Patrick as to why a geologic map in itself was not adequate to count for a master's thesis. Patrick responded in quoting one of his own professors who told him that anyone could make a geologic map — all they had to do was to put down what is there. Williams disagreed emphatically with that idea. Cameron noted that it takes black box geology to get the grants necessary to run a successful geology department. Bethune stated that whoever thinks that anyone could make a geologic map should see some of the maps submitted to the EPA. Bicker said that schools tend to train their students for a particular profession and that his school, as was true for many others, prepared its students for the oil industry. Bill Moore said that he was taught geologic mapping in Mississippi by William Parks and others after his education. Crawford suggested that mapping is not as spectacular as other subjects in geology so that it is not chosen by students.

Wayne Newell of USGS said that a geologic map is a tool. The scale 1/24,000 is good, but some users want maps at 1/12,000 or even more detailed. In New Jersey they are making a state geologic map at 1/100,000 and gathering data appropriate to that scale. The trend nationally is to have a state map at 1/250,000 and to make a wall-hanging at 1/500,000. Digital maps allow you to go from one scale to another and are the trend of the future. Cameron asked if studies had been done of the cost/benefit ratio for geologic mapping. Newell replied that Kentucky, which is completely mapped geologically on 7½-minute quadrangles, had estimated a benefit to cost ratio as high as 50 to 1. Saucier pointed out that the 7½-minute scale may not be applicable state-wide; for example, the alluvial plain could be adequately mapped on 15-minute quadrangles.

SUMMARY

After lamenting the present slowdown in geologic mapping, the conferees generally agreed that geologic mapping needed to be reemphasized. Most were interested in geologic maps that could be used for site-specific determinations of geologic units and preferred 7½-minute quadrangle maps. A wide variety of ideas about the preferred scale for a state geologic map was presented.

The meeting was brought to a close by Conrad Gazzier, who thanked each conferee and asked that they mail in their comments as to the kind of mapping projects they believed the Mississippi Bureau of Geology should undertake.

The following pages contain papers wherein many of the conference participants expand their views or present information about their geologic mapping programs.

GEOLOGIC MAPPING BY THE MISSISSIPPI GEOLOGICAL SURVEY/MISSISSIPPI BUREAU OF GEOLOGY

Michael B. E. Bograd
Mississippi Bureau of Geology

The Mississippi Geological Survey (MGS) was created in 1850 to map the geology and mineral resources of the state. The enabling legislation has never been repealed, but the agency has undergone several name changes over the years. It is presently called the Bureau of Geology of the Mississippi Department of Natural Resources (MBG in this paper).

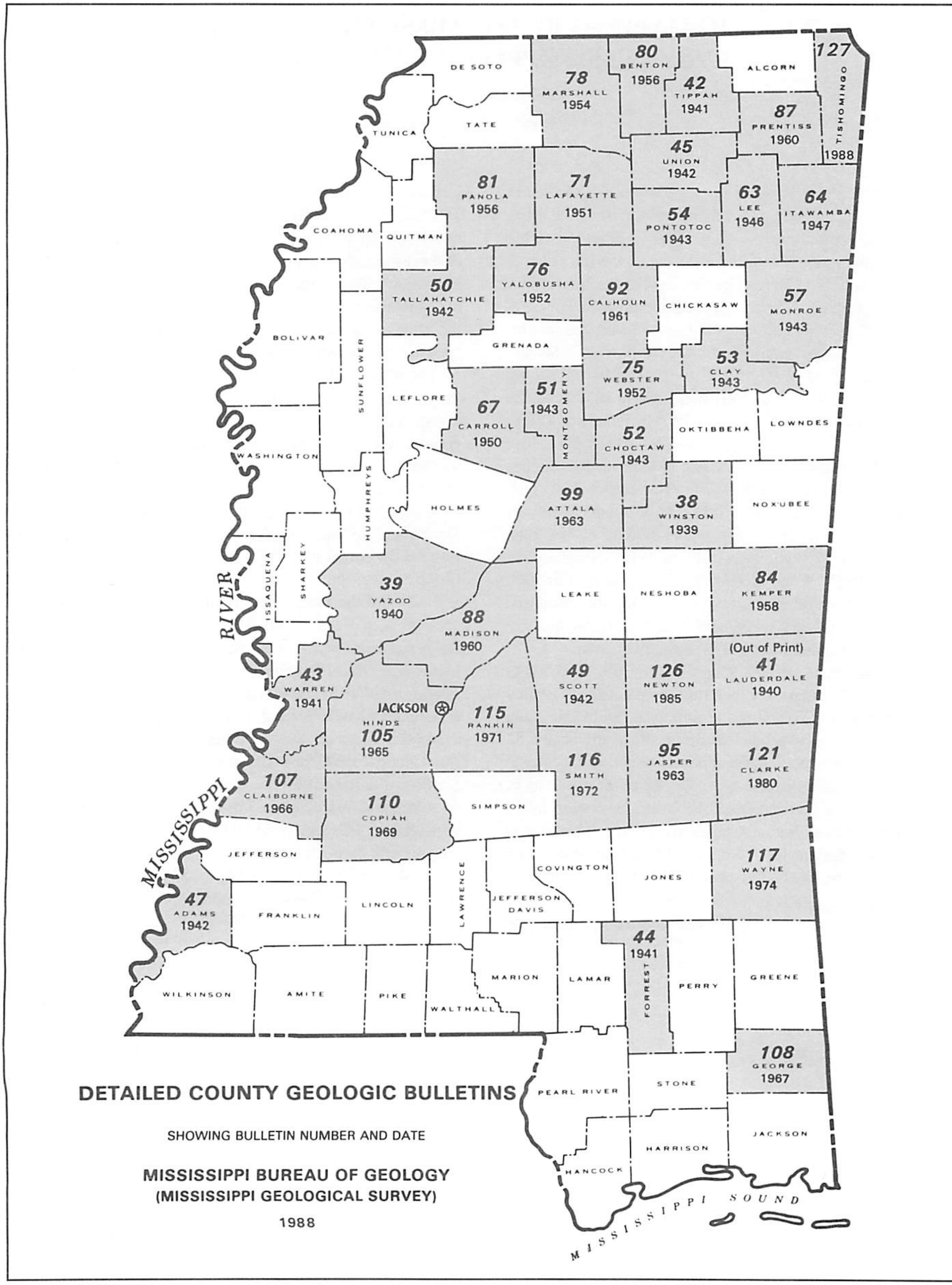
For several decades, MGS geologists concentrated on preparing a state geologic map. The first geologic map of Mississippi was published by O. M. Lieber in 1854 in *Mining Magazine*. Subsequent maps were published in 1857 by Lewis Harper, 1860 by Eugene W. Hilgard, 1905 by Eckel and Crider of the U.S. Geological Survey, 1907 by Albert F. Crider (MGS), 1928 by USGS and MGS, and 1945 by the Mississippi Geological Society and USGS. The present state geologic map was published by MGS in 1969. Information about these maps can be found in "Brief History of the Bureau of Geology, 1850-1983," by William A. Gilliland, MBG Information Series 84-2, 1984. When the MGS was reorganized in 1906 after a hiatus, the bulletin series of publications was instituted. The first three bulletins (on cement materials, clays, and lignite) contained copies of the 1907 state geologic map.

The primary geologic mapping effort by the MGS/MBG for the past half century has been the preparation of county geologic and mineral resources reports (see figure and Table 1). County reports have been made on 40 of the state's 82 counties. All but one of these reports contained a geologic map. Most were published at the scale of 2 miles to one inch. The first two maps (Winston and Yazoo counties) were called provisional and published at 4 miles to one inch. Three maps (Tippah, 1941; Union, 1942; Kemper, 1958) were at the scale 1.5 miles to one inch. The Lafayette County bulletin contained two 15-minute topographic quadrangles (covering most of the county) with contacts printed. The latest bulletin, Tishomingo County, is printed on two sheets at one mile to the inch.

The county geologic maps were printed in black and white (with outcrop belts indicated by patterns of lines, dots, and dashes) through Attala County in 1963. Starting with Hinds County in 1965 the maps have been printed in color. The colors were selected, as much as possible, to match the colors of the state geologic map (Quaternary in grays, Tertiary in browns and yellows, Cretaceous in greens).

The MGS/MBG has published a few additional geologic maps. Bulletin 55, on the geology and water resources of Camp McCain, has a geologic map of parts of Grenada, Montgomery, Calhoun, and Webster counties. This map is much like the county geologic maps of that time — black and white, with patterns, at 2 miles per inch. Bulletin 56 is a similar study for Camp Van Dorn, but contains only a sketch map showing locations of borings and some outcrops (at 3 miles per inch). Bulletin 58 covers an area of over 2400 square miles around Camp Shelby; the "reconnaissance" geologic map is printed at 4 miles to the inch. Bulletin 60, published in 1944, has a geologic map of the six coastal counties at 4 miles to an inch; it too is black and white, with patterns. MGS published a geologic map of the NE quarter of the West Point 15-minute quadrangle in 1964, in color at 1 mile to an inch. Two geologic quadrangles have been published by MGS/MBG in color at 1:24,000. These are the Mendenhall West quadrangle, Simpson County, 1976, and the adjoining Braxton quadrangle, Simpson and Rankin counties, 1980.

Additional mapping in Mississippi, both published and unpublished, has been done by USGS and other federal agencies, university geology departments, and individuals. These maps, along with those of the MGS/MBG, form a strong foundation for continued mapping endeavors in Mississippi.


DETAILED COUNTY GEOLOGIC BULLETINS
SHOWING BULLETIN NUMBER AND DATE
MISSISSIPPI BUREAU OF GEOLOGY
(MISSISSIPPI GEOLOGICAL SURVEY)
1988
DE SOTO
78 MARSHALL 1954
80 BENTON 1956
42 TIPPAH 1941
ALCORN
127 TISHOMINGO 1988
TUNICA
TATE
87 PRENTISS 1960
45 UNION 1942
81 PANOLA 1956
71 LAFAYETTE 1951
63 LEE 1946
64 ITAWAMBA 1947
54 PONTOTOC 1943
COAHOMA
QUITMAN
76 YALOBUSHA 1952
50 TALLAHATCHIE 1942
92 CALHOUN 1961
CHICKASAW
57 MONROE 1943
BOLIVAR
SUNFLOWER
GRENADA
53 CLAY 1943
LEFLORE
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WASHINGTON
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HOLMES
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NOXUBEE
ISSAQUENA
SHARKEY
39 YAZOO 1940
LEAKE
NESHOBA
84 KEMPER 1958
RIVER
88 MADISON 1960
(Out of Print)
41 LAUDERDALE 1940
43 WARREN 1941
49 SCOTT 1942
126 NEWTON 1985
JACKSON
HINDS 105 1965
115 RANKIN 1971
116 SMITH 1972
95 JASPER 1963
121 CLARKE 1980
MISSISSIPPI
107 CLAIBORNE 1966
110 COPIAH 1969
SIMPSON
JEFFERSON
COVINGTON
JONES
117 WAYNE 1974
LAWRENCE
47 ADAMS 1942
FRANKLIN
LINCOLN
JEFFERSON DAVIS
44 FORREST 1941
WILKINSON
AMITE
PIKE
MARION
LAMAR
PERRY
GREENE
WALTHALL
108 GEORGE 1967
PEARL RIVER
STONE
JACKSON
HARRISON
HANCOCK
MISSISSIPPI SOUND

Figure 1.

TABLE 1. COUNTY GEOLOGIC REPORTS

bulletin no.	county	date	geologic map
38	Winston	1939	bw, provisional, 4 mi/in
39	Yazoo	1940	bw, provisional, 4 mi/in
41	Lauderdale	1940	bw, patterns, 2 mi/in
42	Tippah	1941	bw, patterns, 1.5 mi/in
43	Warren	1941	no geologic map; map of structure contours on Glendon limestone, 2 mi/in
44	Forrest	1941	bw, patterns, 2 mi/in
45	Union	1942	bw, patterns, 1.5 mi/in
47	Adams	1942	bw, 2 mi/in
49	Scott	1942	bw, patterns, 2 mi/in
50	Tallahatchie	1942	bw, patterns, 2 mi/in
51	Montgomery	1943	bw, patterns, 2 mi/in
52	Choctaw	1943	bw, patterns, 2 mi/in
53	Clay	1943	bw, patterns, 2 mi/in
54	Pontotoc	1943	bw, patterns, 2 mi/in
57	Monroe	1943	bw, patterns, 2 mi/in
63	Lee	1946	bw, patterns, 2 mi/in
64	Itawamba	1947	bw, patterns, 2 mi/in
67	Carroll	1950	bw, patterns, 2 mi/in
71	Lafayette	1951	contacts drawn on 2 15-minute quadrangles, 1 mi/in
75	Webster	1952	bw, patterns, 2 mi/in
76	Yalobusha	1952	bw, 2 mi/in
78	Marshall	1954	bw, patterns, 2 mi/in
80	Benton	1956	bw, patterns, 2 mi/in
81	Panola	1956	bw, patterns, 2 mi/in
84	Kemper	1958	bw, patterns, 1.5 mi/in
87	Prentiss	1960	bw, patterns, 2 mi/in
88	Madison	1960	bw, patterns, 2 mi/in
92	Calhoun	1961	bw, patterns, 2 mi/in
95	Jasper	1963	bw, patterns, 2 mi/in
99	Attala	1963	bw, patterns, 2 mi/in
105	Hinds	1965	color, 2 mi/in
107	Claiborne	1966	color, 2 mi/in
108	George	1967	color, 2 mi/in
110	Copiah	1969	color, 2 mi/in
115	Rankin	1971	color, 2 mi/in
116	Smith	1972	color, 2 mi/in
117	Wayne	1974	color, 2 mi/in
121	Clarke	1980	color, 2 mi/in
126	Newton	1985	color, 2 mi/in
127	Tishomingo	1988	color, 2 sheets, 1 mi/in

THE LATEST COUNTY GEOLOGIC MAPS PUBLISHED BY THE MISSISSIPPI BUREAU OF GEOLOGY

Robert K. Merrill
Mississippi Bureau of Geology

The most recent geologic maps published by the Mississippi Bureau of Geology cover a total land area of 1014 square miles and are published in the county bulletin series as Merrill et al. (1985 and 1988). The purpose of these reports is to ascertain the areal and subsurface distribution of stratigraphic units and mineral resources within a given county. Color coded maps and cross sections are utilized in these reports in order to readily facilitate three-dimensional correlation of stratigraphic units that underlie a particular county. Base maps are constructed from 7 1/2-minute topographic map composites in order to accurately portray the relationship of cultural features with the geologic units they overlie.

Geologic maps that supplement the Newton and Tishomingo county reports are the result of extensive field observation and correlation between naturally occurring and artificial (man-made) exposures of all strata contained in those counties. Test holes were drilled by the Mississippi Bureau of Geology in areas where water well geophysical and sample data were lacking or nonconclusive. Shallow test holes were drilled in areas of least exposure and areas where weathering of surface exposures altered the original characteristics of strata to the point of nebulous correlation. Deeper test holes were drilled in order to ascertain the subsurface distribution of strata underlying the counties, and to illustrate surface and subsurface distribution of exposed stratigraphic units. Petroleum test well data were utilized in order to facilitate deeper subsurface correlations of sedimentary rocks that underlie Tishomingo County.

Field work concerning the Newton County report (Merrill et al., 1985) commenced on April 7, 1981. This aspect of the study consisted of mapping stratigraphic units contained in the Wilcox, Claiborne, and Jackson groups as well as Pleistocene and Recent fluvial deposits onto topographic base maps. The mapping phase of Merrill et al. (1985) was complemented by the drilling of 21 test wells, the last of which was completed on December 15, 1983. The cross sections that accompany the Newton County report were constructed from these test wells as well as water wells for which a complete set of geophysical and sample data was available. The topographic profiles along these lines of section were plotted from 7 1/2-minute topographic maps and presented at a vertical exaggeration of 52.8 in order to illustrate the relationships of the topography with geologic units upon which the topography is developed. The surface and subsurface distribution of geologic units encountered along the two lines of cross section (strike section and dip section) are illustrated on Plate 2 of Merrill et al. (1985). The accompanying manuscript was completed in March of 1984, and the bulletin was published in July of 1985. The Newton County report contains additional sections describing clay mineralogy, the U. S. Bureau of Mines clay testing program, and ground-water resources contributed by Dr. D. E. Gann, K. J. Liles, and J. J. Sims, respectively.

Tishomingo County is underlain by stratigraphic units that are quite variable in composition, depositional history, and age, and contains the oldest rocks exposed in Mississippi. The Lower Devonian Ross Formation is the oldest exposed unit, and is overlain by limestones, sandstones, and shales comprising the Chattanooga, Fort Payne, Tuscumbia, Pride Mountain, and Hartselle formations. Uppermost intervals of these units are locally truncated by the erosional surface at the base of the thick sequence of Upper Cretaceous coastal plain sediments. The Upper Cretaceous sequence consists of mostly unconsolidated gravels, sands, and clays comprising the Tuscaloosa, McShan, Eutaw, and Coffee formations. Pleistocene and Recent fluvial deposits comprise the youngest exposed geologic units. The intricate areal distribution of strata exposed in Tishomingo County necessitated an increased scale from that previously utilized in the county bulletin series (1 in. = 2 mi. or 1:126,720) to 1 in. = 1 mi. (or 1:63,630). The larger scale of 1 in. = 1 mi. horizontally and 1 in. = 100 ft. vertically was utilized for the cross sections in the Tishomingo County report.

The geologic map of Tishomingo County (Plate 1 of Merrill et al., 1988) was constructed from a compilation of 7 1/2-minute topographic maps (scale 1:24,000) upon which geologic units were delineated by actual outcrop observation in the field. Field mapping began in May of 1984 and the drilling program commenced in March of 1987. A wealth of geophysical and subsurface sample data for central Tishomingo County was gathered by the U. S. Army Corps of Engineers and the U. S. Geological Survey during geologic and hydrologic studies concerning the Tennessee-Tombigbee Waterway. The availability of this information greatly enhanced the subsurface aspects of the Tishomingo County report. Geologic mapping and corehole data reported in Russell et al. (1975) for the T.V.A. Yellow Creek nuclear power plant were of great value in northeastern Tishomingo County. The geologic map of the power plant site (Russell, 1975) was utilized as a learning tool in the initial stages of mapping Tishomingo County, and Dr. Russell freely shared his data and professional opinions. The availability of knowledge gained from previous geologic investigations in Tishomingo County facilitated an earlier completion date for both the mapping and drilling programs than would otherwise have occurred with one geologist assigned to complete a geologic map of what is probably Mississippi's most complex geology. Test wells were drilled by the Bureau of Geology in areas not covered by previous drilling operations in Tishomingo County. Surface mapping of the 436 square mile area comprising Tishomingo County was completed in December of 1987. The drilling program was completed in April of 1987. Bulletin 127 entitled "Tishomingo County Geology and Mineral Resources" has recently been published.

Previous literature concerning the Paleozoic rocks of Tishomingo County utilized the locally accepted nomenclature of Morse (1930). Bulletin 127 utilizes nationally accepted nomenclature concerning the Paleozoic rocks of Mississippi. The color code for the Tishomingo County maps and cross sections is the nationally accepted stratigraphic color scheme established by the U. S. Geological Survey. Previous geologic maps published by the Mississippi Bureau of Geology utilized a separate color scheme. A series of 9 geologic maps reproduced on $7^1/_2$-minute quadrangle base maps has been prepared for publication as open file reports. Additional sections on clay mineralogy and sedimentary rocks petrology by Dr. D. E. Gann and ground-water resources by S. P. Jennings are included in Bulletin 127.

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GEOLOGIC MAPPING OF UPPER CRETACEOUS UNITS IN NORTHEASTERN MISSISSIPPI

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Mississippi State, Mississippi

This is a summary of geologic mapping in northeastern Mississippi. Dr. Donald M. Keady and I have worked so closely on field problems and have such overlapping interests that we have combined this summary. In light of the lithic units we recognize in the field I have included a short discussion of the nomenclature of these units.

Our geologic mapping (henceforward, all uses of the term mapping will refer to geologic mapping and will be specified as either reconnaissance or detailed) in Mississippi began in 1958 and can be divided into two parts, 1) that done by me as a consultant, and 2) that done with my colleague Dr. Donald M. Keady, Professor of Geology, Mississippi State University. During the period from 1958 to present Keady and I have made a reconnaissance of the entire Upper Cretaceous outcrop belt in Mississippi on topographic maps available at the time and on the newer maps.

Geologic Mapping by Dr. Ernest E. Russell as a Consultant:

In 1958 I began mapping the Upper Cretaceous of western Tennessee for the Tennessee Division of Geology. This work resulted in the publication of a series of $7^1/_2$-minute geologic quadrangles, the Cretaceous part of the State Geologic Map of Tennessee (1965, West Sheet, scale 1:250,000), and a bulletin on the Cretaceous of western Tennessee (1975, Bulletin 65). In order not to have a state line "fault" I mapped boundaries into northern Mississippi for the better part of one topographic quadrangle.

Beginning in 1961, I mapped Alcorn County, Mississippi, for the USGS Groundwater Branch Office in Jackson, Mississippi (this was not published). The Corinth 15-minute topographic quadrangle was enlarged to 1:24,000 for the mapping.

Beginning in 1978, I did the detailed geologic mapping of the Yellow Creek and Doskie $7^1/_2$-minute topographic quadrangles in Tishomingo County, Mississippi, for the Tennessee Valley Authority (TVA) for the 5-mile radius site map for the Yellow Creek Nuclear Power Plant. The Nuclear Regulatory Commission required that the cuts then being made for the Divide Cut in the Tennessee-Tombigbee Waterway be examined by TVA and I was selected to make those geologic studies. Thus I mapped the areas adjacent to the waterway into southern Tishomingo County. Further, in doing ground truth studies of lineaments defined from remote sensing I did geological reconnaissance on $7^1/_2$-minute topographic quadrangles of Tishomingo, northern Itawamba and Prentiss counties, and eastern Alcorn County.

From west to east I have mapped the following areas: the Walnut quadrangle north of U.S. Highway 72 in Tippah County, Alcorn County, and the Doskie, Yellow Creek and Waterloo $7^1/_2$-minute quadrangles in Mississippi. The lithic units mapped are those recognized by the Mississippi Bureau of Geology and the Tennessee Division of Geology.

Geologic Mapping by Dr. Ernest E. Russell and Dr. Donald M. Keady:

Older Mapping: In 1958, preliminary copies of $7^1/_2$-minute topographic maps became available from the USGS for a large area of the Cretaceous outcrop in Chickasaw, Clay, Lowndes, Noxubee, and Oktibbeha counties in east-central Mississippi. (These maps were reduced to 15-minute maps when initially published by the USGS; recently they have been republished as $7^1/_2$-minute topographic quadrangles as originally drawn.) At that time Dr. Keady and I began to map on the preliminary copies of the $7^1/_2$-minute quadrangles. Our first projects were the mapping of the Bluffport Marl Member of the Demopolis Formation from Noxubee County to Chickasaw County, Mississippi, the Arcola Limestone Member of the Mooreville Formation from northern Noxubee County to Monroe County, the *Diploschiza cretacea* Zone in Lowndes County, a thin bed of pycnodonts from Noxubee County to northern Chickasaw County, and various "synchronous" beds in the Cretaceous outcrop. $7^1/_2$-minute portions of the Van Vleet, Pheba, and West Point 15-minute quadrangles were mapped with students (Torries, Stowers, Carmichael, and Greely), and Keady and I mapped the $7^1/_2$-minute Wren quadrangle in northern Monroe County.

In the early 1960's we began to develop a series of composite geologic sections in the Upper Cretaceous of Mississippi because there were no cored sections available in this area. The sections were based on field mapping of outcrops using elevations and locations, provided by the excellent topographic map coverage, to locate significant outcrops in their correct three-dimensional position. Once accomplished we then selected the outcrops necessary to complete the geologic section. The purpose was to better understand lithic relationships as a basis for biostratigraphic studies. We now have three complete composite geologic sections in Mississippi and one in Tennessee.

Recent mapping and comments on nomenclature: In a study of the aggregates in the Tombigbee River Drainage for the MMRI, housed at the University of Mississippi, the chert-bearing alluvium and terrace deposits of the Tombigbee River and its tributaries and the gravels of the "Tuscaloosa" Formation in Mississippi were mapped. The mapping program in the Tombigbee drainage included all, or parts of, twenty-two $7^1/_2$-minute quadrangles and two 15-minute quadrangles. The Cretaceous lithic units, other than the gravels, in the vicinity of the above were reconnaissance mapped.

Mapping of Cretaceous gravels in the aforementioned study and palynological data confirmed that gravels mapped as

Tuscaloosa (and correlated, by some, with the Gordo in Alabama) in Tishomingo County, Tennessee and northwestern Alabama are, in fact, two distinct lithic units of different age. The lower gravels are chert gravels in a quartz sand matrix that can be traced southeast into the Gordo Formation. The upper chert gravel, with rare lenses of chert sand and kaolinitic clay, is best developed to the north in Tishomingo County and lies unconformably on the lower unit. This upper gravel is probably equivalent to the McShan Formation.

In order to better understand the problems of the "Tuscaloosa," McShan and Eutaw lithic units in the Mississippi outcrop and subsurface, a mapping program was started which led us into western Alabama where these units were mapped on several 7½-minute topographic quadrangles. This mapping, which is still going on, has resulted in a much clearer understanding of the lithic and time relationships of that complex group. None of this data has been published to date.

When the 7½-minute quadrangles became available in Lowndes, Oktibbeha and Noxubee counties, we began to transfer and add new data to them, recognizing that at least two new lithic units must be added in order to utilize our findings. First, it was obvious in our earlier petrographic studies that the Selma "Chalk" was not all chalk in the technical sense. E. A. Smith said this, essentially, in the early part of this century in a cement resources study of the Cretaceous in Alabama. Based on field and lab studies, there is only one lithic unit in the Selma Group of Mississippi (and for that matter, most of Alabama) that can be called (technically) a chalk. It is very impure (75-90% $CaCO_3$); European chalks run 99% $CaCO_3$. The rest of the so-called "chalk" in Mississippi is what the English would call marl and that is what Keady and I call it. Stratigraphically, the impure chalk (about 160 feet thick) is near the middle of the Demopolis Formation (the X-point in the subsurface and the Annona of Mellen is in the chalk interval). It is overlain by a marl, the Bluffport Marl Member (about 40 feet thick) of the Demopolis Formation, and is underlain by an unnamed marl member (greater than 200 feet thick). The underlying Mooreville Formation is also a marl (50-75% $CaCO_3$ and sometimes less) that grades into calcareous clays in Lee and Prentiss counties, Mississippi, before grading into sands and clays of the Coffee and Tombigbee sands in northern Prentiss and southern Tishomingo counties.

The Tombigbee Sand has, since Stephenson, been considered a member of the Eutaw Formation and certainly no one would argue that they are not closely related. In fact, at their contacts it is not unusual to find Tombigbee Sand lithologies in the Eutaw and vice-versa. However, the Tombigbee Sand is a lithologically distinct, mappable unit by any standard, and it is, frequently, very fossiliferous in contrast to the "typical" Eutaw. It, obviously, was deposited in a quiet zone transitional to shelf muds, unlike the lower Eutaw which was deposited in shallow, high-energy, near-shore waters. Perhaps the Tombigbee should be removed from the Eutaw Formation.

South of Chickasaw County, particularly at Tibbee Creek, the Ripley Formation thins and can be differentiated into three lithic units: a lower calcareous clay, a middle fossiliferous sand, and an upper calcareous clay. A short distance to the south the calcareous clays become marls and the middle sands lose their character. Significant barnacle horizons are present in both the lower and upper calcareous clays.

Tertiary mapping: Two 7½-minute sections of the Chunky 15-minute quadrangle have been enlarged to 1:24,000 and mapped by students for M.S. theses at Mississippi State University in the area west of Meridian, with Laswell and Russell as advisors.

Reconnaissance mapping of the Midway-Wilcox sequence on the outcrop in Mississippi was done by Keady, Lins and Russell as part of a groundwater study for the Water Resources Research Institute at Mississippi State University in the late 1970's.

SUMMARY OF GEOLOGIC MAPPING BY THE MISSISSIPPI MINERAL RESOURCES INSTITUTE

Charles T. Swann
The Mississippi Mineral Resources Institute
University, Mississippi

The Mississippi Mineral Resources Institute conducts geologic mapping to provide basic geologic data for mineral exploration. Geologic mapping, in various stages of completion, is ongoing in Tippah, Lafayette, and Perry counties. Mapping in Perry County is in conjunction with a study of the Glazier Salt Dome. The stratigraphic units involved are the Miocene Hattiesburg Formation and the Plio-Pleistocene Citronelle Formation. The purpose of this mapping is to determine if there is evidence of post-Quaternary diapiric movement of the salt stock.

A majority of the surface geologic mapping has been associated with the construction of a series of open-file reports referred to as "mineral exploration data bases." These reports are constructed on a quadrangle by quadrangle basis with the purpose of updating existing summaries of the quadrangle's mineral resources and provide basic geologic information. The geologic map is only part of the information contained in the reports. Also included are mineral exploration and selected water well data, locations of active and abandoned sand and gravel pits, locations of mineral prospects, and an interpretation of LANDSAT satellite imagery.

Preliminary mapping in Lafayette County (7$^1/_2$-minute Yocona Quadrangle) has identified the Wilcox Group and the Meridian Sand as the major stratigraphic units. Construction sand and clay-sand fill material from the Meridian Sand have been the principal mineral products in the Yocona Quadrangle to date, though kaolinitic clays of the Wilcox Group may have ceramic potential. Completed "data base" reports are available for the Walnut, Falker, and Peoples 7$^1/_2$-minute quadrangles in Tippah County. Work on the 7$^1/_2$-minute Chalybeate Quadrangle is nearing completion. The stratigraphic units included in these quadrangles include the Cretaceous McNairy Sand, a member of the Ripley Formation, and the Owl Creek Formation. The Tertiary formations include the Clayton, Porters Creek, and Meridian Sand. The Wilcox Group was mapped as a single unit. Future mapping as part of the "mineral resources data base" series is planned for Tippah and Lafayette counties.

Much of the area that has been mapped by the Mississippi Mineral Resources Institute was previously mapped by the Mississippi Geological Survey (1940's and 1950's). This earlier mapping was conducted without the aid of adequate vertical control as provided by 7$^1/_2$-minute topographic maps. Mapping with the aid of the modern 7$^1/_2$-minute quadrangles allows much more information to be derived from the study. For example, structure can be more easily determined and various stratigraphic relationships more easily identified. Lack of adequate topographic maps and unrecognized structure resulted in the misidentification of stratigraphic units in northern Tippah County. Therefore, it is believed that new mapping would prove useful in all areas where previous mapping was conducted without the aid of adequate topographic base maps.

Surface geologic mapping is an extension of the principles of stratigraphy. The units mapped in the field should be assigned to some formally described lithostratigraphic unit. However, if the formal unit to which the field unit is assigned is ambiguous, then the surface mapping is also somewhat ambiguous. Therefore, the stratigraphic nomenclature should be reviewed and revised, if necessary. However, the needed revisions and redefinitions should be considered carefully so as not to promote excessive proliferation of stratigraphic names.

Prior to field mapping a basic philosophy should be established. Recently it has been proposed that lithostratigraphic boundaries be redefined in the classic sections of the Midway Group on the basis of sequence stratigraphy (Mancini and Tew, 1988). Application of sequence stratigraphy to define unit boundaries is undesirable because sequence stratigraphy requires interpretation. The interpreted boundary may or may not coincide with lithologic boundaries. Where the boundary does not coincide with a major lithologic change its location cannot be reliably established in the field. Therefore, the usefulness of the field study is diminished. Vertical distribution of heavy minerals in a section has also been used in southern Mississippi to define formational contacts (Brandwein and White, 1983). This methodology is also flawed in that contacts cannot be recognized in the field. Therefore, it is strongly suggested that mapping adhere to the rules set forth in the North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 1983). This set of rules has been composed by a cross section of geologists in industry, academia, and government, with interaction by the International Subcommission on Stratigraphic Classification. Use of the "code" provides the advantage of uniformity of interpretation of stratigraphic units. If the North American Stratigraphic Code is used as the standard for unit definition, then the theoretical basis of the unit boundaries would be recognized world-wide.

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Mancini, E. A., and B. H. Tew, 1988, Paleocene sequence stratigraphy of southwestern Alabama: Transactions, Gulf Coast Association of Geological Societies, v. 38, p. 453-460.

North American Commission on Stratigraphic Nomenclature, 1983, North American stratigraphic code: American Association of Petroleum Geologists Bulletin, v. 67, no. 5, p. 841-875.

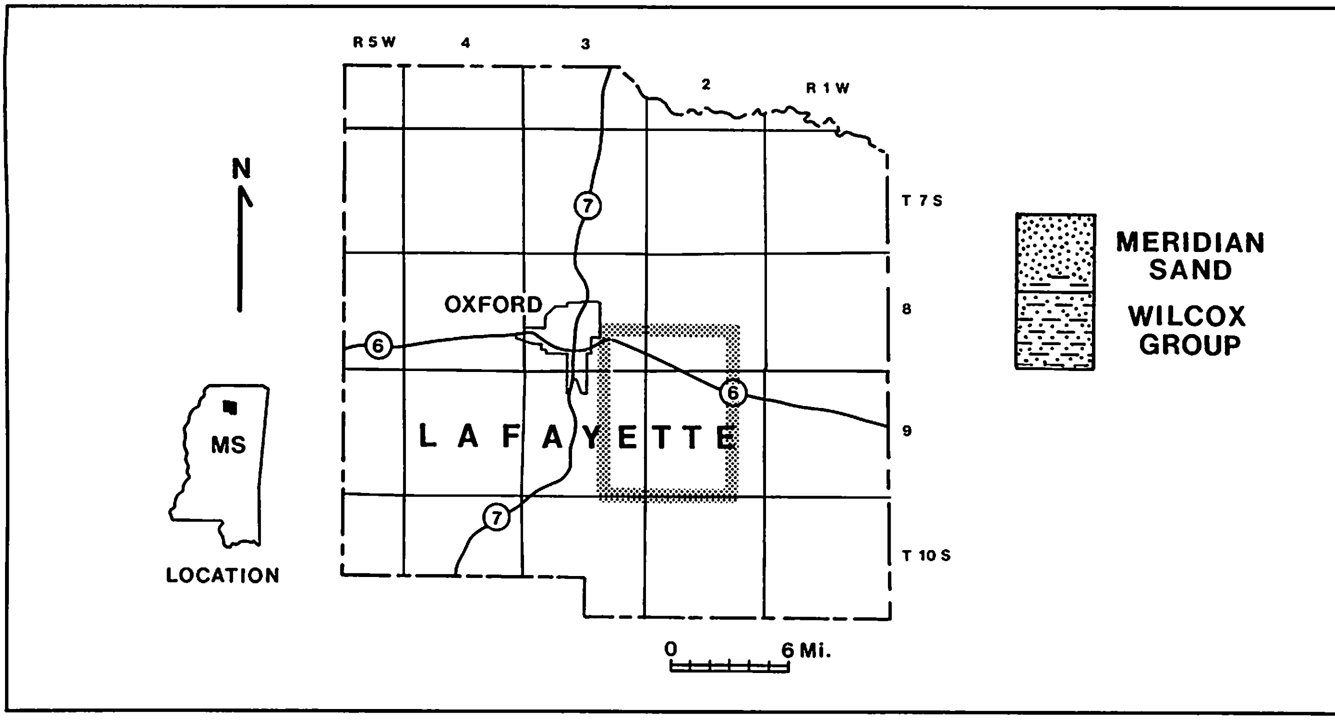

Figure 1.

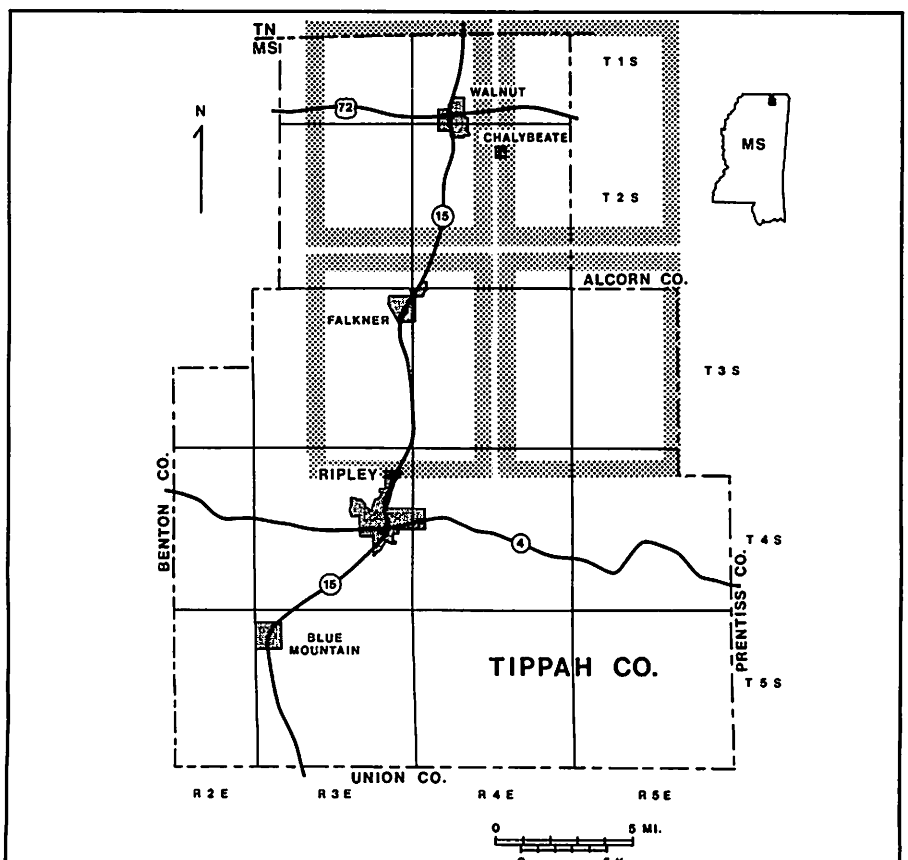

Figure 2.

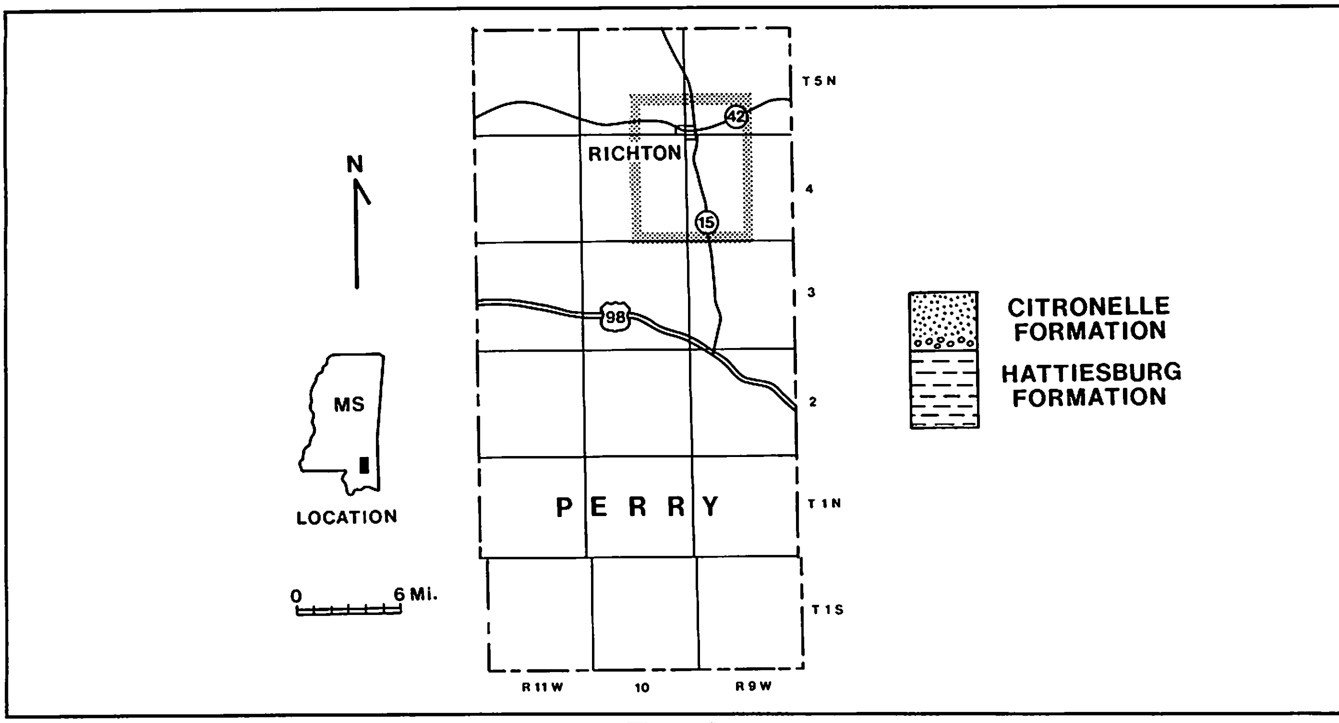

Figure 3.

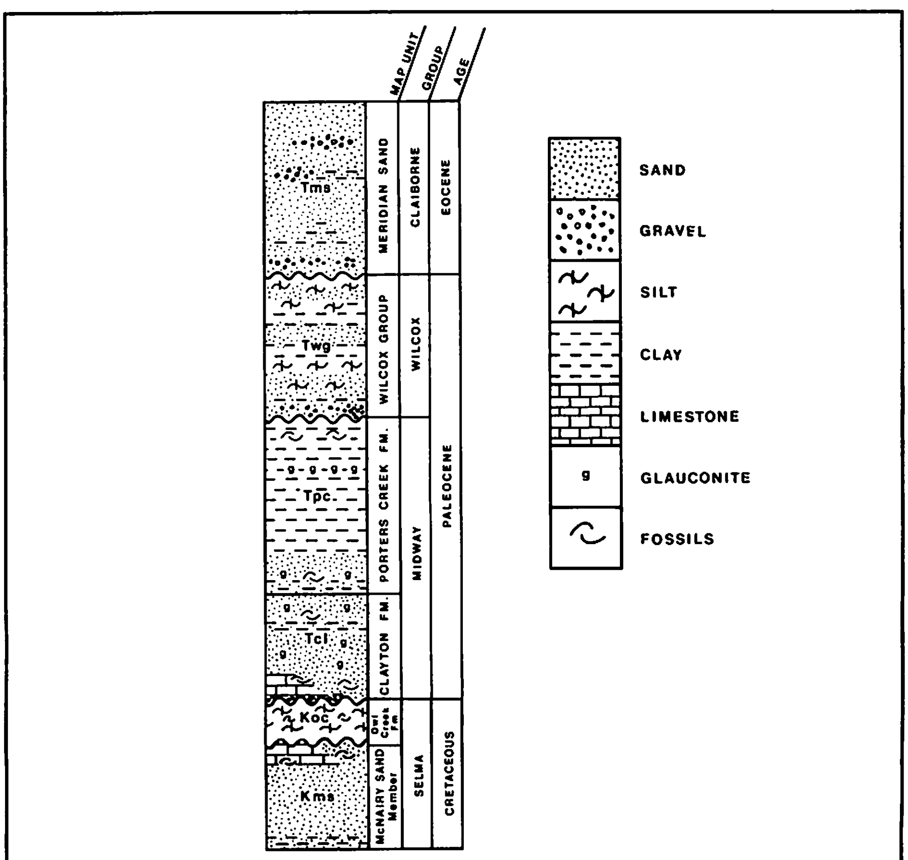

Figure 4. Stratigraphic section for Figure 2.

A REVISION OF THE FEARN SPRINGS FORMATION AND RELOCATION OF THE MIDWAY-WILCOX GROUP BOUNDARY IN MISSISSIPPI

David T. Dockery III
Mississippi Bureau of Geology

ABSTRACT

The Fearn Springs Formation is revised to member status and is removed from the Wilcox Group and placed in the Naheola Formation of the Midway Group. This change alters the position of the Midway-Wilcox boundary in Mississippi and necessitates changes in the current State geologic map and geologic column. A revision of the Midway-Wilcox interval is given for the *Stratigraphic Column of Mississippi* by Dockery (1981).

INTRODUCTION

A revision of the Fearn Springs Formation was prompted by two unrelated geologic studies. The first of these was a U.S. Geological Survey open-file report by Meissner and Heermann (1982). In this report the authors found a lignite (or lignite interval) in the Oak Hill Member of the Naheola Formation in Alabama to be the same bed (or interval) as that described in the Fearn Springs Formation of the Wilcox Group in Mississippi. The second study concerned the location of the Midway-Wilcox boundary in a salt-water disposal well at Heidelberg in Jasper County, Mississippi. This boundary was placed at the contact of the Naheola and Nanafalia formations as determined from electric logs and cuttings of adjacent wells. The Naheola and Nanafalia sections in these wells were correlated respectively to units mapped by Foster (1940) in Lauderdale County, Mississippi, as the Fearn Springs and Ackerman formations of the Wilcox Group.

REVISION OF THE FEARN SPRINGS FORMATION

The Fearn Springs Formation was named by Mellen (1939) for clays, sands, and lignites disconformably overlying the Betheden Formation (a lateritic soil zone developed on the Porters Creek Formation) in Winston County, Mississippi. Mellen placed the Fearn Springs Formation as the basal unit of the Wilcox Group in Winston County, which also included in ascending order the Ackerman, Holly Springs, and Hatchetigbee formations. Foster (1940) recognized these formations in his geologic map of Lauderdale County. This map is reproduced in part in Figure 1 along with a portion of the Sumter County, Alabama, geologic map by Sanford and Ellard (1978). The junction of these two maps at the state line shows the Naheola and Fearn Springs formations as mapped by Foster to be equivalent to the Naheola Formation in Alabama and the Ackerman Formation to be equivalent to the Nanafalia Formation.

Mellen (1950) in a discussion of the status of the Fearn Springs Formation recognized three depositional cycles in the lowermost Tertiary of Mississippi: a Midway Cycle, a Fearn Springs Cycle, and an Ackerman Cycle. He correlated the Midway and Fearn Springs cycles into the subsurface of southern Alabama with the use of oil test hole electric logs (Mellen, 1950, fig. 8). One Alabama electric log used in this correlation was that of the Hunt Oil Company, No. 1 A. M. Dubose, in Section 18, T. 9 N., R. 3 W., Choctaw County, Alabama. This log is included in the cross section in Figure 2 showing the stratigraphic sequence and contacts as picked by the Geological Survey of Alabama. The Fearn Springs Cycle of Mellen (1950, fig. 8), according to these picks, is equivalent to the Naheola Formation.

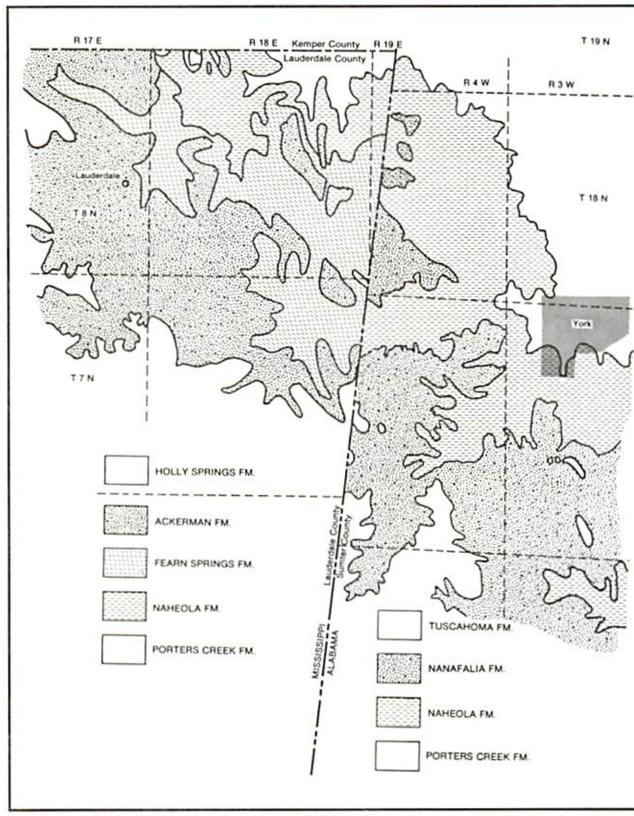

Figure 1.

The Fearn Springs Formation of Mellen (1939) is of economic importance because of its ball-clay type clay deposits in Winston County. These clays have been quarried for many years as a component in the manufacture of brick and other ceramic materials. This unit also contains deposits of lignite and of the iron ore siderite, which have been studied for their possible economic potential. The Fearn Springs is a useful stratigraphic term for the interval described by Mellen (1939) containing the previously mentioned mineral deposits. It is here placed as a member of the Naheola Formation and is considered to be an updip facies of the Oak Hill Member in Alabama. Figure 3 illustrates a thin lignite bed in the upper part of the Fearn Springs Member in Kemper County, Mississippi. According to Mancini (1983), lignites of the Fearn Springs and Oak Hill members accumulated in a system of lower delta plain marshes that developed between two delta lobe complexes.

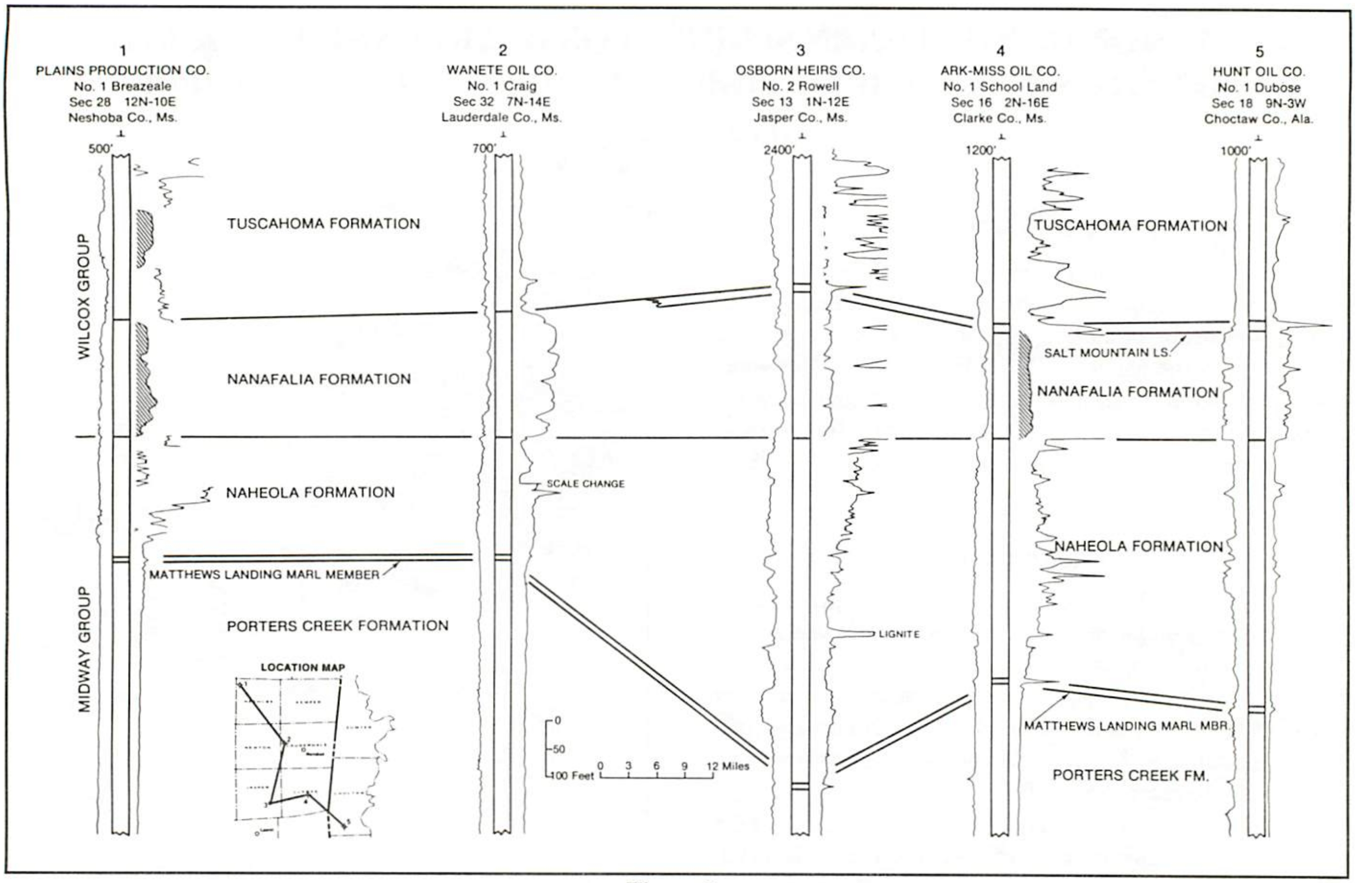

Figure 2.

THE NANAFALIA FORMATION IN MISSISSIPPI

The lower Wilcox sand mapped by Foster (1940) in Lauderdale County, Mississippi, as the Ackerman Formation is equivalent to the Nanafalia Formation of Alabama as shown in Figure 1. Hughes (1958) recognized the Nanafalia rather than the Ackerman Formation in Kemper County, Mississippi, and placed the Fearn Springs as its lower member. According to Hughes (1958, p. 141-142), the "Ackerman" Formation at its type locality correlates with beds well up in the Tuscahoma Sand of Alabama and is thus unsuited as a stratigraphic term for beds of Nanafalia age.

The Ackerman Formation as mapped by Foster (1940) in Lauderdale County is here recognized as the Nanafalia Formation. The "gritty" coarse-grained, basal sands of this unit rest disconformably above finer grained sediments (silty clays, sands, and lignites) of the Fearn Springs Member of the Naheola Formation. The disconformity at the base of the Nanafalia Formation in Mississippi (Figure 3) is pronounced, showing strong relief and marking a notable change in texture. The coarse-grained sands of this formation (Figure 4) are probably an updip equivalent of the Gravel Creek Sand Member, the lower member of the Nanafalia Formation in Alabama. In Mississippi, these sands generally appear to have been deposited in a braided fluvial system; however, Hughes (1958) found molds of marine fossils to occur in some portions of this formation in Kemper County. The Nanafalia Formation is roughly equivalent to the lower Wilcox aquifer as cited by Boswell, Thomson, and Shattles (1970).

THE MIDWAY-WILCOX BOUNDARY

Harris (1896) formally defined the Midway Stage and referenced the Oakhill-Pine Barren section in Alabama as a typical section. He placed the top of this stage at the top of the Matthews Landing Marl. Crider and Johnson (1906) introduced the name Wilcox as a formation to replace the Lignitic division of Hilgard (1871) and included within it the "complex mass of sands, clays, lignites, marls, etc., between the Porters Creek clays below and the Tallahatta buhrstone above." This definition placed the Naheola Formation as a member in the Wilcox "Formation." However, later in the same year, Crider (1906) excluded the Naheola from the Wilcox and placed it in the Midway. Brantley (1920) followed the latter definition of Crider and placed the base of the Wilcox at the base of the Nanafalia Formation. Cooke (1926) also placed the Naheola in the Midway Group and included the Nanafalia, Tuscahoma, Bashi, and Hatchetigbee formations in the Wilcox Group. This definition of the Wilcox Group has been largely followed by later workers and is the definition presently followed by the Mississippi and Alabama geological surveys.

Mellen (1939, 1950) recognized that the Fearn Springs "Formation" was bound above and below by disconformable contacts. He chose the lower of these disconformities as the Midway-Wilcox boundary even though he stated that the upper disconformity was more pronounced in outcrop exposures. This choice was based on the time required to produce the lateritic soil of the Betheden Formation, which underlies the lower disconformity. However, the placement of the Midway-

Figure 3.

Figure 4.

Wilcox boundary in Mississippi depends upon which of these disconformities correlates with the Naheola-Nanafalia contact in Alabama and not on the duration of the hiatus. On this basis, the Midway-Wilcox boundary in Mississippi is placed here at the Nanafalia-Fearn Springs contact. This boundary is indicated in the cross section in Figure 2 and is shown diagrammatically in Figure 5. The latter figure is drawn to the same scale as the *Stratigraphic Column of Mississippi* by Dockery (1981) so that it can be photocopied, cut out, and overlain on this column.

ACKNOWLEDGMENTS

The writer gratefully acknowledges Ernest A. Mancini, Charles W. Copeland, and Dorothy E. Raymond of the Geological Survey of Alabama and Gary V. Wilson of the State Oil and Gas Board of Alabama for their discussion of the Midway and Wilcox groups in Alabama. Michael B. E. Bograd also helped in reviewing the manuscript.

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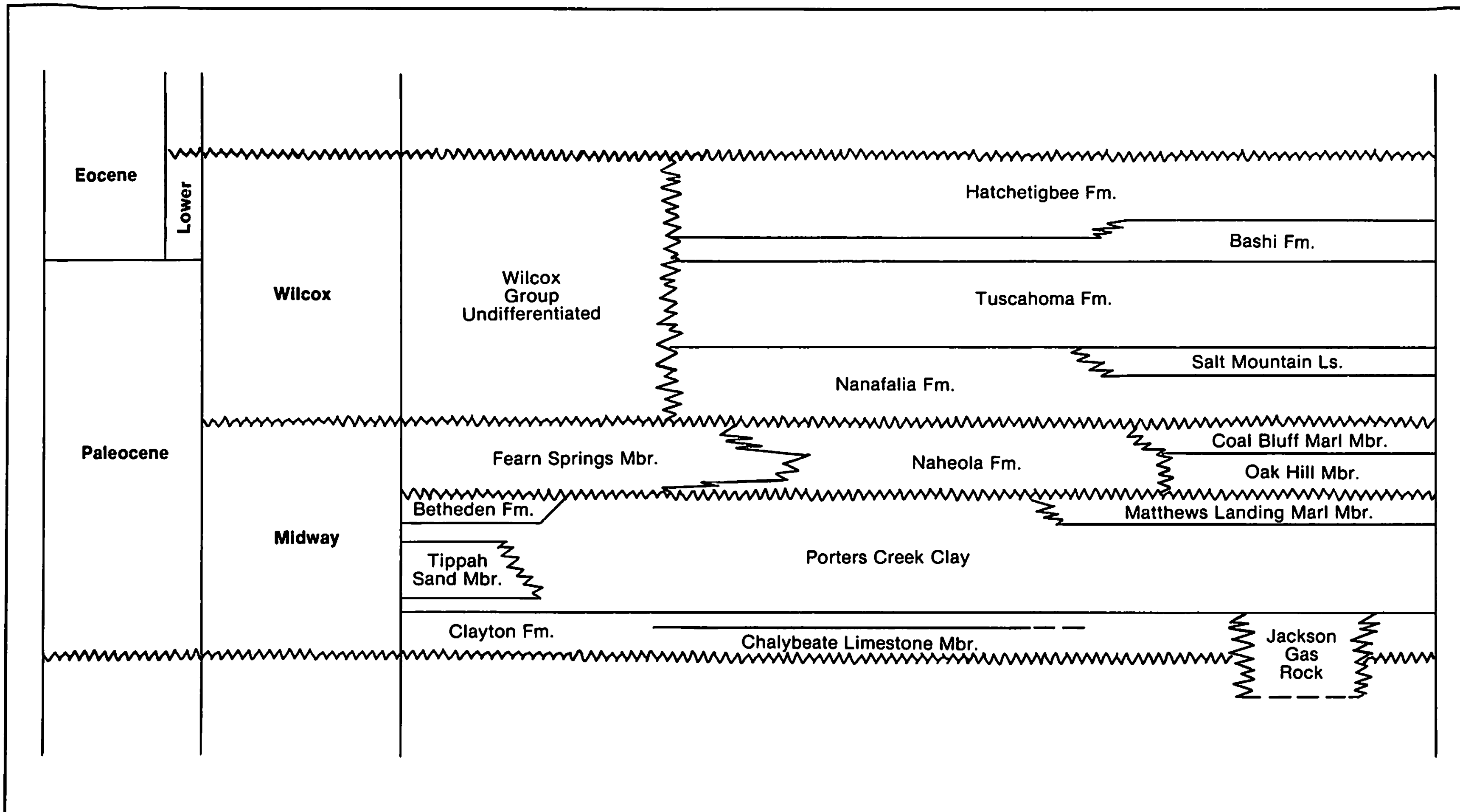
Eocene
Lower
Paleocene
Wilcox
Midway
Wilcox
Group
Undifferentiated
Hatchetigbee Fm.
Bashi Fm.
Tuscahoma Fm.
Salt Mountain Ls.
Nanafalia Fm.
Fearn Springs Mbr.
Naheola Fm.
Coal Bluff Marl Mbr.
Oak Hill Mbr.
Betheden Fm.
Matthews Landing Marl Mbr.
Tippah
Sand Mbr.
Porters Creek Clay
Clayton Fm.
Chalybeate Limestone Mbr.
Jackson
Gas
Rock

Figure 5.

KEY CONCEPTS TO AID IN MAPPING NON-MARINE SEDIMENTS IN MISSISSIPPI

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The correlation of non-marine units in the southern half of Mississippi is a major problem. If certain key concepts are recognized the complex geology of central and southern Mississippi can be placed in proper perspective. An extremely important observation is that the updip Miocene does not maintain a consistent stratigraphic position. The lower Miocene sediments rest on progressively older units to the north and east. For example, the Miocene lies on the Bucatunna Formation in Simpson County and on the Forest Hill Formation in parts of Hinds County. If this truncation is not considered, correlations become very confusing.

Equally important is the occurrence of coarse sand and chert gravel in the subsurface Miocene. Where these sand and gravel units outcrop they may be severely oxidized and reworked into a geologic complex where similar looking strata can differ greatly in age. The Citronelle controversy is an example of this problem.

It is suggested that the Forest Hill Formation be used as an example of how a formation can change in character from the subsurface to the surface. What could be more striking than the comparison of the dark gray, organic-rich sands and clays of the subsurface Forest Hill to the bright red sands and silicified wood of the Forest Hill at the petrified forest at Flora? This same change of character takes place with sediments in the Miocene. The Forest Hill is suggested as a model because, unlike many of the Miocene sediments, it is bounded above and below by mappable units. Understanding this phenomenon is of primary importance in mapping the surface deposits in southern and central Mississippi.

STRATIGRAPHY AND DEPOSITIONAL ENVIRONMENTS OF CATAHOULA SANDSTONES AND ASSOCIATED FACIES IN SOUTH-CENTRAL MISSISSIPPI

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SUMMARY

Surface and subsurface studies of the Catahoula "Formation" in a seven-county area of south-central Mississippi have revealed major problems and misconceptions regarding Neogene stratigraphy and geological mapping in this part of the Gulf Basin (May, 1976, 1980; Wojna, 1985; and Day, 1987). The results of these investigations show that the traditional stratigraphic subdivisions of the "updip" Neogene section in Mississippi are invalid, and that the fundamental criteria for defining rock stratigraphic units at the formation rank are nonexistent. Although the base of the Neogene section is reasonably well defined by virtue of its relatively continuous contact with the Bucatunna Formation (Oligocene Vicksburg Group), a mappable bounding sequence above the Catahoula - Bucatunna Formation contact does not exist in the study area (Figures 1 and 2).

An overall fine-grained interval (Hattiesburg "Formation"?) above the Catahoula "Formation" appears to wedge-out before reaching outcrop. Hence, differentiation between updip sandy gravels of the Catahoula and similar facies of the Citronelle "Formation" is difficult (if not impossible). Further complicating the problem of stratigraphic unit discrimination is the discovery of sandy gravels within the Hattiesburg "Formation" interval (by Gerald, 1985).

A subsurface analysis in this study area revealed that the Catahoula "Formation," as defined by Cameron and Day (in preparation), attains a thickness of 625 feet, and has a rough three-tiered stratigraphy: (a) a basal unit (75-140 feet thick) composed of sands and subordinate fine-grained facies; (b) a relatively fine-grained middle unit (250-350 feet thick) composed of silts and clays with recurrent, discontinuous sand bodies; and (c) an upper unit (175-325 feet thick) composed largely of sand and gravels. This study confirmed that most of these sediments are the product of fluvial channel and associated floodplain deposition. However, in the basal unit deltaic facies appear to be preserved on outcrop in Smith County, and perhaps in a mild structural depression in the southwestern portion of the study area.

The Neogene section is an important economic unit, hosting most of the important aquifers in southern Mississippi, as well as shallow hydrocarbon reservoirs in the southwestern portion of the state. The latter are usually ascribed to being part of the "Frio." A vigorous effort should be made to accurately define the stratigraphy and facies relationships in this succession. A considerable amount of detailed work must be done before an acceptable formal stratigraphic scheme can be generated. This work should involve methods in palynology and paleomagnetism, as well as the application of advanced stratigraphic principles which combine depositional environment analysis with sequence stratigraphy and interpretation. Specifically:

1. Regional surface and subsurface studies should be extended, (a) to the west where an attempt should be made to correlate the Catahoula "Formation" in Mississippi to that defined by recent studies in Louisiana by investigators at the University of New Orleans and the U. S. Army Engineer District in Vicksburg, Mississippi (e.g. Albertson, et al., 1986), and (b) to the east where correlations with the Neogene section there are in need of revision and improvement.

2. Palynological and paleomagnetic research in the onshore Neogene section should be encouraged. These methods offer the only possible zonation alternative to physical rock stratigraphy (the latter being fraught with inadequate surface mapping criteria, uncertainty in the correlation of widely spaced drill holes, and traditional prejudices).

3. Further detailed outcrop mapping should be performed in Smith County to enhance definition of the upper Catahoula sand unit(s). These efforts should be supported by integration of new subsurface data as it becomes available.

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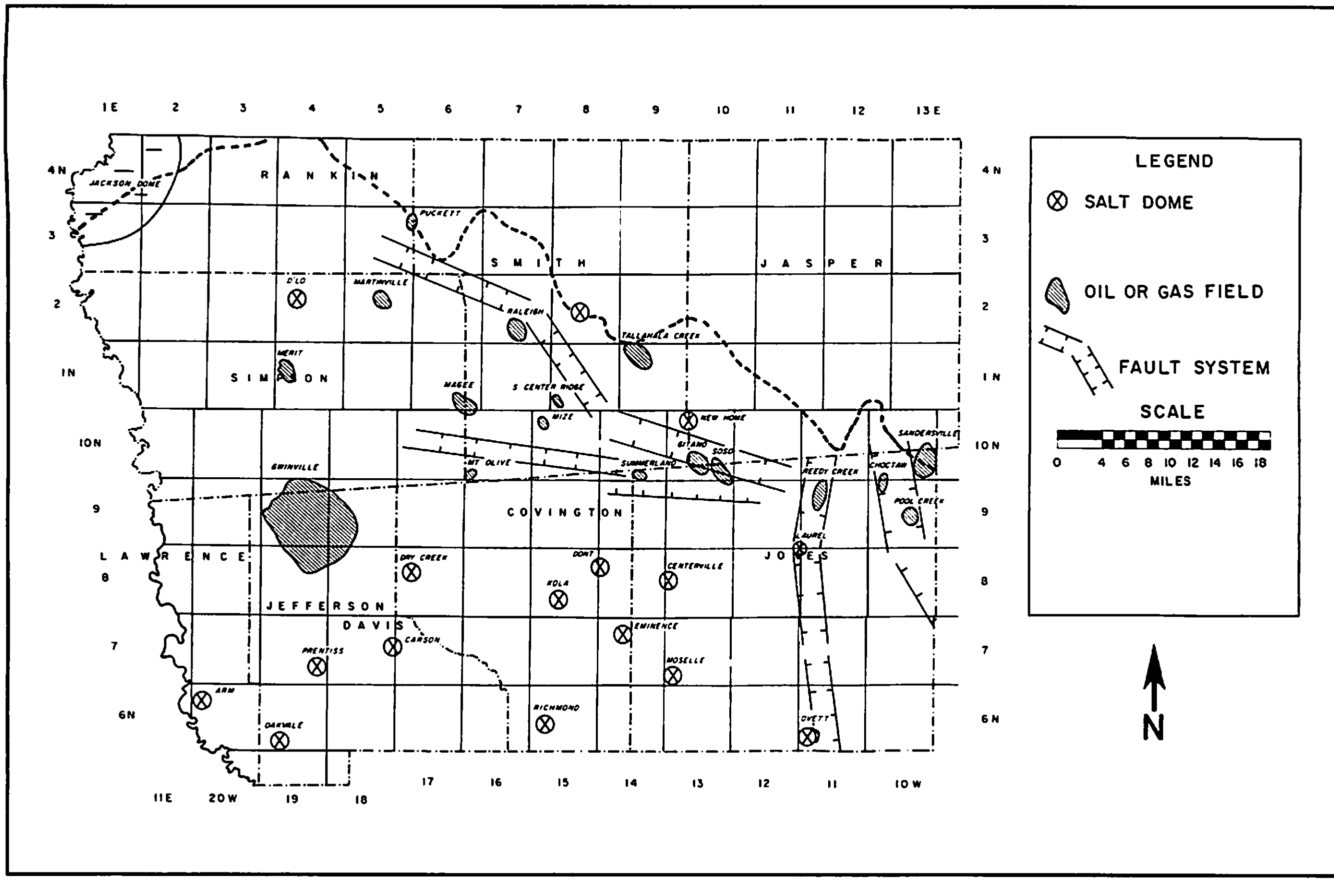

Figure 1. Outline map of the study area showing the updip outcrop limit of the Neogene section (dashed line) and subsurface geologic features.

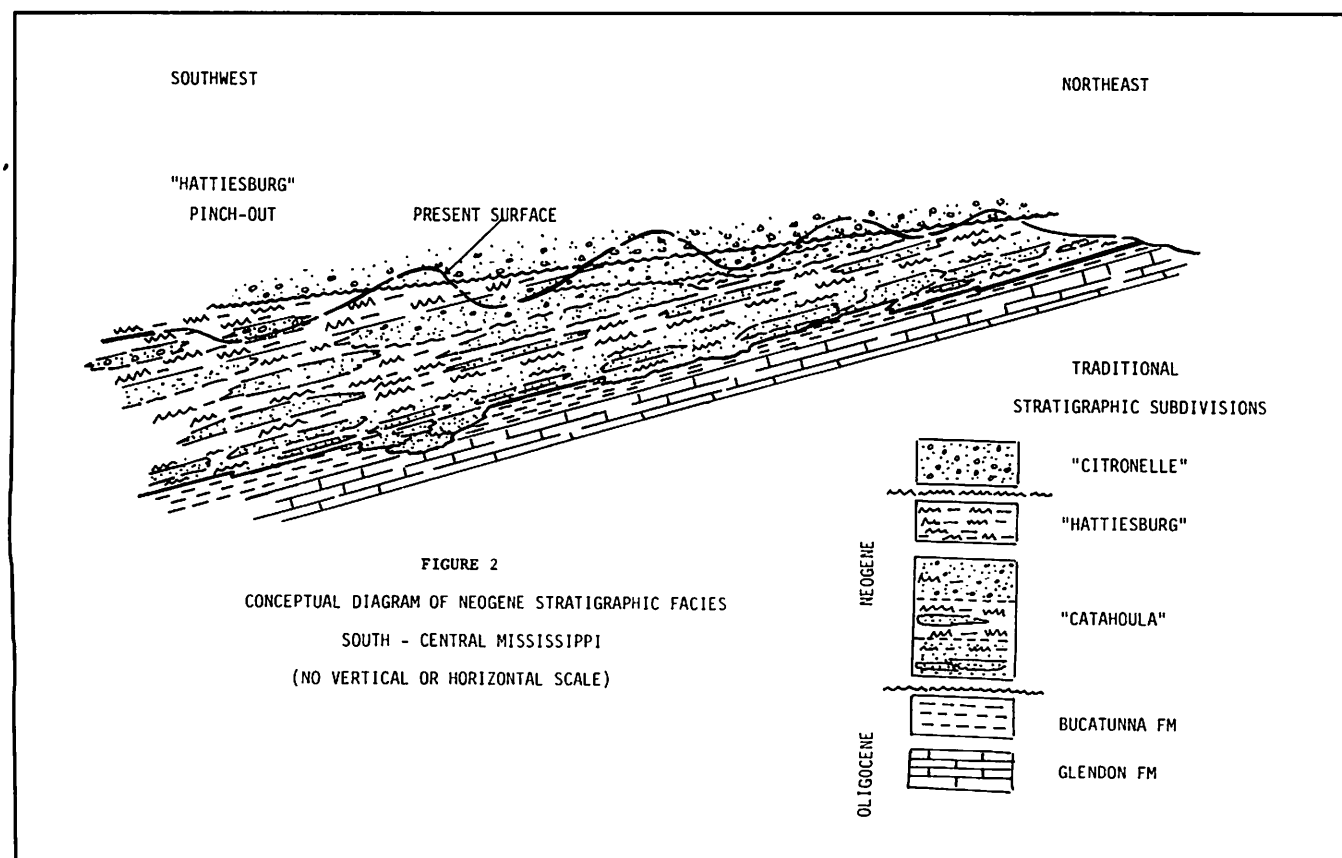

Figure 2. Conceptual diagram of Neogene stratigraphic facies in south-central Mississippi.

GEOLOGIC MAPPING IN THE HATTIESBURG DISTRICT, MISSISSIPPI

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The patterns displayed on the 1:500,000 *Geologic Map of Mississippi* (1969) south of the Oligocene Series outcrop line (approximately 1/3 of the state) bear little relation to the existing superficial and near-surface geology. Mapping reveals that only the fact that these deposits are late Oligocene or younger in age is essentially correct. The published 1:125,000 series of county maps in this part of Mississippi are somewhat better, taken as a whole; even so, their quality is highly variable. Significant errors exist on the Wayne County, Jasper County, and Smith County maps, and minor errors are present on the George County map, while the Forrest County map is near-useless.

Largely, the mapping errors result from the preparers' acceptance of then-prevailing dogma of Gulf Coast geology or from their unfamiliarity with the problems of mapping complexes of alluvial deposits. Specifically, usage of the terms Catahoula, Hattiesburg, Pascagoula, and Citronelle formations (none of which have described reference or type sections in this part of Mississippi or nearby) has been extensively misleading. My detailed mapping (1:20,000 and 1:24,000) of the surface geology of the Cypress Creek Salt Dome (49 sq. mi.) and Richton Salt Dome (78 sq. mi.) areas in Perry County and the Eastabuchie Quadrangle (57 sq. mi.) in Forrest and Jones counties has demonstrated the fallacy of using these traditional stratigraphic terms, for lithostratigraphic continuity over any significant distance in these surface and near-surface deposits is uncommon. This observation applies throughout the 50 x 60 mile district (with Hattiesburg a little NW of the center of the district) over which I have conducted semi-detailed surface geologic studies.

Numerous geologic problems needing further study (aside from the completion and publication of the detailed maps of this area and the erecting and defining of new or revised stratigraphic units) have been identified from my mapping to date, as, for example:

A. The thickness and distribution of the alluvial blanket of deposits (the unit I describe as Upland Graveliferous Deposits, which more or less corresponds to the "Citronelle Formation, *senso lato*"), which are draped over a markedly irregular topography developed on the Miocene (?) Lutites (a collection of mildly indurated muddy strata, to which the names Hattiesburg, Pascagoula, and Catahoula formations have traditionally been applied). Particularly striking are the extensive, subparallel, NNW'ly striking low ridges of the Miocene Lutites which are discordant with existing stream systems or other identified structural or tectonic trends.

B. The mapping of the fossil channels in the Upland Graveliferous Deposits - the largest so far studied is up to 1 1/2 mi. across, 50 feet in sand and gravel thickness, and traceable for a course of more than 40 miles, while other, smaller channels occur to the sides, above, and below this one in the same areas.

C. The determination of the ages of these deposits, for to the present there exist only poor collections of plant debris and petrified wood (largely of undetermined phyletic relations); quite likely, a program of well-planned sampling could produce deposits from which diagnostic palynomorphs could be recovered.

GEOLOGIC MAPPING ISSUES IN SOUTHERN MISSISSIPPI

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The "Citronelle" Question. Deposits consisting of interbedded sands, gravels, and mottled lutites, particularly when capping hills and exhibiting red, hematite-coated weathering zones, are described and mapped as the "Citronelle Formation." Although contacts with underlying Miocene sediments are indicated, there are no precise, in a stratigraphic sense, boundaries for this formation as there are none for the Hattiesburg Formation (May, 1980). Apparently, the presence of gravels or gravelly sands is often used to designate the "Citronelle;" however, the examination of the Miocene in the subsurface demonstrates that gravels and coarse sands are not limited to surface formations, but also occur in downdip equivalents of the Catahoula and Hattiesburg formations (Gerald, 1986). Generally, petrologic composition is not a particularly useful key to distinguish between these Miocene and possibly younger units (Kirby and Patrick, 1985; Adamczak, 1986). Figure 1 is a north-south dip section through Forrest County showing subsurface gravels and very minor correlation with information on the current geologic map reproduced at the top of the illustration. Geologic sections through adjoining areas reveal similar anomalies. These data suggest that the extension of the term "Citronelle" into southern Mississippi for mapping purposes should be re-examined. Another interesting aspect of this question is the relationship between those deposits lying along the bluff line in western Mississippi and mapped as "Citronelle" or terrace in the west and similar-looking deposits in southeastern Mississippi.

Alluvial Valley Mapping. Geologic mapping of alluvial valleys in south-central Mississippi is complicated by the presence of at least four or five terrace surfaces of presumed Quaternary age which extend some distance into upland areas (Cotten, 1986). These terrace surfaces are apparent along streams, including the Pearl, Bowie, and Leaf rivers, flowing into the Gulf; however, their presence along the southwestern, bluff-line streams flowing into the Mississippi River is not known. Figure 2 illustrates the distribution of terrace surfaces along the Pearl River between Jackson and Columbia, Mississippi. Where studied in detail, these terraces are erosional in origin and are underlain by older Miocene/Plio-Pleistocene sediments rather than Quaternary alluvium (Patrick, 1989). Furthermore, there is a high probability that deposits lying along these streams and in upland areas which have been mapped as "terrace" are, in fact, geologically older than Quaternary and geomorphically unrelated to the present drainage system. Some of the materials mapped as terraces in one area may be mapped as "Citronelle" in another area. Thus, geologic maps of these areas must be labeled such that one may distinguish between Quaternary terraces versus Quaternary alluvium. This distinction is of both scientific and practical importance, respectively, in terms of valley history and land use/development.

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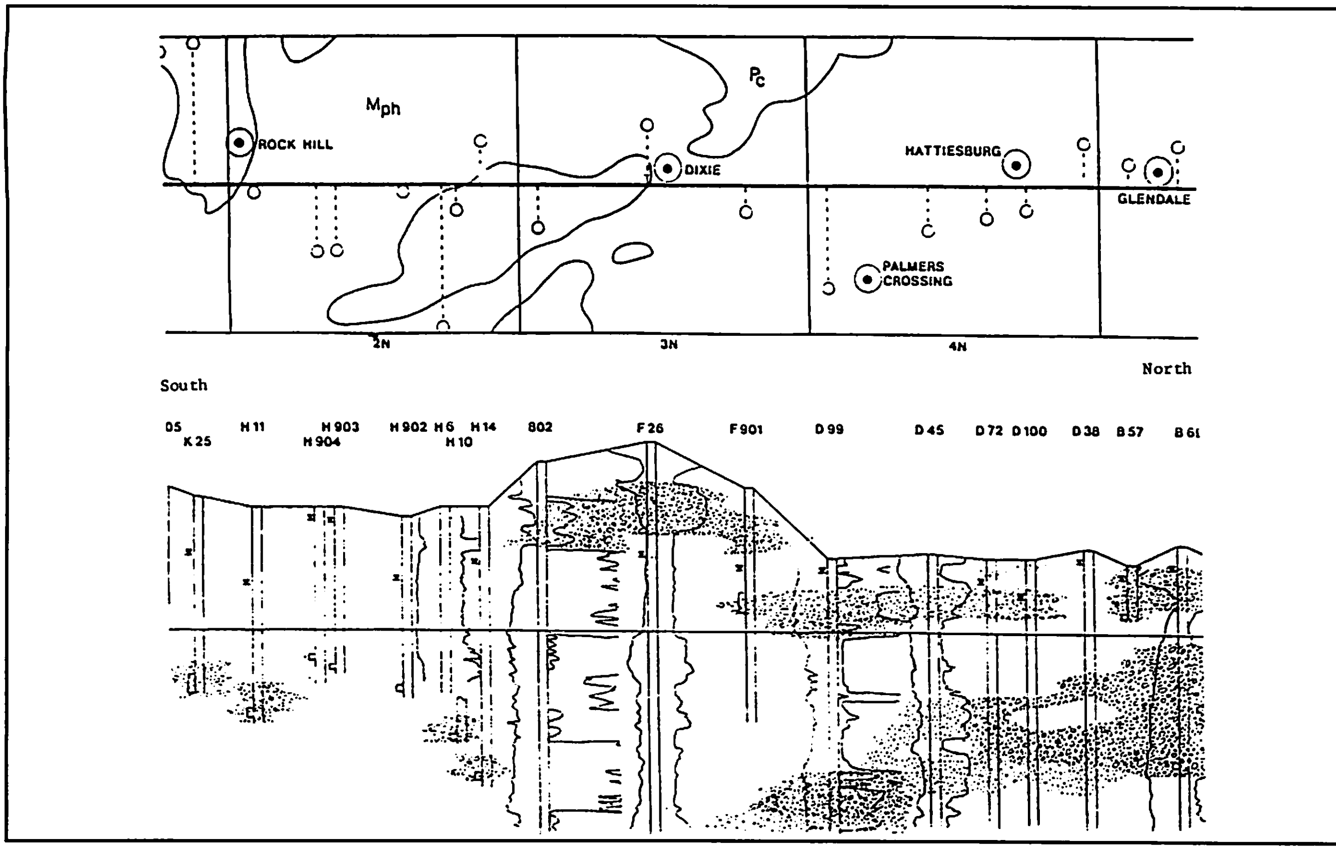

Figure 1. North-south dip section through Forrest County, Mississippi, showing subsurface lithology and its relation to information on the current geologic map (after Gerald, 1986).
Vertical Scale 1" = 280'

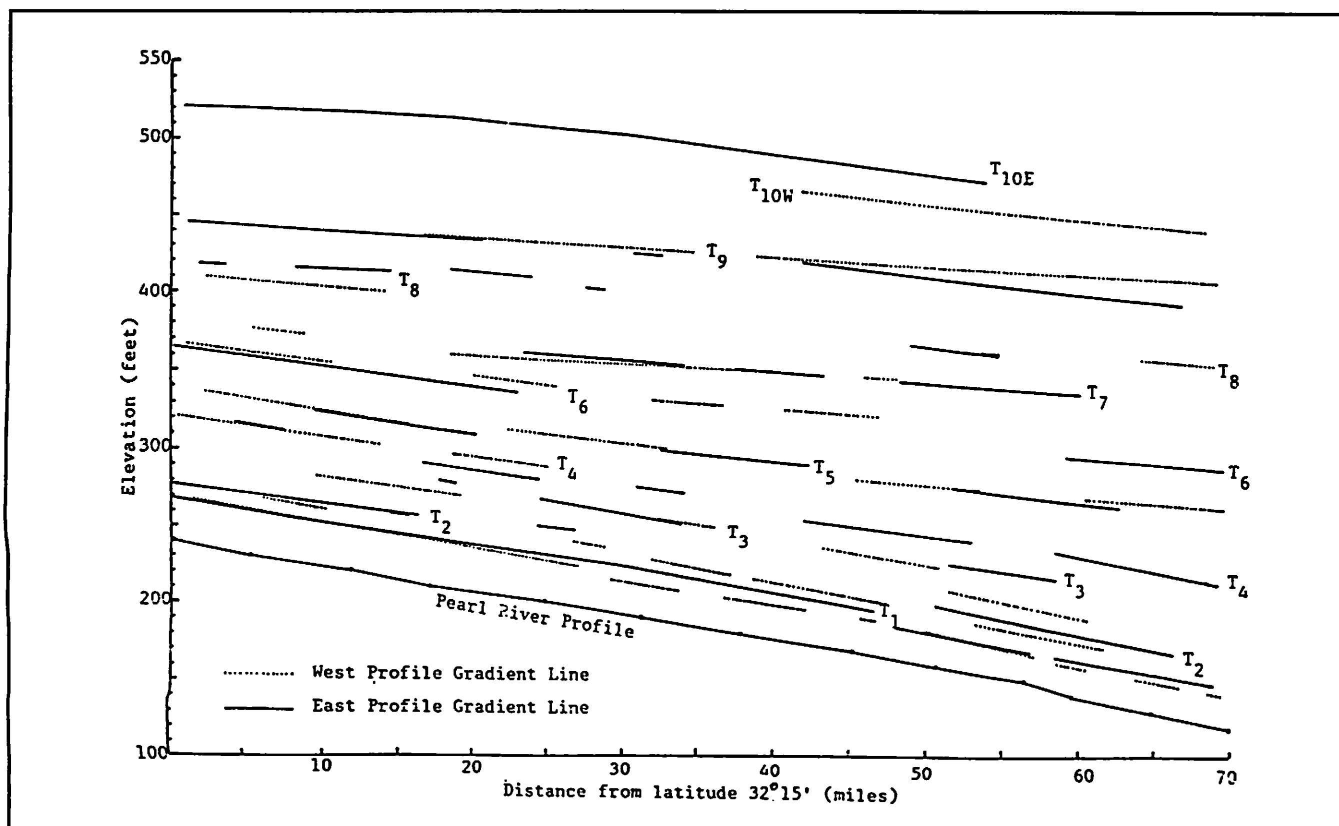

Figure 2. Longitudinal section along the Pearl River between Jackson and Columbia, Mississippi, showing the distribution of terrace surfaces (Cotten, 1986).

GEOLOGIC MAPPING AT THE WATERWAYS EXPERIMENT STATION

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The Geologic Environments Analysis Section (GEAS) has completed the geological engineering mapping of approximately 50 quadrangles in west-central Mississippi. Geological engineering quadrangles include surface geologic environments (point bar, back swamp, highland, etc.), contours of the top of Tertiary, at least two geologic cross sections per quadrangle, and a written geologic description of the respective quadrangle areas.

Approximately 40 quadrangles have been mapped in Louisiana and many have also been done in Arkansas. The Arkansas maps are geomorphologic interpretations with bedrock geology included. These geomorphologic maps are used primarily by archaeologists and engineers in completing environmental impact statements and various Corps reports.

Limited quantities of maps are published and when supplies are exhausted, reprinting is done only at sponsor's request and with sponsor's funding.

MISSISSIPPI QUADRANGLE MAPS

Quadrangle Map*	Date of mapping or revision
Horseshoe Lake	1980's
Horn Lake	1980's
Latour	1980's
Clayton	1980's
Crenshaw	1980's
Farrell	1980's
Marks	1982
Sledge	1980's
Sardis	—
Mellwood	1982
Clarksdale	1982
Tutwiler	1980
Crowder	1980
Oakland	—
Big Island	1982
Pace	1981
Mound Bayou	1981
Sumner	1980
Philipp	1980
Grenada	—
Lamont	1981
Choctaw	1981
Cleveland	1981
Schlater	1980
Greenwood	1980
Greenville	1981
Tralake	1981
Baird	1981
Mossy Lake	1980
Seven Pines	1980
Readland	1979
Swan Lake	1981
Auter	1981
Mileston	1980
Lexington	1980
Lake Providence	1979
Lorenzen	1979
Bayland	1979
Valley	1979
Alsatia	1979
Onward	1979
Mechanicsburg	1958
Talla Bena	1979
Vicksburg	1979

* Yazoo Basin maps above are listed in order from north to south.

South of Vicksburg

Quadrangle Name

Yokena
Natchez
St. Joseph
Kingston
Woodville
Artonish

Reports:

Proposed Shoccoe Dam Reservoir Area

Information on availability of maps above can be obtained by contacting: CEWES-GR-GR, Attn.: Robert Larson, P. O. Box 631, Vicksburg, MS 39180-0631. Telephone: (601) 634-3201.

PROGRESS AND PROBLEMS IN THE SYNTHESIS OF THE QUATERNARY OF MISSISSIPPI

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INTRODUCTION

The stated purpose of the MISGEOMAP Conference is to identify and discuss current mapping projects and future mapping needs and priorities. This presentation does not discuss particular projects in specific areas but rather focuses on a state-wide synthesis of the Quaternary geology and its status. Therefore, its significance is primarily in terms of updating the state geologic map.

BACKGROUND

In the presentation by Dr. Robert J. Larson of the Geotechnical Laboratory, U. S. Army Engineer Waterways Experiment Station, it was indicated that systematic, large-scale (1:62,500) mapping of the Quaternary deposits of the Mississippi Alluvial Valley has been ongoing for 30 years. To date, more than 200 quadrangles in the Mississippi Valley have been mapped, including all in the State of Mississippi, and over 50 have been revised and reissued with significant new information. For example, most quadrangles in the Yazoo Basin portion of the state are available in second edition form.

The classification scheme used in the mapping focuses on environments of deposition since we are dealing with unconsolidated fluvial materials laid down by meandering and braided streams. The mapping has been done in direct support of engineering activities, primarily site selection and foundation design, and secondarily for project planning. The latter has included environmental assessments and cultural resources surveys.

PAST SYNTHESES

The systematic mapping just described, which is at the same time both geologic and geomorphic characterization and delineation, has necessarily emphasized lithology and geotechnical properties. Information and interpretations regarding stratigraphy and chronology have been substantial by-products of the mapping, but these have limited significance in purely engineering applications — so say the engineers. Unfortunately, they do not always take a holistic view of what is necessary to advance geologic knowledge.

After spending about 12 years heavily involved in this mapping effort, it became apparent to me that long-term implications regarding Lower Mississippi Valley stratigraphy and chronology may indeed turn out to be the single most important result of the effort from a geological perspective. For example, by the early 1970's a large volume of evidence had accumulated indicating that aspects of Harold Fisk's classical and widely accepted 1944 treatise (Fisk, 1944) on the geology of the Lower Mississippi Valley were completely out of date and often erroneous. His concepts of regional controls such as slope and faulting were incorrect and his elaborate reconstruction of river channel migration and course changes was completely invalid because of some wrong basic assumptions. Within the last decade, it has further come to light that Fisk's terrace formation model and terrace stratigraphy also are in need of major revision.

During the 1960's and early 1970's, I was able, via occasional journal articles and papers, to get some of this "new thinking" into the literature. For example, I expounded on the evidence for two rather than one episode of Wisconsin-stage outwash deposition and valley train formation. This began a chain reaction in late Pleistocene chronostratigraphy, indicating that certain landforms were 5 to 10 times older than previously estimated. This was welcome news to some archeologists who were deeply concerned about why 12,000-year old Indian sites were showing up on what geologists had told them were 5,000-year old landforms.

Interest on the part of cultural resources managers in updated Mississippi Valley chronology was a driving force in my preparation, in 1974, of a monograph on the Quaternary geology of the Lower Mississippi Valley that was published by the Arkansas Archeological Survey as part of a Corps of Engineers-funded region overview (Saucier, 1974). This was the first such summary in 30 years and it was accompanied by a color plate at a scale of about 1:1,000,000. This map was used by Philip B. King when he prepared the Geologic Map of the United States that was published by the USGS the same year.

THE DNAG IMPETUS

After 1974, I was no longer actively involved in the mapping effort, but I followed its progress closely since it continued to produce information vital to solving increasing problems in regional correlations. A golden opportunity for an updated synthesis arose in late 1986 when I was asked to participate in writing a chapter for the Geological Society of America's (GSA's) Decade of North American Geology (DNAG) series. The particular chapter is on the Quaternary geology of the Lower Mississippi Valley and it will be in the volume (K-2) on the Quaternary Nonglacial Geology of the Conterminous United States (Autin et al., in press). The chapter is in galley proof stage, and it is scheduled for publication in October 1989.

Coauthors of the chapter are Whitney Autin and John Snead of the Louisiana Geological Survey, Scott Burns of Louisiana Tech University, and the late Bobby Miller of Louisiana State University who died in 1987. The chapter contains a full-color, 1:1,000,000-scale geologic map that contains 46 mapping units (Figure 1). The map includes the entire alluvial valley and deltaic plain of the Mississippi River plus the lower

GSA/DNAG Vol. K-2, Chap. 17
Quaternary Non-Glacial Geology: Conterminous US
Lower Mississippi Valley

Map Units

Holocene
Undifferentiated alluvium
Mississippi River meander belts (5)
Arkansas River meander belts (7)
Red River meander belts (6)
Backswamp
Mississippi River delta complexes (6)
Deltaic barrier landforms
Abandoned distributaries
Chenier plain and cheniers
Coastal plain barrier landforms

Pleistocene
Late Wisconsin valley train
Loess
Sand dune fields
Deweyville complex
Cache River Terrace
Early Wisconsin valley train
Finley Terrace
Brownfield Terrace
Prairie complex
Relict Pleistocene channels
Relict Pleistocene ridges
Hatchie Terrace
Metropolis Terrace
Undifferentiated terraces
Intermediate complex
Upland complex

Figure 1. Map units used on the 1:1,000,000-scale map of the Quaternary geology of the Lower Mississippi Valley to be published by GSA.

portions of its tributaries. In Mississippi, this includes Bayou Pierre plus the Homochitto, Big Black, Yalobusha, Yokona, Tallahatchie, and Coldwater rivers. On these streams, terraces have been delineated for the first time on a small-scale map.

The geologic map also depicts the Pearl River basin and the upland Quaternary (?) deposits of southwestern and coastal southeastern Mississippi; however, the mapping was taken largely without modification from the latest state geologic map. Some adjustments were made to minimize "state-line faults," but these could not be completely eliminated. Herein lies a problem I will discuss more fully later.

All of the basic mapping in the Mississippi Alluvial Valley and its tributaries was performed on 1:62,500-scale or 1:24,000-scale quadrangles and photographically reduced for basic compilation on 1:250,000-scale sheets. Overlays at this scale were then photographically reduced to 1:1,000,000 for drafting of the final plate, which meets national cartographic standards and convention.

In summary, I am pleased to be able to say that, as far as the Holocene and late Pleistocene units of the state are concerned, very soon we will have a highly precise (and hopefully also highly accurate) compilation of 30 years of intensive effort. This information should be directly applicable to the proposed new state map. The mapping is supplemented with text discussions of previous investigations and correlations, processes and modes of formation, and the latest thinking on chronology. For example, Figure 2, modified from a DNAG chapter figure, shows the latest and best estimates of the ages of meander belts, delta lobes, and cheniers in the Mississippi, Arkansas, and Red River valleys.

UPLAND QUATERNARY UNITS

Concerning early to middle Pleistocene units, the picture is not so bright and is in a state of flux. A comparison of Fisk's 1944 classification of Quaternary terraces to my latest interpretation shows both new terrace complexes not recognized by Fisk plus substantially changed nomenclature (Figure 3). This is the classification used in the DNAG map and which is essentially that used in the Geologic Map of Louisiana prepared in 1984. It resulted from several studies made during the 1960's and 1970's in the Florida Parishes of Louisiana.

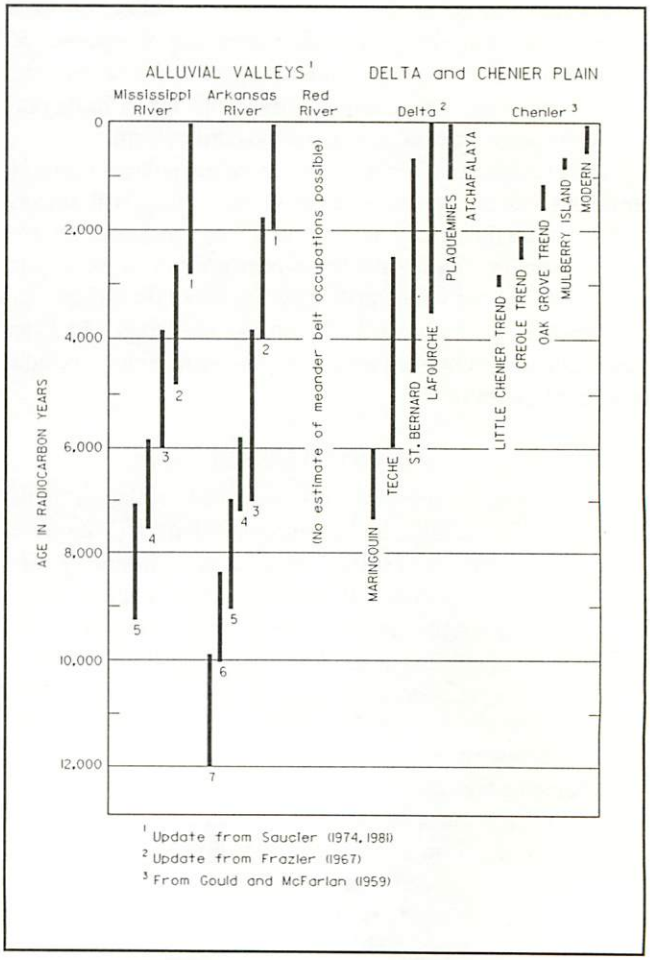

Figure 2. Estimates of meander-belt ages for Holocene alluvial valleys and ages of development of Mississippi River delta complexes and cheniers.

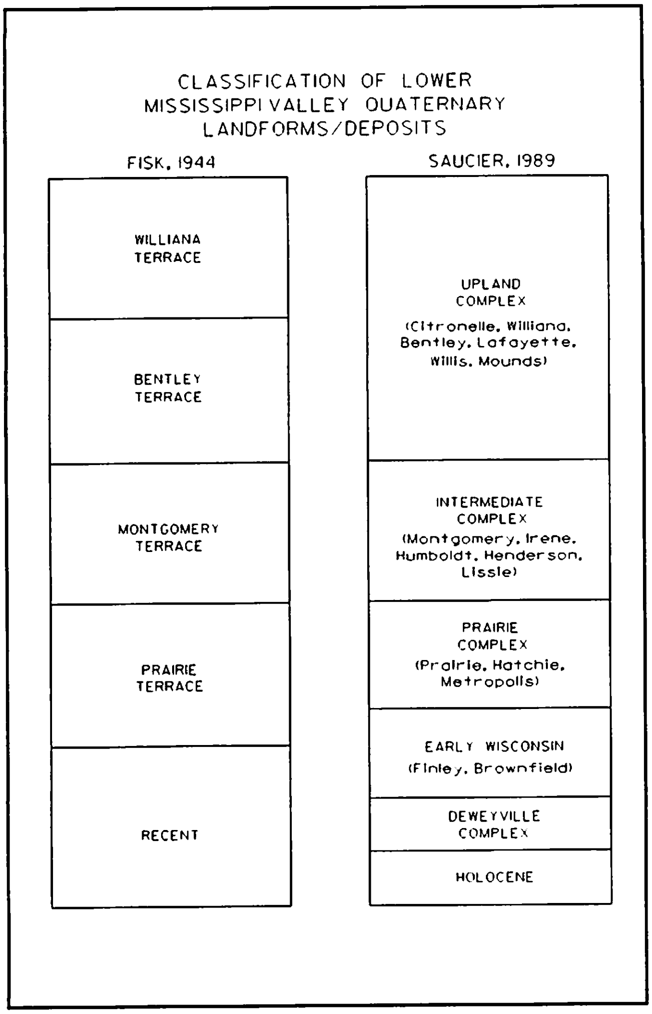

Figure 3. Classification of Lower Mississippi Valley Quaternary landforms/deposits.

The need to revise Fisk's simple 4-terrace classification arose because of eventual realization that the sequence of continental glaciations is far more complex than originally thought plus there is now a new concept of terrace formation. Figure 4 shows that rather than a progressive narrowing and downcutting of the Mississippi Valley as was postulated in the Fisk model (top), the valley has downcut but actually widened throughout the Quaternary (bottom). This has significant implications with regard to interpretations of the upland graveliferous deposits of north-central, west-central, and southwestern Mississippi. To make a long story short, it now appears that the vast majority of these deposits are Plio-Pleistocene in age (i.e., the Citronelle); however, there are erosional surfaces of Quaternary age present that represent responses to regional base level changes. Thus, we can say that topographic terraces are present but not depositional terraces a la Fisk. We also know that many of the deposits are of Appalachian origin; however, in some areas glacial erratics are incorporated indicating an upper Midwest glacial origin. Regrettably, they have not been delineated areally.

A methodology for unraveling some of the confusion over the upland Quaternary deposits exists, but it needs to be implemented more widely. Identification and correlation of geosols offers considerable promise as demonstrated by this north-south section through the Louisiana Florida Parishes from about New Orleans north to the state line (Figure 5). This approach badly needs to be extended northward into the southwestern corner of Mississippi.

A different application of this methodology involves the recognition and correlation of geosols in loess deposits capping the upland graveliferous deposits. This section (Figure 6) shows the results of preliminary correlations made by the late Bobby Miller. Three loess sheets are recognized at Vicksburg and five are recognized on Crowleys Ridge in eastern Arkansas. Notice the large gap in data from northern Mississippi. Filling this gap should shed much light on the age and origin of the underlying graveliferous deposits. Note that recognition criteria for loess geosols are available (Figure 7) as shown by this tabulation that will be one of several to appear in the DNAG chapter.

To summarize this section, much work remains to be done with regard to upland graveliferous deposits. Differentiation of the deposits according to source areas and ages and their regional correlation will take years of effort and obviously cannot be done before an update of the state map is needed. However, I recommend strongly that efforts be started now to critically examine and decide on a definition and classification scheme and to begin work on more detailed field mapping or areal differentiation. It is regrettable to have to say that Mississippi lags well behind all of its neighboring states in its mapping of upland Quaternary deposits.

APPLICATIONS

As I mentioned before, engineering applications have been the driving force behind the intensive work accomplished in the Mississippi Alluvial Valley; however, dozens of other applications have been made in such fields and activities as pedology, biology, hydrology, history, agronomy, archeology, agriculture, forestry, and land use planning. The mapping products available are readily adaptable to an unlimited number of applications in landscape analysis using Geographic Information Systems. As all of you are aware, Quaternary studies inherently are multidisciplinary and the disciplines contributing to and benefitting from them continue to increase in number. As an example, for the first time I am aware of, soil scientists have correlated soil types to alluvial deposits of various ages as shown in Figure 8, which is taken from the DNAG chapter in preparation. Similar correlations have been made for all major Quaternary units in Louisiana.

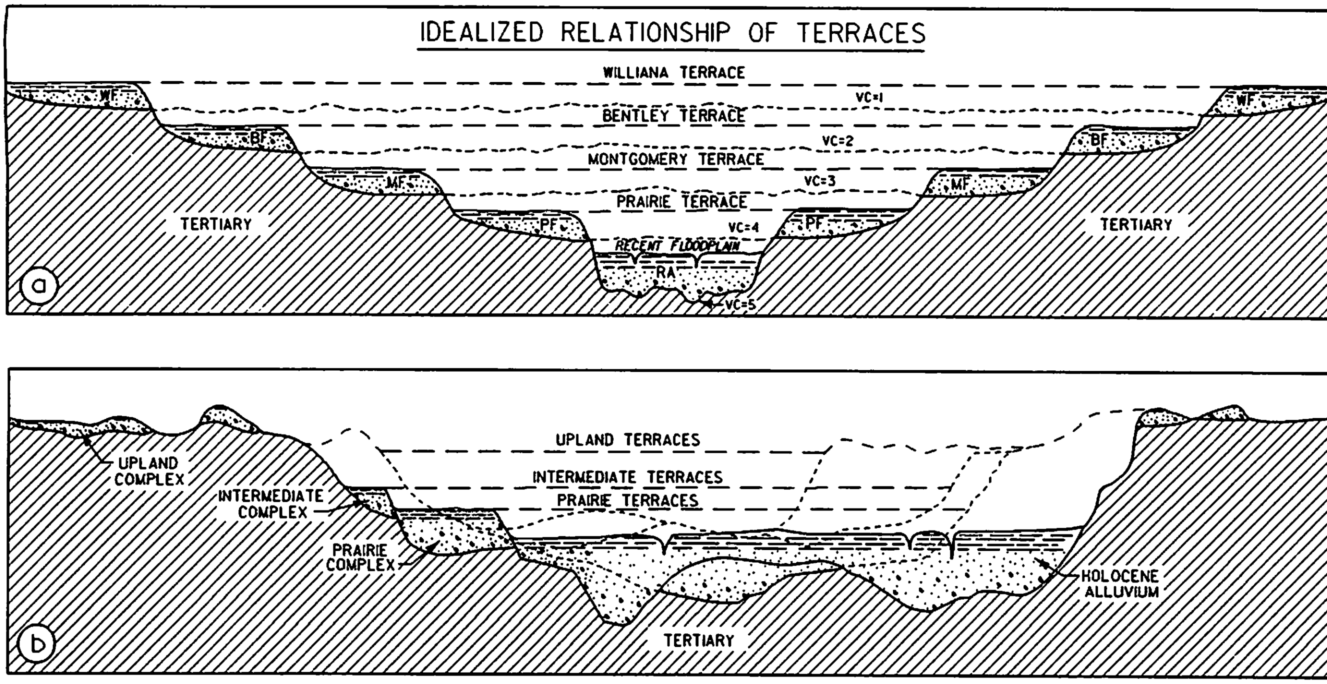

Figure 4. Idealized cross section of the Lower Mississippi Valley comparing (a) relationships of terraces as envisioned by Fisk (1944) with (b) the presently hypothesized concept.

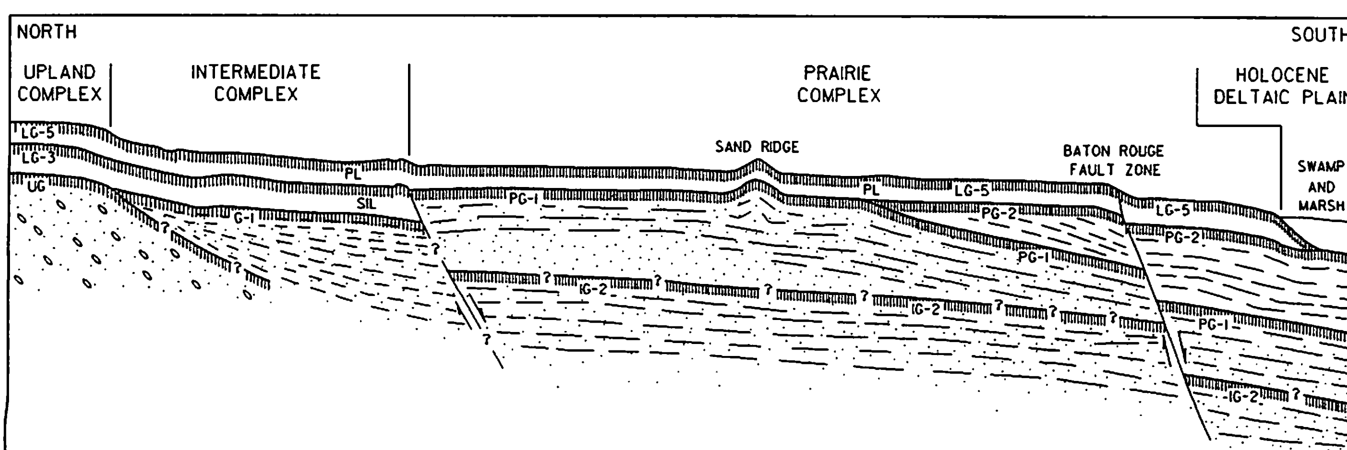

Figure 5. Diagrammatic north-south transect through the Florida Parishes of southeastern Louisiana showing interpretation of Quaternary geosols.

The upland Quaternary units long have been a valuable aggregate resource, but I feel certain that this use has not been fully exploited because of limited geologic mapping on a regional basis. I know of several industries that have conducted their own resource surveys, but have been frustrated by a lack of basic information for use in predicting trends. In the future, I foresee increased emphasis on these deposits from the viewpoint of environmental geology. Two critical areas will be groundwater quality and toxic and hazardous waste management.

ACKNOWLEDGMENT

Permission was granted by the Chief of Engineers to publish this information.

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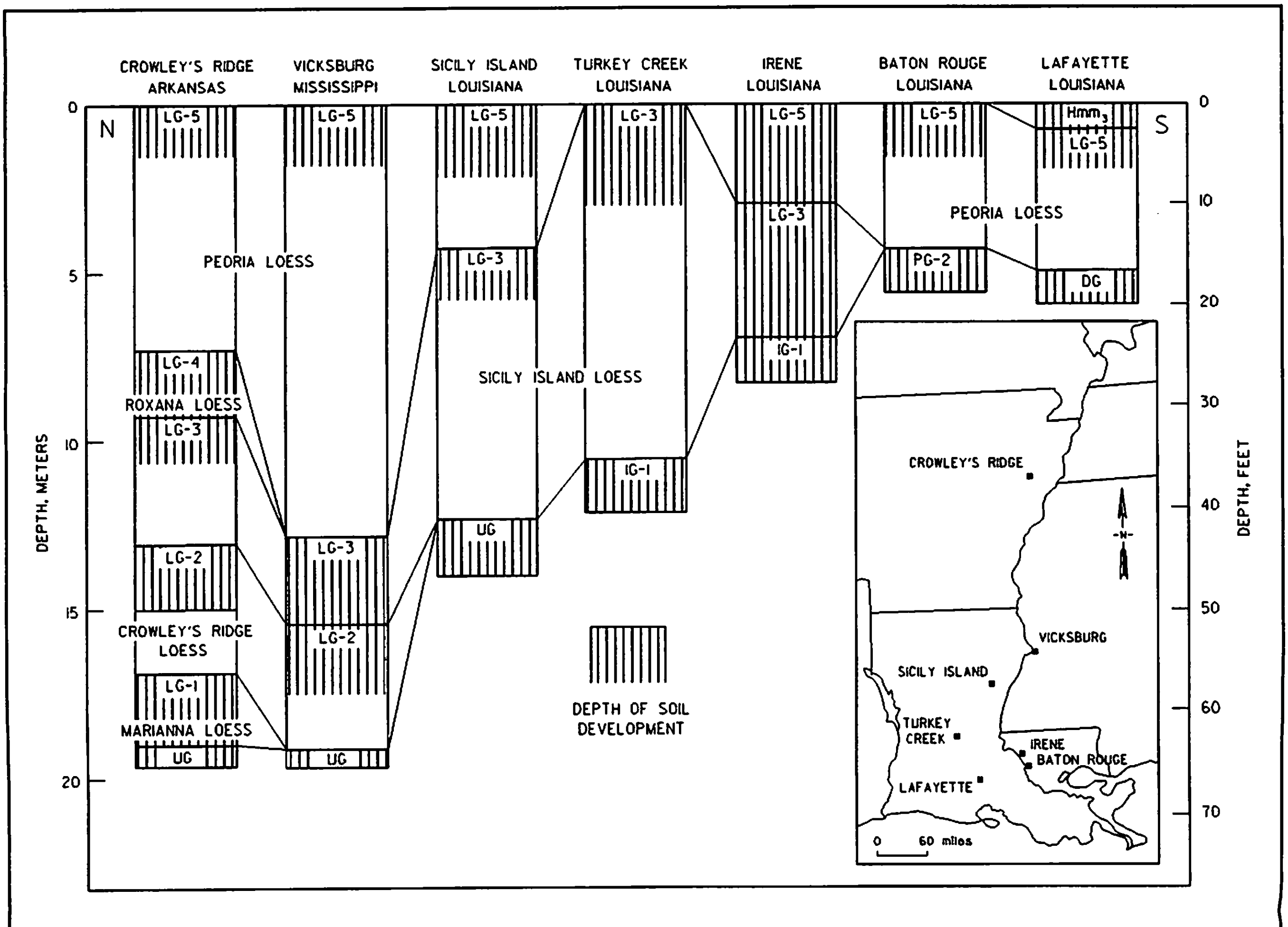

Figure 6. Correlation of Lower Mississippi Valley loesses and geosols.

COMPARISONS AMONG GEOSOLS DEVELOPED IN LOESSES IN THE LOWER MISSISSIPPI VALLEY

LOCATION	CROWLEY'S RIDGE, ARKANSAS	CROWLEY'S RIDGE, ARKANSAS	CROWLEY'S RIDGE, ARKANSAS	VICKSBURG, MISSISSIPPI	VICKSBURG, MISSISSIPPI	TURKEY CREEK, LOUISIANA	BATON ROUGE, LOUISIANA	LAFAYETTE, LOUISIANA
MATERIAL BURYING GEOSOL	PEORIA LOESS	ROXANA LOESS	CROWLEY'S RIDGE LOESS	PEORIA LOESS	SICILY ISLAND LOESS	NONE	NONE	HOLOCENE ALLUVIUM
PARENT MATERIAL AND GEOSOL	ROXANA LOESS (LG-4)	SICILY ISLAND LOESS (LG-3)	MARIANNA LOESS (LG-1)	SICILY ISLAND LOESS (LG-3)	CROWLEY'S RIDGE LOESS (LG-2)	SICILY ISLAND LOESS (LG-3)	PEORIA LOESS (LG-5)	PEORIA LOESS (LG-5)
CLASSIFICATION	TYPIC CRYOCHREPT (?)	(?)	TYPIC HAPLUDALF	TYPIC HAPLUDALF	TYPIC HAPLUDALF	ULTIC HAPLUDALF	TYPIC HAPLUDALF	TYPIC OCHRAQUALF
B HORIZON THICKNESS (CM)	100	118	231	188	198	250	142	193
HORIZON SEQUENCE	A-Bw-	A-Bt-Bw	A-Bt-	-Bt-Bw-	-Bt-C	A-E-Bw-Bt-Bc-C	Ap-Bt-Bw-C	-Bt-C
MAXIMUM CLAY CONTENT OF B HORIZON (%)	18	33	25	33	49	43	27	29

Figure 7. Comparisons among geosols developed in loesses in the Lower Mississippi Valley.

PEDOGENIC SUCCESSION IN SELECTED SOILS DEVELOPED ON DEPOSITS OF MISSISSIPPI RIVER MEANDER BELTS 1 THROUGH 5

MISSISSIPPI RIVER MEANDER BELT(S)	1	1,2,(3?)	3,4,5	1,2	1,2	3,4,5
SOIL SERIES	CONVENT	BRUIN	DUNDEE	COMMERCE	MHOON	DUNDEE
CLASSIFICATION	AERIC FLUVAQUENT	AQUIC FLUVENTIC EUTROCHREPT	AERIC OCHRAQUALF	AERIC FLUVAQUENT	TYPIC FLUVAQUENT	AERIC OCHRAQUALF
SOLUM THICKNESS RANGE (CM)	10 TO 25	45 TO 100	60 TO 150	50 TO 100	50 TO 125	60 TO 150
TYPICAL HORIZON SEQUENCE	A-C	A-Bw-C	A-Btg-Bg-Cg	A-B-C	A-Bt-Cg	A-Btg-Bg-Cg
CLAY CONTENT[1] (%)	<18	<18	18 TO 35	18 TO 35	18 TO 35	35 TO 60

MISSISSIPPI RIVER MEANDER BELTS(S)	1	1	1,2,3	3,4,5
SOIL SERIES	BARBARY	FAUSSE	SHARKEY	ALLIGATOR
CLASSIFICATION	TYPIC HYDRAQUENT	TYPIC FLUVAQUENT	VERTIC HAPLAQUEPT	VERTIC HAPLAQUEPT
SOLUM THICKNESS RANGE (CM)	0 TO 25	60 TO 125	90 TO 150	100 TO 150
TYPICAL HORIZON SEQUENCE	O-A-Cg	A-Bg-Cg	A-Bg-Cg	A-Bg-Cg
CLAY CONTENT (%)	>60	>60	>60	>60

[1]AVERAGE OF 25 TO 100 CM ZONE.

Figure 8. Pedogenic succession in selected soils developed on deposits of Mississippi River meander belts 1 through 5.

GEOLOGICAL MAPPING PROJECTS, COASTAL MISSISSIPPI; PAST RESULTS AND SUGGESTIONS FOR THE FUTURE

Ervin G. Otvos
Geology Section
Gulf Coast Research Laboratory
Ocean Springs, Mississippi

INTRODUCTION

Since 1970, one main research objective of the Gulf Coast Research Laboratory (GCRL) geology program has been the detailed reconstruction of Quaternary events on the Mississippi coast and adjacent northeastern Gulf coastal areas between the Mississippi River and the eastern Florida Panhandle "big bend" coast. Pleistocene deposits form most of the coastal plain. Detailed, reliable stratigraphic and applied geological documentation of these units is now required. In combination with field surveys, laboratory analysis data from several hundred cores were utilized during these nineteen years in an attempt to identify and distinguish between Pleistocene, Holocene and directly underlying Neogene units. As a result, we have described one new Pliocene formation as well as several Pleistocene formations and terrace units in recent years. The now obsolete terrace nomenclature and morphostratigraphic system of the area (e.g., Brown et al., 1944; based on Cooke, 1939) has also been significantly revised (Otvos, 1973).

Most of our research findings are documented in the form of detailed lithologic and microfossil logs and tabulations, based on drillcore samples. Concise documentation, including cross sections and small-scale maps, are available in various new publications, including papers, field trip guidebooks and the DNAG chapter on the northeastern Gulf coastal plain sector (Otvos, in press).

The demand is pressing for an update of the old and the construction of new middle- and large-scale regional and state geological maps. Accurate environmental and other applied geological maps that include coastal areas in the three states are also required. The most recent Mississippi state map (1969) exemplifies the urgent need for such a thorough update: a single, generalized "Holocene coastal deposits (Qc)" unit covers the entire length of the coast on this state geologic map. This symbol extends well inland in the form of two broad embayments around alluvial valleys and even spills over the surrounding highlands. If results of our field work would be utilized in a future updated Mississippi state map, locally up to seven accurately defined stratigraphic units, ranging in age from Pliocene to Holocene, would share the area of this "unit" instead. In addition to this update, we suggest that preparations should also be undertaken for the publication of larger-scale geological and environmental geological maps with detailed accompanying text to cover the three coastal counties of Mississippi.

NEAR-SURFACE AND SURFACE STRATIGRAPHIC UNITS, MISSISSIPPI COAST

The following is a list of stratigraphic units and previously proposed terms that, according to our past investigations, should be utilized in future geological surface and subcrop maps and charts that deal with the Mississippi coastal area. Old, apparently obsolete terms that should be discontinued are also noted. Brief comments accompany each item.

Neogene

Undifferentiated Nonmarine Clastics

The above is the proposed name for a thick, clayey, sandy-muddy and sandy, alluvial-paralic sequence, without accurately datable fossils or other age-diagnostic characteristics. Being generally overlain by younger deposits (north of the coastal plain, mostly by the Citronelle), only limited areas of the sequence are mappable, except on subcrop maps. Various portions of the sequence had been described as geological formations, on the basis of locally recognizable but non-diagnostic characteristics (e.g., consolidated, bluish green clays with sand lenses, etc.). Units in the sequence are presently referred to as the Middle Miocene Hattiesburg, the Upper Miocene Pascagoula and the Pliocene Graham Ferry formations. These formation designations, although widely cited in the local geological and hydrogeological literature, do not have valid paleontological, lithologic or other (unconformities, defined by buried soil zones, oxidized zones, lithology, etc.) stratigraphic support for their existence. They can not be satisfactorily delineated and correlated with units in other areas. We suggest that these terms be discontinued; only the term, shown in the above heading, should be retained.

In certain coastal drillholes the sequence can be defined as underlain by the well-defined Upper Oligocene and/or Lower Miocene *Heterostegina* Zone, by identifiable Catahoula (L. Miocene) beds or, as in southeastern Mississippi, by the Middle Miocene Amos Member of the Middle-to-Upper Miocene Pensacola Formation (Otvos, 1988).

Citronelle Formation

Late Pliocene, alluvial, clastic to coarse (gravel-bearing) clastic, redbeds in upland areas. North of the coastal area, where Citronelle-like deposits of unknown age overlie increasingly older units (e.g., the Catahoula, south of Jackson; Bicker, 1969), the term should be replaced by a more general designation (e.g., Neogene coarse clastics).

Pleistocene

Pre-Sangamonian Alluvial Deposits ("Big Ridge Formation")

These are alluvial deposits that include locally carbonized wood fragments and gravel layers. They underlie limited areas of relict level surfaces in coastal Mississippi and Alabama at 40-50 feet above sea level elevations. They occur significantly higher than the adjacent Prairie Formation surface. The deposits cover a sizable area north of the Big Ridge (fault ?) Scarp of the central Mississippi coast (Otvos, 1973, 1985) and apparently also occur east of the Pascagoula River in Jackson County.

Late Pleistocene Units

The Late Pleistocene Sangamonian interglacial transgressive-regressive cycle and high sea level stand were associated with the deposition of three separate, well and broadly recognizable formations (Otvos, 1973). These also occur along the entire length of the north Gulf coastal plain:

Biloxi Formation
Open marine-to-brackish estuarine muds and sandy muds, overlain by younger deposits. Found only in artificial exposures (roadcuts, channel excavations). May be mapped only in subcrop maps. Often underlies the Gulfport Formation.

Gulfport Formation
Shoreface-to-eolian dune sand barrier unit. This is the northeastern Gulf coast equivalent of the Texas-SE Louisiana ? Ingleside barrier ridge trend.

Prairie Formation
Alluvial complex, its extensive surface correlated with the youngest, Prairie, coastwise "terrace" surface in adjacent southeastern Louisiana. Interfingers with the Biloxi Formation.

Deweyville Alluvial Unit/Surface (Wisconsinan ?)

Narrow, intermediate stream valley terrace surfaces and meander belts, above (in elevation) the Holocene alluvium and cut into valley walls, which are usually composed of the Prairie Formation. These features are found in many coastal plain river valleys, including in the Pearl, Pascagoula and minor stream valleys of Mississippi. This unit may only be displayed on large-scale maps.

Holocene-Recent Units

Small-scale maps should show distinction between (a) alluvial floodplains, (b) subaerial river deltas, and (c) combined areas of recent mainland coastal barriers, barrier islands, Late Holocene relict barrier island and recent fresh water-, brackish- and salt-marsh deposit. More detailed maps should carry at least six of these subunits. Future, detailed coastal environmental geology maps should take advantage of charts compiled in past years by the GCRL Botany Section (Dr. L. Eleuterius and coworkers). These show various marsh categories in great detail and indicate not only the present distribution pattern of the state's marshlands, but also past changes in their distribution.

Future environmental geology charts should depict all the significant erosional (accretional) changes that have occurred during the past 140 years along our mainland and island shores.

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COMMENTS FROM THE U. S. ENVIRONMENTAL PROTECTION AGENCY

Nancy Bethune
U. S. Environmental Protection Agency
Region IV
Atlanta, Georgia

The following comments were taken from a memorandum written by John Dickinson, Acting Chief, Waste Engineering Section, and directed to Rebecca Slack, Chief, Information Services Staff, and dated November 15, 1988.

The Waste Engineering Section of the Environmental Protection Agency, Region IV, would like to have $7^1/_2$-minute quadrangle maps (preferably digitized), depicting information needed for the reissuance of current RCRA land disposal permits and the anticipated issuance of RCRA storage permits. Maps depicting the following information, as appropriate, are needed:

1. Evaluation of coastal zones affected by salt water encroachment.
2. Identification of areas of potential sinkhole development.
3. Fault, lineament, and fracture zone identification (targeted areas include the Salt Dome Province of Mississippi and Alabama, the southern Appalachians, the Piedmont Plateau, the Charleston Dome, the Nashville Dome).
4. Effects of major and minor stresses on thixotropic clays; the identification of areas with these kinds of clays.
5. Groundwater geochemical maps showing the relationship of water quality and rock type; soil geochemical maps.
6. Vertical permeability maps of regionally significant confining units, such as the Opaline Claystone at GSX and the Selma Chalk at Waste Management.
7. Regional maps and cross sections that show the approximate lateral and vertical extent (regional recharge and discharge) of primary drinking water aquifers; recharge areas for all major confined drinking water aquifers and zones of preferential vertical leakage through confining units should be identified.
8. Identification of areas where the regional aquifers exhibit artesian flow conditions.
9. Basic geologic maps and cross sections, with emphasis on the upper section of the sediment column (surface level to a depth of approximately 500 feet).
10. Hydrologic maps which will display the basic hydrologic units of an area, including hydraulic properties such as conductivity, permeability, transmissivity, and storage coefficient.

COMMENTS ON FORESTRY USES OF GEOLOGIC MAPS

Freddie Jordan
Mississippi Forestry Commission
Jackson, Mississippi

The following is a list of issues relating to forestry that may be useful in consideration of geologic maps.

1. Forest resource areas could be based upon the major surface soil structures.
2. Wetlands are becoming of great importance to workers in all areas of natural resources. A delineation of these areas, to include hydric soils, would be useful long into the future.
3. Any kind of information that can be used to assess and improve water quality (both surface and ground) problems is needed. This could include effects of certain practices on different soil types and, in many cases, subsoil structure as it relates to aquifer recharge and water movement.

APPENDIX A
MISGEOMAP Conference
List of Conferees

Bethune, Nancy
U. S. Environmental Protection Agency
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Bicker, Alvin R., Jr.
former State Geologist
Jackson, Mississippi

Bograd, Michael B. E.
Mississippi Bureau of Geology
Jackson, Mississippi

Bowen, Richard L.
University of Southern Mississippi
Hattiesburg, Mississippi

Cameron, Christopher P.
University of Southern Mississippi
Hattiesburg, Mississippi

Clevenger, Charlie
Mississippi Bureau of Land and Water Resources
Jackson, Mississippi

Copeland, Charles W.
Geological Survey of Alabama
Tuscaloosa, Alabama

Crawford, James
Mississippi Bureau of Land and Water Resources
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Dockery, David T., III
Mississippi Bureau of Geology
Jackson, Mississippi

Gann, Delbert E.
Millsaps College
Jackson, Mississippi

Gazzier, Conrad A.
Mississippi Bureau of Geology
Jackson, Mississippi

Haley, Boyd
Arkansas Geological Commission
Little Rock, Arkansas

Harrelson, Danny W.
U. S. Army Corps of Engineers
Vicksburg, Mississippi

Hinton, Robert B.
U.S.D.A. Soil Conservation Service
Jackson, Mississippi

Johnson, Henry
Mississippi Mineral Resources Institute
University, Mississippi

Jordan, Freddie
Mississippi Forestry Commission
Jackson, Mississippi

Keady, Donald M.
Mississippi State University
Starkville, Mississippi

Knox, S. Cragin
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Larson, Robert J.
Waterways Experiment Station
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Lucas, Wilmuth C.
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Lusk, Tracy W.
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Luther, Edward T.
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McCulloh, Richard P.
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Medlin, Jack H.
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Merrill, Robert K.
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Jackson, Mississippi

Miller, Edwin
U. S. Forest Service
Jackson, Mississippi

Moore, William H.
former State Geologist
Jackson, Mississippi

Newell, Wayne L.
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Reston, Virginia

Otvos, Ervin G.
Gulf Coast Research Laboratory
Ocean Springs, Mississippi

Owens, James P.
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Reston, Virginia

Parks, William S.
U. S. Geological Survey
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Patrick, David M.
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Hattiesburg, Mississippi

Reynolds, William R.
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University, Mississippi

Russell, Ernest E.
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Schrader, Edward L.
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Smith, Charles M.
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Swann, Charles T.
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University, Mississippi

Tourtelot, Harry A.
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Denver, Colorado

Williams, Norman F.
Arkansas Geological Commission
Little Rock, Arkansas