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TOWARD A REVISION OF THE GENERALIZED STRATIGRAPHIC COLUMN OF MISSISSIPPI

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INTRODUCTION

The stratigraphic columns presented here are a more informative revision on the state's 1981 column published as one sheet (Dockery, 1981). This revision was made for a future text on "An Overview of Mississippi's Geology" and follows the general format and stratigraphy as published in the Correlation of Stratigraphic Units of North America (COSUNA) charts (see Thomas and Osborne, 1987, and Dockery, 1988). The following discussion is a brief background, giving the major sources used in the chart preparations. Suggestions for improvements may be directed to the author.

PALEOZOIC STRATIGRAPHIC UNITS

All units shown in the Paleozoic stratigraphic column are from the Black Warrior Basin in northern Mississippi. Many of these units are known only from the subsurface, as Paleozoic outcrops of Devonian - Mississippian age are restricted to the Tennessee River Valley in Tishomingo County. Correlations with global and North America chronostratigraphic units are from Lindberg (1984, 1987), and the numerical time scale showing ages in millions of years (m.y. or Ma) at stage boundaries is from Harland et al. (1990).

The state's Precambrian subsurface stratigraphy is from Thomas and Osborne (1987), and the Cambrian-Pennsylvanian section is modified from Dockery (1981). References for the Cambrian-Ordovician section of the 1981 column include Mellen (1974, 1977); this stratigraphy is also found in Henderson (1991).

When subdivided in oil test records, the state's Ordovician section generally contains the Knox Dolomite, the Stones River Group (see Alberstadt and Repetski, 1989), and the Nashville Group, while the Silurian contains the Wayne Group and Brownsport Formation. The Tennessee Valley Authority's (1977) description of a 1,326-foot core hole at their proposed Yellow Creek Nuclear Plant site in northeastern Tishomingo County greatly refined the stratigraphy between the Lower Ordovician Knox Dolomite and the Ross Formation of Devonian age. This stratigraphy is shown in the updip Silurian section of the 1981 chart and is repeated here. Not shown on these charts are TVA's (1977) differentiation of the Middle Ordovician Stones River Group into formations, including in ascending order the Murfreesboro, Pierce, Ridley, and Lebanon limestones of Blackriverian age, and the Carters Limestone of Rocklandian age (see also Sauve, 1981). The latter section is like that of Column 11 (Cumberland Plateau and Adjacent Areas, Tennessee) of the COSUNA Southern Appalachian Region Correlation Chart

(Luther, 1984).

The Devonian-Pennsylvanian section presented here is similar to columns 17-19 of COSUNA's Texas-Oklahoma Tectonic Region Correlation Chart (Thomas and Osborne, 1987; Copeland, 1987) with the exception of the Ross Formation, which is not shown on the COSUNA chart. This Lower Devonian formation is the oldest rock to outcrop in the state and one of the few formations in the state containing trilobites (see Dockery and Merrill, 1984).

The Mississippian sections of both the 1981 and current Mississippi columns were drafted with the help of Black Warrior Basin geologist Stewart W. Welch. Published charts used as reference include Welch (1959, Figure 4), Thomas (1972a, Figure 10; see replies of Mellen, 1972, and Welch, 1972), Thomas (1972b, Figure 2), and Cleaves (1983, figures 1 and 2). Revisions to the current Mississippian section are: (1) the omission of Morse's (1930) archaic stratigraphy, which was also omitted by Merrill et al. (1988), (2) the truncation of the Bangor Limestone by the Carter Sand (as suggested by Rick Ericksen), and (3) the subdivision of the *Millerella* Zone into a lower "*Millerella* sand" and upper "*Millerella* limestone."

Mississippi's Pennsylvanian section in both the 1981 and current columns contains only the Pottsville Formation. However, this section is shown by Thomas and Osborne (1987) to reach thicknesses of 5,900 to 9,180 feet in the subsurface of Oktibbeha County. It contains important coal resources in Clay County and elsewhere (Mellen, 1949; Ericksen, 1992).

No rocks of Permian age are shown to occur in the state on the current or 1981 columns; however, Permian-age metamorphic basement rocks are known to occur in the Wiggins Uplift of Jackson County in southern Mississippi. Here Champlin Oil Company geologists found metamorphic rocks at 18,678-18,689 feet in their No. 1 International Paper Company well with an radiometric age of 282±14 million years. This age is similar to the 272 million year age of basement rock from the nearby Amoco No. 1 Cumbest well (Harrelson and Jennings, 1990). These rocks indicate the Permian to be a time of mountain building and erosion in Mississippi.

MESOZOIC STRATIGRAPHIC UNITS

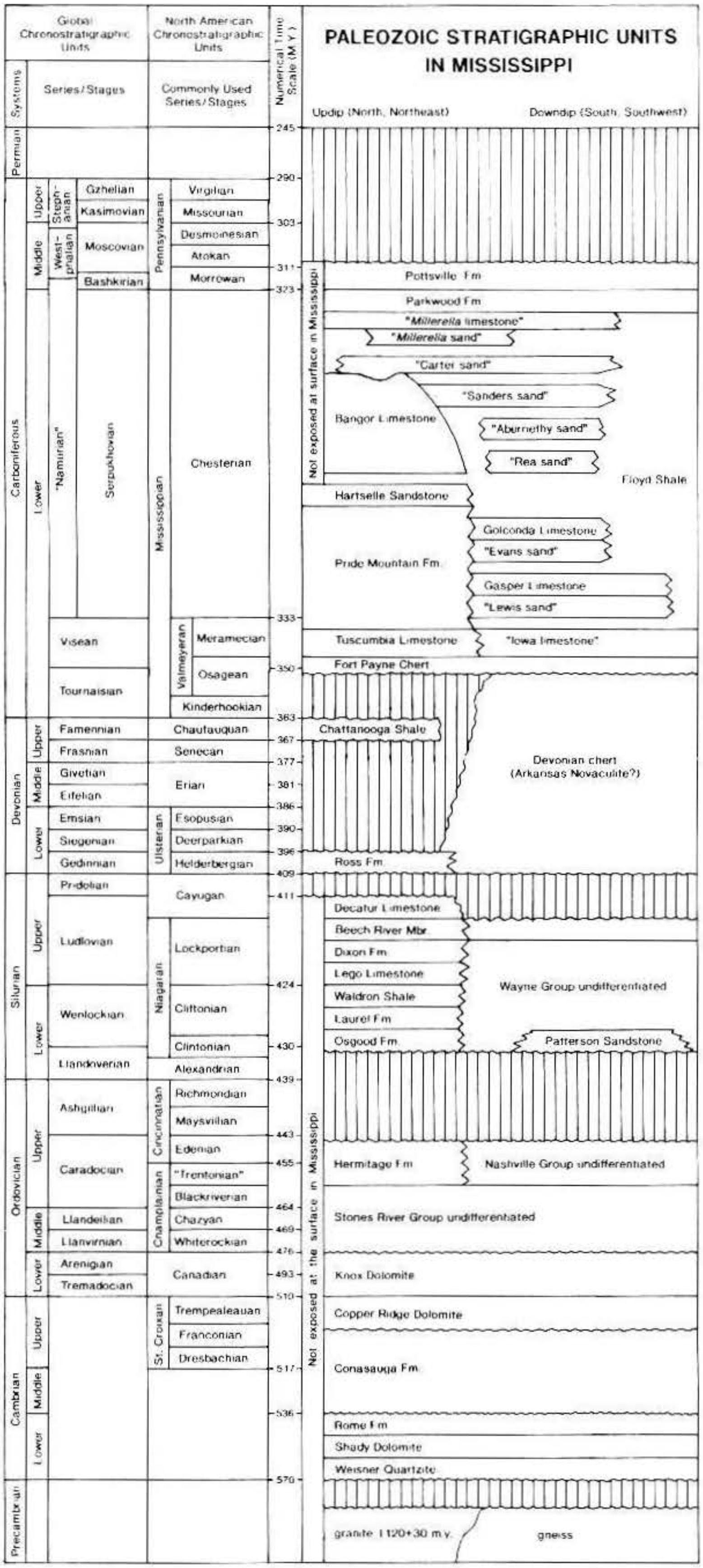
The Triassic - basal Lower Cretaceous section of the 1981 column followed that given in Dinkins et al. (1968, Plate 1) with the addition of an informal unit, the B Limestone, in the upper Cotton Valley Group. This unit is recognized mainly in northern Louisiana and is not included in the column presented here. Also the Schuler Formation and its Shongaloo and Dorcheat members are dropped because of disuse in the state, and the Cotton Valley Group is shown as an undifferentiated section of both Jurassic and Cretaceous age. New Jurassic units appearing in this column are the Pine Hill Anhydrite Member, which overlies the Louann Salt, and the Frisco City Sand, a facies of the Buckner Anhydrite. These units are present on the flanks of the basement metamorphic rocks at the core of the Wiggins Uplift in southern Mississippi (Rhodes and Maxwell, 1993).

The Lower Cretaceous section of the 1981 column is essentially that published by Nunnally and Fowler (1954) and Devery (1981, 1982), with the exception that it recognizes the Stuart City-Edwards-Glen Rose "Reef" trend in the subsurface of southern Mississippi and the James Limestone as a downdip equivalent of the Rodessa Formation. This section has not been modified in the column presented here.

The Upper Cretaceous section of the new column includes several revisions over the 1981 column. Hiatuses are shown above and below the Tuscaloosa Group, and the Eagle Ford Shale is placed in the Tuscaloosa Group rather than as a downdip equivalent to the McShan Formation of the Eutaw Group. Palynology studies indicate the McShan to be of Santonian age (Smith and Mancini, 1983), and thus not an equivalent to the Turonian Eagle Ford. Forgotson (1958) recognized problems with the McShan-Eagle Ford correlation and argued that the Eagle Ford was below the Austin unconformity. The shale above this unconformity he named the Rapides Formation. This unit was correlated from Louisiana into Mississippi by Spooner (1964) and is adopted here.

Additions to the Campanian section (Selma Group) of the new column include the transgressive sands of the Sardis Formation (Russell, 1986, Figure 3) and the "Frankstown sand" (Manning and Dockery, 1992), which overlie the Coffee Sand. Also the Demopolis Formation is further divided into a lower Tibbee Creek Marl Member and a "middle chalk member" (in place of Russell's Artesia Chalk Member, the name Artesia being preoccupied) after Russell *in* Hancock et al. (1992, Figure 1).

The planktonic foraminiferal zonation of the Mesozoic column begins in the Lower Cretaceous and is taken from Caron (1985). In ascending order according to stages, these zones are the **Hauterivian** *Globuligerina hoterivica*, the **Barremian** *Hedbergella sigali*, the **Aptian** *Globigerinelloides blowi*, *Schakoina cabri*, *Globigerinelloides algeriana*, and *Hedbergella gorbachikae*, the **Albian** *Ticinella bejaouensis*, *Ticinella primula*, *Biticinella breggiensis*, *Rotalipora subticinensis*, *Rotalipora ticinensis*, and *Rotalipora appenninica*, the **Cenomanian** *Rotalipora brotzeni*, *Rotalipora reicheli*, and *Rotalipora cushmani*, the **Turonian** *Whiteinella archeocretacea*, *Helvetoglobotruncana helvetica*, and *Marginotruncana sigali*, the **Coniacian** *Dicarinella primitiva* and *Dicarinella concavata*, the **Santonian** *Dicarinella asymetrica*, the **Campanian** *Globotruncanita elevata*, *Globotruncana ventricosa*, and *Globotruncanita calcarata*, and the **Maastrichtian** *Globotruncanella havanensis*, *Globotruncana aegyptiaca*, *Gansserina gansseri*, and *Abathomphalus mayaroensis*. The CC (=Cretaceous cal-


PALEOZOIC STRATIGRAPHIC UNITS IN MISSISSIPPI
Global Chronostratigraphic Units
North American Chronostratigraphic Units
Numerical Time Scale (M.Y.)
Systems
Series/Stages
Commonly Used Series/Stages
Updip (North, Northeast)
Downdip (South, Southwest)
Permian
245
290
303
311
323
333
350
363
367
377
381
386
390
396
409
411
424
430
439
443
455
464
469
476
493
510
517
536
570
Carboniferous
Upper
Middle
Lower
Stephanian
Westphalian
"Namurian"
Gzhelian
Kasimovian
Moscovian
Bashkirian
Serpukhovian
Visean
Tournaisian
Pennsylvanian
Virgilian
Missourian
Desmoinesian
Atokan
Morrowan
Mississippian
Chesterian
Valmeyeran
Meramecian
Osagean
Kinderhookian
Pottsville Fm.
Parkwood Fm.
"Millerella limestone"
"Millerella sand"
"Carter sand"
"Sanders sand"
Bangor Limestone
"Abernethy sand"
"Rea sand"
Floyd Shale
Hartselle Sandstone
Golconda Limestone
"Evans sand"
Pride Mountain Fm.
Gasper Limestone
"Lewis sand"
Tuscumbia Limestone
"Iowa limestone"
Fort Payne Chert
Devonian
Famennian
Frasnian
Givetian
Eifelian
Emsian
Siegenian
Gedinnian
Chautauquan
Senecan
Erian
Ulsterian
Esopusian
Deerparkian
Helderbergian
Chattanooga Shale
Devonian chert
(Arkansas Novaculite?)
Ross Fm.
Silurian
Pridolian
Ludlovian
Wenlockian
Llandoverian
Cayugan
Niagaran
Lockportian
Cliftonian
Clintonian
Alexandrian
Decatur Limestone
Beech River Mbr.
Dixon Fm.
Lego Limestone
Waldron Shale
Laurel Fm.
Osgood Fm.
Wayne Group undifferentiated
Patterson Sandstone
Ordovician
Ashgillian
Caradocian
Llandeilian
Llanvirnian
Arenigian
Tremadocian
Cincinnatian
Richmondian
Maysvillian
Edenian
Champlainian
"Trentonian"
Blackriveran
Chazyan
Whiterockian
Canadian
Hermitage Fm.
Nashville Group undifferentiated
Stones River Group undifferentiated
Knox Dolomite
Cambrian
St. Croixan
Trempealeauan
Franconian
Dresbachian
Copper Ridge Dolomite
Conasauga Fm.
Rome Fm.
Shady Dolomite
Weisner Quartzite
Precambrian
granite 1120±30 m.y.
gneiss
Not exposed at surface in Mississippi
Not exposed at the surface in Mississippi

careous nannoplankton) zonation is that of Sissingh (1977) as illustrated in Perch-Nielsen (1985, Figure 7), only without showing subzones (i.e. those labeled a, b, or c).

Mesozoic radiometric ages are from Gradstein et al. (1995), and closely follow the ages of Obradovich (1993) for much of the Cretaceous interval. Of particular interest are two locally obtained radiometric ages. The first is the 84.2 m.y. age shown for the Tombigbee Sand below the Santonian/Campanian boundary (Obradovich, 1988, p. 760 as 84.2±0.9 Ma; 1993, locality 12, p. 383 as 84.09±0.40 Ma). This age was determined for sanidine from the basal Tombigbee bentonite mined at Aberdeen, Mississippi. The second is the 75.4 m.y. age shown for the Demopolis Formation, an unpublished age by Obradovich (personal communication) for sanidine associated with a biotite layer in the middle chalk member exposed in an exploratory trench of the Holnam Inc. Quarry south of Artesia, Mississippi (Schmitz and Russell, 1994).

CENOZOIC STRATIGRAPHIC UNITS

The Paleogene section of the 1981 column generally followed that shown for Mississippi in Dockery (1980, Figure 1) as modified from Hughes (1958) and Williamson (1976). The revised column more closely follows that of Mancini and Tew (1991, Figure 2), especially in its correlation of the lithostratigraphy with calcareous nannofossil and planktonic foraminiferal zones and global chronostratigraphic units, with the exception that the Thanetian Stage is added to the Paleocene following Berggren et al (1995). Radiomertic ages given at stage boundaries are from Berggren et al. (1995). Dates of regional interest are two ages of 34.3 m. y. (Obradovich et al., 1993) and 33.7 m.y. (Obradovich and Dockery, 1996) obtained from bentonites in the Yazoo Clay; the latter age is at or near the Eocene/Oligocene boundary.

Revisions in the Paleocene and Lower Eocene section (Midway - Lower Claiborne groups) follow progress in recent surface mapping activities. The Naheola and Nanafalia formations are subdivided into members (Thompson, 1995), and the Greggs Landing and Bells Landing members are recognized in the Tuscahoma Formation (Steve Ingram, personal communication). Revisions in the Oligocene section include recognition of the Frio Formation, now an oil objective in southwestern Mississippi (Champlin, 1995). Hiatuses below the Eocene Meridian Sand and Oligocene Waynesboro Sand are from Ingram (1992) and Johnson (1982), respectively. The hiatus beneath the Mint Spring Formation is in recognition of its diachronous age from NP21 in eastern Mississippi to NP22 in the western part of the state. The Neogene section of the revised column is much the same as the classical stratigraphy (i.e. Brown et al., 1944) shown in the 1981 column despite criticisms from May et al. (1995), Otvos (1995), and others. Correlations of this stratigraphy with global chronostratigraphic units and planktonic microfossil zones is problematic (note the questionmarks at contacts), but follows that of COSUNA's Gulf Coast Region Correlation Chart (Dockery, 1988, column 14).

Correlations of Paleogene microfossil zonations are from Mancini and Tew (1991) with P = Paleogene planktonic Foraminifera and NP = Nannoplankton Paleogene (Martini, 1971). Paleogene planktonic foraminiferal interval zones (or range zones where so cited) designated by key species are from Mancini and Tew (1991) as adopted from Bolli (1957, 1966) and others. In ascending order, these are the **Paleocene** *Subbotina pseudobulloides*, *Subbotina trinidadensis*, *Morozovella uncinata*, *Morozovella angulata*, *Planorotalites pusilla pusilla*, *Planorotalites pseudomenardii* (Range Zone), and *Morozovella velascoensis* zones, the **Eocene** *Morozovella subbotinae*, *Hantkenina aragonensis*, *Globigerapsis subconglobata* (Concurrent-Range Zone), *Orbulinoides beckmanni* (Range Zone), *Truncorotaloides rohri*, *Porticulasphaera semiinvoluta*, and *Globorotalia cerroazulensis* zones, and the **Oligocene** *Pseudohastigerina micra, Globigerina amplispertura, Globorotalia opima opima* (Range Zone), and *Globigerina ciperoensis* zones. Correlations of Neogene planktonic microfossil zones are from the COSUNA Gulf Coast Region Correlation Chart(Lindberg, 1988) with N = Neogene planktonic Foraminifera and NN = Nannoplankton Neogene (Martini, 1971). Microfossil zones are not continued into the Pliocene and Pleistocene where the COSUNA chart and the *Plankton Stratigraphy* of Bolli et al. (1985) are in conflict. Also, the planktonic stratigraphy of this interval has little relevance to the marginal marine facies of the Mississippi's Pliocene/Pleistocene section.

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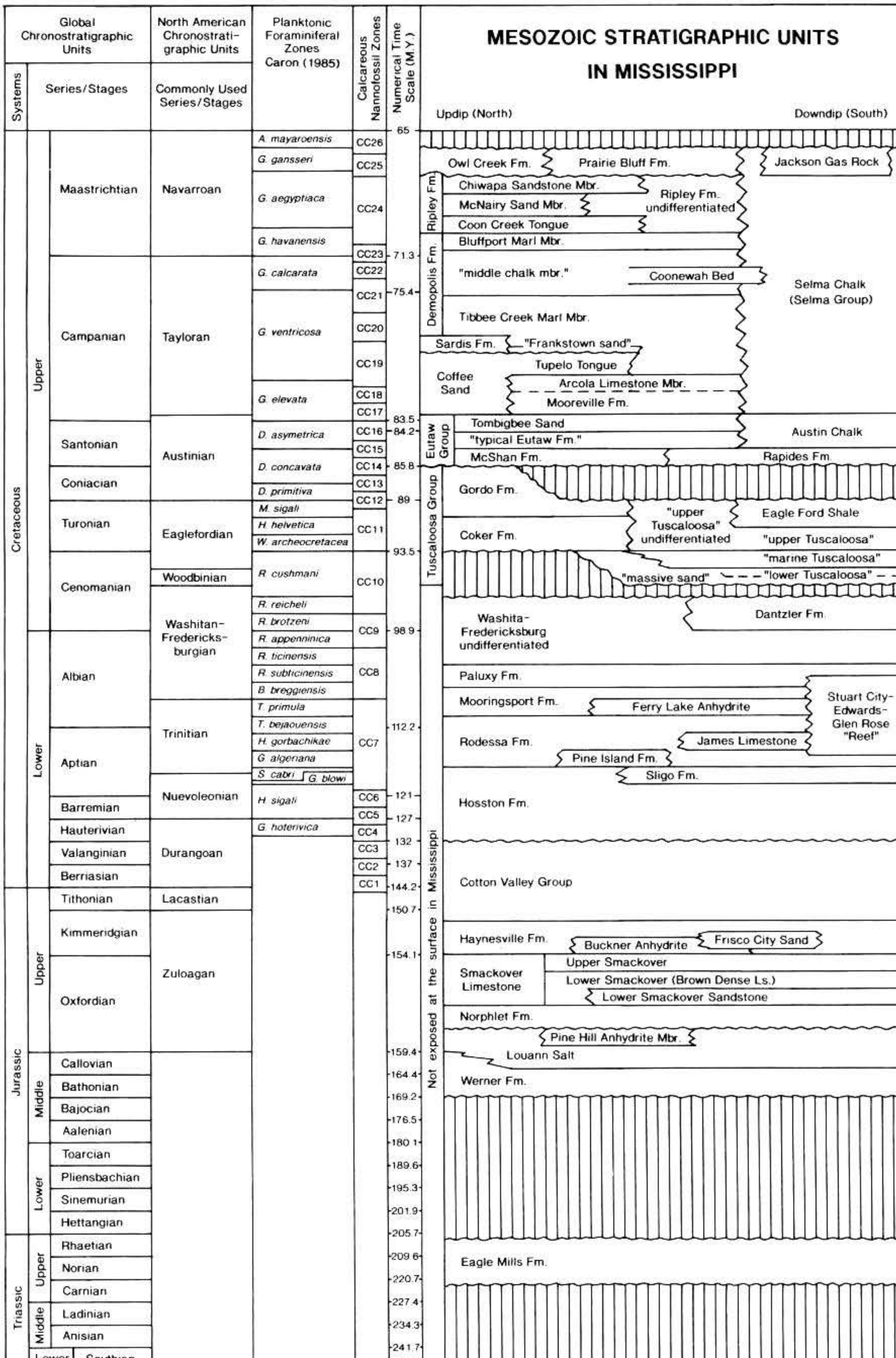

MESOZOIC STRATIGRAPHIC UNITS IN MISSISSIPPI
Global Chronostratigraphic Units
Systems
Series/Stages
North American Chronostrati-graphic Units
Commonly Used Series/Stages
Planktonic Foraminiferal Zones Caron (1985)
Calcareous Nannofossil Zones
Numerical Time Scale (M.Y.)
Updip (North)
Downdip (South)
Cretaceous
Upper
Lower
Maastrichtian
Campanian
Santonian
Coniacian
Turonian
Cenomanian
Albian
Aptian
Barremian
Hauterivian
Valanginian
Berriasian
Jurassic
Upper
Middle
Lower
Tithonian
Kimmeridgian
Oxfordian
Callovian
Bathonian
Bajocian
Aalenian
Toarcian
Pliensbachian
Sinemurian
Hettangian
Triassic
Upper
Middle
Lower
Rhaetian
Norian
Carnian
Ladinian
Anisian
Scythian
Navarroan
Tayloran
Austinian
Eaglefordian
Woodbinian
Washitan-Fredericks-burgian
Trinitian
Nuevoleonian
Durangoan
Lacastian
Zuloagan
A. mayaroensis
G. gansseri
G. aegyptiaca
G. havanensis
G. calcarata
G. ventricosa
G. elevata
D. asymetrica
D. concavata
D. primitiva
M. sigali
H. helvetica
W. archeocretacea
R. cushmani
R. reicheli
R. brotzeni
R. appenninica
R. ticinensis
R. subticinensis
B. breggiensis
T. primula
T. bejaouensis
H. gorbachikae
G. algeriana
S. cabri
G. blowi
H. sigali
G. hoterivica
CC26
CC25
CC24
CC23
CC22
CC21
CC20
CC19
CC18
CC17
CC16
CC15
CC14
CC13
CC12
CC11
CC10
CC9
CC8
CC7
CC6
CC5
CC4
CC3
CC2
CC1
65
71.3
75.4
83.5
84.2
85.8
89
93.5
98.9
112.2
121
127
132
137
144.2
150.7
154.1
159.4
164.4
169.2
176.5
180.1
189.6
195.3
201.9
205.7
209.6
220.7
227.4
234.3
241.7
Owl Creek Fm.
Prairie Bluff Fm.
Jackson Gas Rock
Ripley Fm.
Chiwapa Sandstone Mbr.
McNairy Sand Mbr.
Ripley Fm. undifferentiated
Coon Creek Tongue
Bluffport Marl Mbr.
Demopolis Fm.
"middle chalk mbr."
Coonewah Bed
Selma Chalk (Selma Group)
Tibbee Creek Marl Mbr.
Sardis Fm.
"Frankstown sand"
Tupelo Tongue
Coffee Sand
Arcola Limestone Mbr.
Mooreville Fm.
Eutaw Group
Tombigbee Sand
"typical Eutaw Fm."
Austin Chalk
McShan Fm.
Rapides Fm.
Tuscaloosa Group
Gordo Fm.
"upper Tuscaloosa" undifferentiated
Eagle Ford Shale
Coker Fm.
"upper Tuscaloosa"
"marine Tuscaloosa"
"massive sand"
"lower Tuscaloosa"
Washita-Fredericksburg undifferentiated
Dantzler Fm.
Paluxy Fm.
Mooringsport Fm.
Ferry Lake Anhydrite
Stuart City-Edwards-Glen Rose "Reef"
Rodessa Fm.
James Limestone
Pine Island Fm.
Sligo Fm.
Hosston Fm.
Not exposed at the surface in Mississippi
Cotton Valley Group
Haynesville Fm.
Buckner Anhydrite
Frisco City Sand
Smackover Limestone
Upper Smackover
Lower Smackover (Brown Dense Ls.)
Lower Smackover Sandstone
Norphlet Fm.
Pine Hill Anhydrite Mbr.
Louann Salt
Werner Fm.
Eagle Mills Fm.

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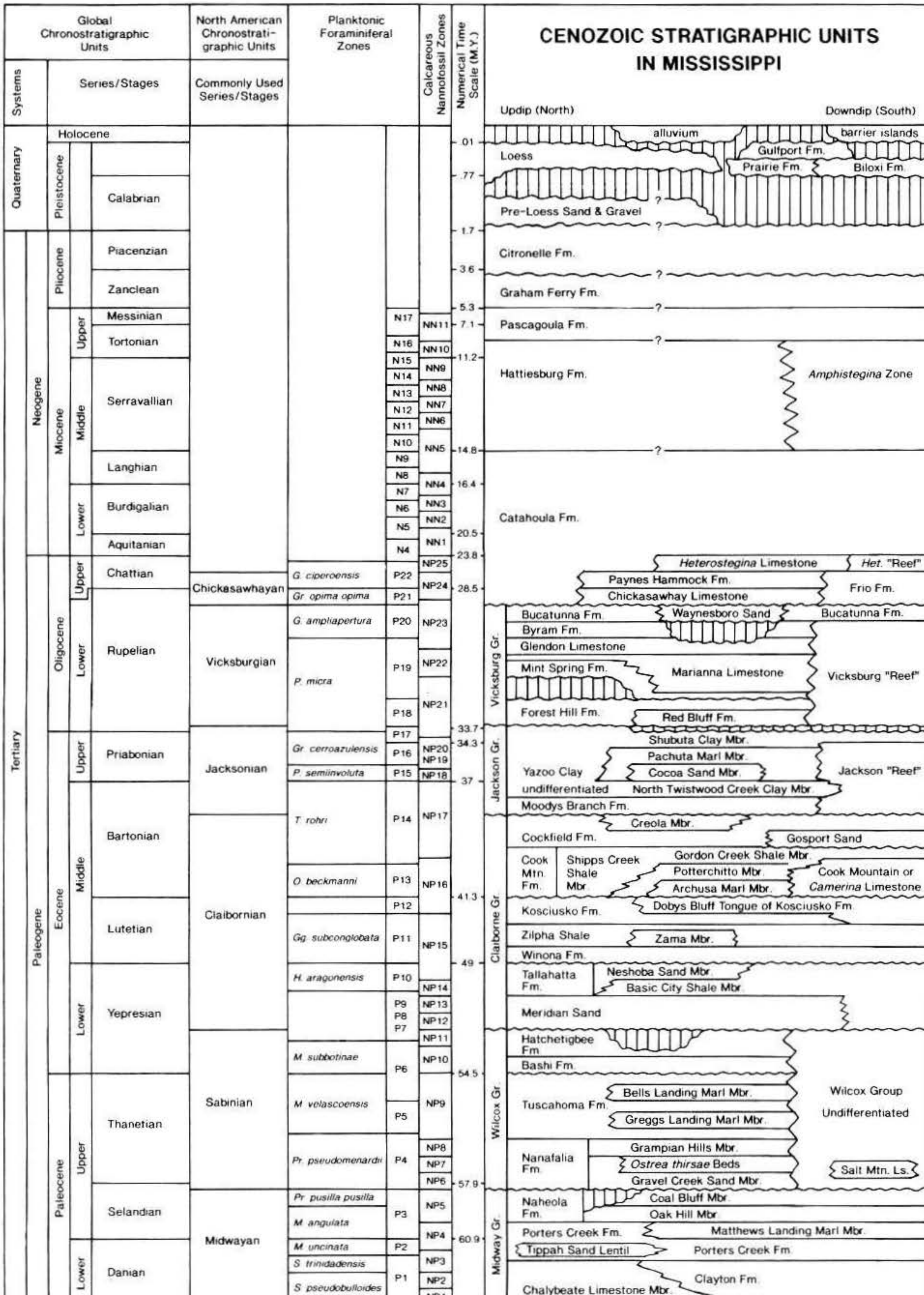
CENOZOIC STRATIGRAPHIC UNITS IN MISSISSIPPI
Global Chronostratigraphic Units
Systems
Series/Stages
North American Chronostratigraphic Units
Commonly Used Series/Stages
Planktonic Foraminiferal Zones
Calcareous Nannofossil Zones
Numerical Time Scale (M.Y.)
Updip (North)
Downdip (South)
Quaternary
Holocene
Pleistocene
Calabrian
Tertiary
Neogene
Pliocene
Piacenzian
Zanclean
Miocene
Upper
Messinian
Tortonian
Middle
Serravallian
Langhian
Lower
Burdigalian
Aquitanian
Paleogene
Oligocene
Chattian
Rupelian
Eocene
Priabonian
Bartonian
Lutetian
Yepresian
Paleocene
Thanetian
Selandian
Danian
Chickasawhayan
Vicksburgian
Jacksonian
Claibornian
Sabinian
Midwayan
G. ciperoensis
Gr. opima opima
G. ampliapertura
P. micra
Gr. cerroazulensis
P. semiinvoluta
T. rohri
O. beckmanni
Gg. subconglobata
H. aragonensis
M. subbotinae
M. velascoensis
Pr. pseudomenardii
Pr. pusilla pusilla
M. angulata
M. uncinata
S. trinidadensis
S. pseudobulloides
N17
N16
N15
N14
N13
N12
N11
N10
N9
N8
N7
N6
N5
N4
P22
P21
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23.8
28.5
33.7
34.3
37
41.3
49
54.5
57.9
60.9
alluvium
barrier islands
Loess
Gulfport Fm.
Prairie Fm.
Biloxi Fm.
Pre-Loess Sand & Gravel
Citronelle Fm.
Graham Ferry Fm.
Pascagoula Fm.
Hattiesburg Fm.
Amphistegina Zone
Catahoula Fm.
Heterostegina Limestone
Het. "Reef"
Paynes Hammock Fm.
Frio Fm.
Chickasawhay Limestone
Vicksburg Gr.
Bucatunna Fm.
Waynesboro Sand
Bucatunna Fm.
Byram Fm.
Glendon Limestone
Mint Spring Fm.
Marianna Limestone
Vicksburg "Reef"
Forest Hill Fm.
Red Bluff Fm.
Jackson Gr.
Shubuta Clay Mbr.
Pachuta Marl Mbr.
Yazoo Clay
Cocoa Sand Mbr.
Jackson "Reef"
undifferentiated
North Twistwood Creek Clay Mbr.
Moodys Branch Fm.
Claiborne Gr.
Creola Mbr.
Cockfield Fm.
Gosport Sand
Gordon Creek Shale Mbr.
Cook Mtn. Fm.
Shipps Creek Shale Mbr.
Potterchitto Mbr.
Cook Mountain or
Archusa Marl Mbr.
Camerina Limestone
Kosciusko Fm.
Dobys Bluff Tongue of Kosciusko Fm.
Zilpha Shale
Zama Mbr.
Winona Fm.
Tallahatta Fm.
Neshoba Sand Mbr.
Basic City Shale Mbr.
Meridian Sand
Wilcox Gr.
Hatchetigbee Fm.
Bashi Fm.
Bells Landing Marl Mbr.
Wilcox Group
Tuscahoma Fm.
Undifferentiated
Greggs Landing Marl Mbr.
Nanafalia Fm.
Grampian Hills Mbr.
Ostrea thirsae Beds
Salt Mtn. Ls.
Gravel Creek Sand Mbr.
Midway Gr.
Naheola Fm.
Coal Bluff Mbr.
Oak Hill Mbr.
Porters Creek Fm.
Matthews Landing Marl Mbr.
Tippah Sand Lentil
Porters Creek Fm.
Clayton Fm.
Chalybeate Limestone Mbr.

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PRELIMINARY PALEONTOLOGICAL REPORT ON THE FORAMINIFERA OF THE MOSSY GROVE CORE, HINDS COUNTY, MISSISSIPPI

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INTRODUCTION

The Mossy Grove core was completed in September 1991 as a joint project of the Mississippi Office of Geology and the Department of Geology of the University of Southern Mississippi. The purpose of the core was to obtain a complete, unweathered section of the Yazoo Clay (Dockery et al., 1991). The core encountered sections of the Forest Hill Formation, the Yazoo Clay, the Moodys Branch Formation, and the Creola Member of the Cockfield Formation. A detailed account of the lithostratigraphy of the Mossy Grove core is included in Dockery et al. (1991).

The cored interval includes formations known worldwide for their well preserved and diverse foraminiferal faunas. These have been described in numerous papers over the years but the two most comprehensive studies were those of Cushman (1935) and Bandy (1949). Both of these studies were limited by the nature of outcrops of the Jackson Group. Cushman (1935) used a series of discontinuous outcrops from throughout the eastern Gulf Coastal Plain to construct a biostratigraphic picture of the Jackson foraminiferal fauna. The section at Little Stave Creek, Clarke County, Alabama, studied by Bandy (1949) contains several covered intervals within the Yazoo Clay portion of the Jackson Group.

The Mossy Grove core has provided an opportunity to collect and study foraminifera at a regular sample interval through a continuous section of the Jackson Group. This allowed the study of species ranges and faunal assemblages with reference to a single geographic point. It is the purpose of this paper to report the preliminary results of the study of the Mossy Grove foraminifera.

METHODS

The Mossy Grove core was sampled at 2-foot intervals from the base of the Forest Hill Formation (at 38 feet) through the upper fossiliferous zone of the Cockfield Formation (base at 512 feet). This sampling interval was selected so that biostratigraphic datums could be located as precisely as possible. Sampling at this scale also permits identification of short-term fluctuations in paleoecologic conditions. A total of 274 samples was collected from the Mossy Grove core for this study.

All samples were split in the laboratory and half of the total was archived at Ball State University. The remainder was split again and a portion reserved for foraminiferal study. The other portion was sent to Dr. M.-P. Aubry of Woods Hole Oceanographic Institution for study of the calcareous nannofossils.

The samples were placed in beakers and dried at 100 degrees Celsius for 24 hours. The samples were then soaked in water for 24 hours. All samples were then washed through a 60 μ sieve. The resultant material was again dried at 100 degrees Celsius for 24 hours. Each sample was then broken into three parts by dry sieving: a >250 μ fraction, a >150 μ fraction, and a <150μ fraction. For biostratigraphic purposes, all fractions were studied. For paleoecologic study, only the >150 μ fraction will be examined.

RESULTS

Planktonic Foraminifera

Planktonic foraminifera were collected from all units of the Mossy Grove core with the exception of the Cockfield Formation. The abundance of planktonic foraminifera through the Moodys Branch Formation and Yazoo Clay has enabled assignment of those units in the Mossy Grove core to biozones. The zonal scheme used in this study is essentially that of Stainforth et al. (1975) with modifications by Berggren and Miller (1988). The taxonomy employed is that of Stainforth et al. (1975) and Blow (1979).

The Moodys Branch Formation and the lower 92 feet of the Yazoo Clay in the Mossy Grove core are assigned to the *Truncorotaloides rohri* Zone (Zone P14). This assignment is based on the sporadic occurrence of *Truncorotaloides rohri* throughout this interval. In the Mossy Grove core, the highest occurrence of *T. rohri* is at the 408 foot mark. Other planktonic foraminifera present in this interval include:

Globigerina eoceana
Globigerina corpulenta
Globigerina officialnis
Globigerina venezuelana
Globigerina increbescens
Globigerina ouachtaensis
Globigerina tripartita
Globorotalia cerroazulensis s.s.
G. cerroazulensis pomeroli
G. cerroazulensis cocoaensis
Pseudohastigerina micra
Pseudohastigerina danvillensis
Pseudohastigerina naguewichensis
Hantkenina alabamensis
Hantkenina longispina
Cassigerinella winniana

Many of the above listed planktonic foraminifera occur throughout the Mossy Grove core. The occurrence within the *Truncorotaloides rohri* Zone of *Cassigerinella winniana* from 452 feet to 448 feet of the Mossy Grove core is important to note. This distinctive foraminiferan is abundant in its narrow range and occurs nowhere else in the core. Mancini and Waters (1986) report a similar occurrence of *C. winniana* from outcrop samples of the North Twistwood Creek Clay Member of the Yazoo in Mississippi and Alabama. The range of *Cassigerinella winniana* may enable recognition of a regional subzone within Zone P14.

The interval from 406 feet to 332 feet is assigned to the *Globigerinatheka semiinvoluta* Zone (P15). This zone is defined by the partial range of *Globigerinatheka semiinvoluta* from the first appearance of *G. semiinvoluta* to the first appearance of *Cribohantkenina inflata*. *Globigerinatheka semiinvoluta* is not present in the Mossy Grove core and has not been reported elsewhere in the eastern Gulf Coastal Plain. The situation is further complicated in the Mossy Grove core by the fact that *Cribohantkenina inflata* occurs only sporadically in the core. Because of this, it is necessary to recognize the *Globigerinatheka semiinvoluta* Zone (P15) and the base of the overlying *Cribohantkenina inflata* Zone (P16) by proxy. The *Globigerinatheka semiinvoluta* Zone in the Mossy Grove core is considered to be represented by the interval between the last occurrence of *Truncorotaloides rohri* and the last occurrence of *Globorotalia cerroazulensis pomeroli*. While it is recognized that this definition of Zone P15 is not precisely the same as that used by Berggren and Miller (1988), it is a close approximation.

The associated planktonic foraminifera fauna of the *Globigerinatheka semiinvoluta* Zone is the same as that in the *T. rohri* Zone with the addition of *Globorotalia opima nana* and *Globorotalia gemma* to the assemblage.

An important occurrence in the *Globigerinatheka semiinvoluta* Zone of the Mossy Grove core is the abundance of individuals of *Hantkenina* found from 406-400 feet. In this interval specimens of both *Hantkenina alabamensis* and *Hantkenina longispina* comprise as much as 40% of the planktonic foraminifera collected. This *Hantkenina* acme has not been previously reported from the Gulf Coastal Plain. It may represent local paleoceanographic conditions or it could be a more significant biostratigraphic marker in the region.

The *Cribohantkenina inflata* Zone (P16) is defined by the total range of *C. inflata*. The first appearance of *Cribohantkenina inflata* in the Mossy Grove core is at 172 feet. The range of *C. inflata* in the core extends from 172 feet through 130 feet but the species is represented primarily by fragmentary individuals. The sporadic nature of the occurrence of this species in the Mossy Grove core has already been discussed. A similar situation was recognized by Coccioni et al. (1988) in the Massignano section of central Italy. In this section, the last occurrence of *Globorotalia cerroazulensis pomeroli* was used to approximate the first occurrence of *Cribohantkenina inflata*. Given the uncertainty of the range of *Cribohantkenina inflata* in the Mossy Grove core, this convention is adopted here. Thus the *Cribohantkenina inflata* Zone (P16) is considered to range from 332 feet to 130 feet in the Mossy Grove core.

Species which appear in the Mossy Grove core for the first time within the *Cribohantkenina inflata* Zone include *Globigerina gortani* and *Globigerina ampliapertura*. Both *G. gortani* and *G. ampliapertura* appear in the Mossy Grove core

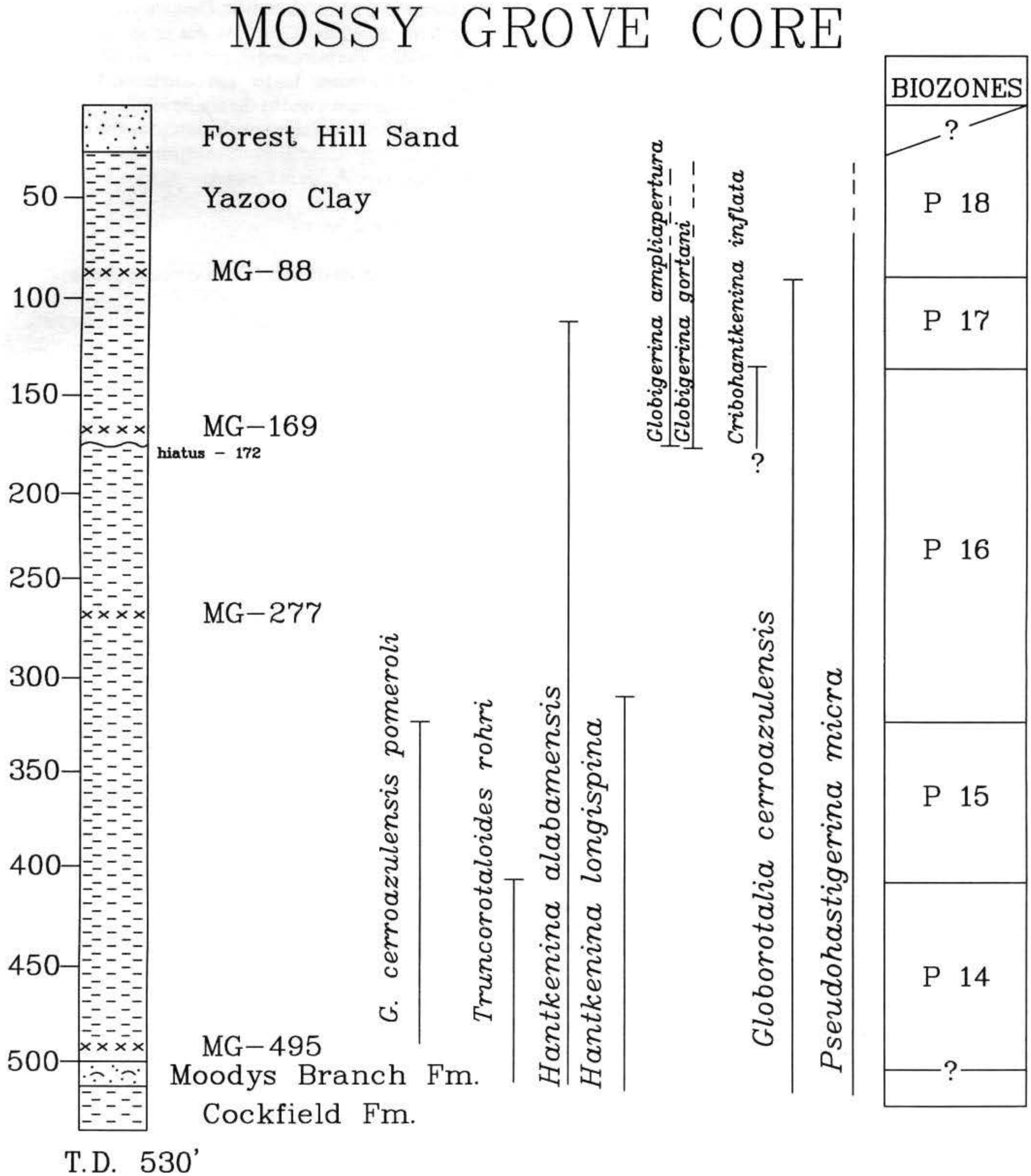

Figure 1. Columnar section of the Mossy Grove core showing ranges of selected planktonic foraminifera and the assigned biozones. Bentonites are identified on the section by the "MG" designation. Biozone definitions are after Berggren and Miller (1988).

at 172 feet. According to Stainforth et al. (1975), a distinct gap should occur between the first appearance of *G. ampliapertura* and *G. gortani*. The first appearance of both at the same level in the Mossy Grove core suggests a hiatus may be present at 172 feet.

The *Cribohantkenina inflata* Zone has not been previously distinguished from the overlying *Globorotalia cerroazulensis* Zone within the outcrop belt of the Yazoo Clay (Mancini and Tew, 1991; Mancini and Waters, 1986; Keller, 1985). This zone was identified in the Yazoo Clay from the Bay Minette core, Baldwin County, Alabama, by Miller et al. (1993). The Bay Minette core is from a downdip area of the Yazoo and may represent a more complete record than the more traditional outcrops of the Yazoo in Alabama. Outcrops studied by Keller (1985) however, were near the location of the Mossy Grove core. The poor preservation and sporadic occurrences of *Cribohantkenina inflata* seen in the Mossy Grove core is one possible explanation. Additionally, the discontinuous nature of the outcrops raises the possibility that the part of the Yazoo section assigned to the *Cribohantkenina inflata* Zone was not sampled in outcrop. The outcrops examined in eastern Mississippi and western Alabama pose a different problem. Exposures at Little Stave Creek, St. Stephens Quarry, the Sepulga River, and the Chickasawhay River are extensive and the sample distribution should have been adequate to distinguish the zone. At these localities, it seems likely that late Eocene sedimentation rates were so low that the two zones cannot be separated.

The interval from 130 feet to 92 feet is assigned to the *Globorotalia cerroazulensis* Zone (P17). This zone is defined as that interval from the last appearance of *Cribohantkenina inflata* through the last appearance of *Globorotalia cerroazulensis*. This zone is the uppermost zone of the Eocene (Berggren et al., 1992) and thus its upper limit is the Eocene-Oligocene boundary. In the Mossy Grove core, Fluegeman et al. (1994) identified the Eocene-Oligocene boundary at 92 feet. This was based on the absence of *Globorotalia cerroazulensis* in samples above 92 feet. In the Mossy Grove core, the *Hantkenina* extinction datum occurs within the *Globorotalia cerroazulensis* Zone. The last sample containing *Hantkenina* (*H. alabamensis*) is at 120 feet.

The Yazoo Clay in the Mossy Grove core from above 92 feet to 76 feet is assigned to the *Pseudohastigerina micra* Zone (P18). This assemblage is characterized by the presence of *Pseudohastigerina micra*, large *Globigerina ampliapertura*, *Globigerina gortani*, and the absence of *Globorotalia cerroazulensis*. This zone contains a dated bentonite in the Mossy Grove core at 88 feet. Dockery (personal communication) reports that John Obradovich of the U. S. Geological Survey has obtained a single crystal Ar/Ar age on sanidine of 33.7 ma from this bentonite. This age is similar to one reported by Obradovich and Dockery (1996) for an outcrop bentonite at Society Ridge. The planktonic foraminiferal assemblage reported from this outcrop is nearly identical to that of the Mossy Grove 88-foot bentonite.

Above 76 feet, no planktonic foraminifera were collected from the Yazoo Clay. At this point, the Yazoo becomes siltier. The increased clastic input was likely from a nearby deltaic source. Under such conditions, the planktonic fauna was suppressed by the clastic influx.

The distribution of selected planktonic foraminifera in the Mossy Grove core and the position of planktonic foraminifera biozones are shown in Figure 1.

Benthic Foraminifera

A detailed study of the benthic foraminifera is the main focus of the Mossy Grove project at Ball State. These studies involve a detailed faunal census of the benthic foraminifera from each sample. The purpose of this study is to use the benthic foraminiferal census data to reconstruct paleoecologic and paleoceanographic conditions during deposition of the upper Cockfield Formation, the Moodys Branch Formation, and the Yazoo Clay. A secondary outcome of this study has been the location of important first appearance datums (FAD's) and last appearance datums (LAD's) for benthic foraminiferal species. While these studies are still underway, some data from the Mossy Grove core have already been presented (Fluegeman et al., 1993; Fluegeman, 1993; Fluegeman et al., 1994; Fluegeman, 1995). A few of the more stratigraphically important datums are highlighted here.

Nonionella cockfieldensis is present in samples of the Creola Member of the Cockfield at 514 feet and in the lower Moodys Branch Formation from 512 to 508 feet. *Nonionella cockfieldensis* is not abundant through this interval but its presence is significant. Its range serves as a biozone in the Yegua Formation of Texas (Stenzel, 1940) and it has been identified from the Cockfield Formation of Louisiana and Mississippi and in the upper Gosport, "Dellet sand", and lower Moodys Branch Formation at Claiborne Bluff, Alabama. *Nonionella cockfieldensis* has not been reported from the much studied Gosport and Moodys Branch outcrops at Little Stave Creek, Clarke County, Alabama. The report of *Nonionella cockfieldensis* in the Moodys Branch Formation of the Mossy Grove core is a first report from this formation in Mississippi.

Other significant benthic foraminiferal datums include the last appearance datum of *Cibicidoides truncatus* at 352 feet, the first appearance datum of *Uvigerina cocoaensis* at 278 feet, and the first appearance datum of *Cibicidina walli* at 168 feet.

Of special biostratigraphic interest is the entire range of *Vaginulopsis cocoaensis* from 202 feet to 87 feet. This species (originally described as *Marginulina cocoaensis* by Cushman) has been noted from the Shubuta Clay Member of the Yazoo in western Alabama and from the Crystal River Formation of Florida. It is abundant in its range in the Mossy Grove core. Although its precise stratigraphic range in the

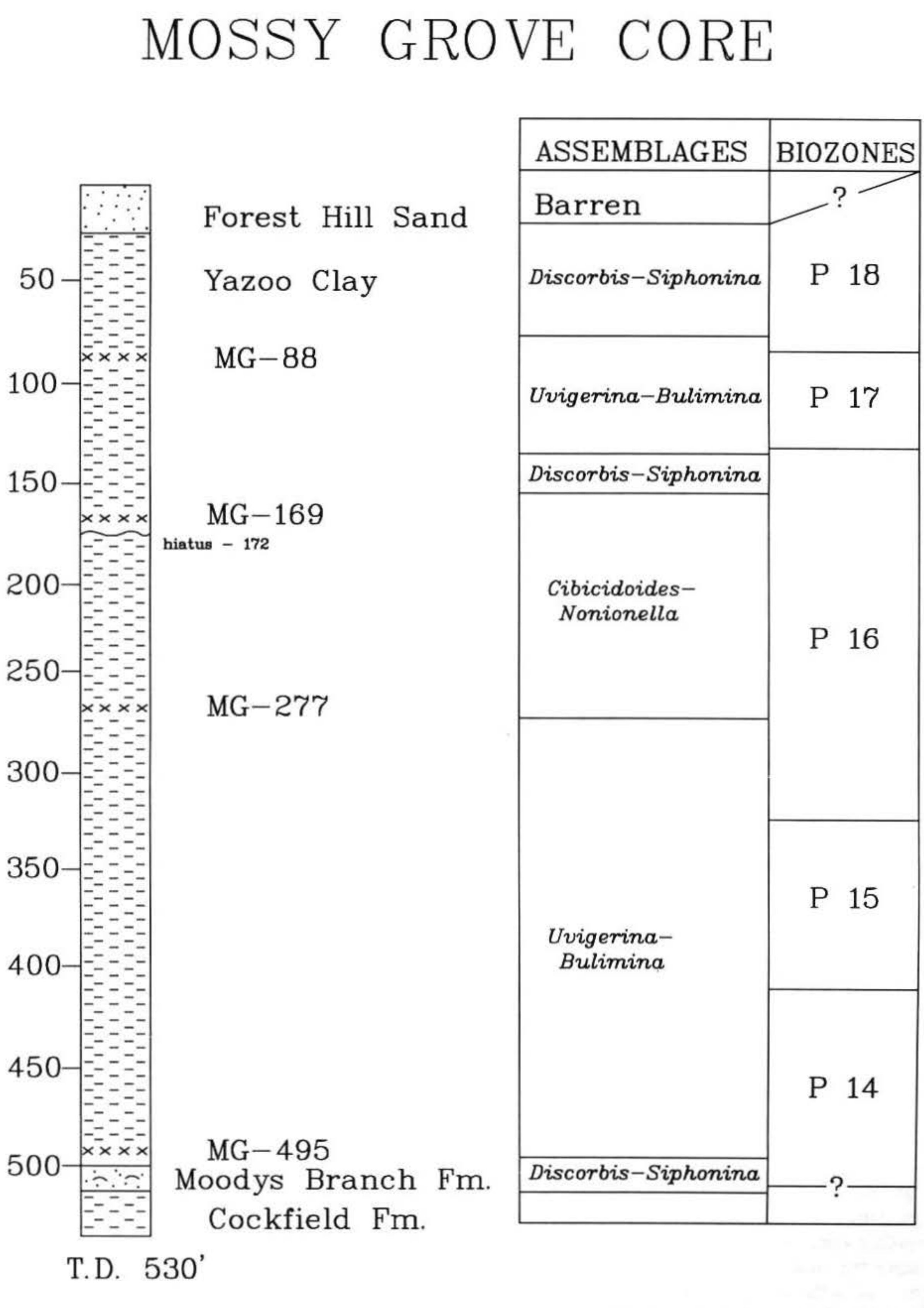

Figure 2. Columnar section of the Mossy Grove core showing the distribution of benthic foraminiferal paleoecologic assemblages and their relationship to planktonic foraminiferal biozones.

Shubuta Clay Member is not known due to poor exposures of the lower Shubuta, *Vaginulopsis cocoaensis* is not present in the underlying Pachuta Marl Member. This does indicate that *Vaginulopsis cocoaensis* has the potential to be an important biostratigraphic marker throughout the eastern Gulf region.

While detailed paleoecologic and paleoceanographic analysis awaits further quantitative study of the benthic foraminifera, some general statements can be made. Three assemblages characterized by the abundance of selected genera can be recognized in the Mossy Grove core. These assemblages are similar to those recognized by Walton (1964) and are here considered to represent similar paleoecologic conditions. The assemblages are: the *Cibicidoides-Nonionella* assemblage representing middle neritic conditions, the *Discorbis-Siphonina* assemblage representing outer neritic conditions, and the *Uvigerina-Bulimina* assemblage representing outermost neritic to upper bathyal conditions. The distribution of these assemblages in the Mossy Grove core is shown in Figure 2. The pattern in the core appears to record two major fluctuations of sea level. This is consistent with the sequence stratigraphic models of Dockery (1990) and Mancini and Tew (1991). What does seem surprising is the thickness of sediment in the Mossy Grove core assigned the *Uvigerina-Bulimina* assemblage. Conditions of the upper bathyal are expected to generally have low sedimentation rates yet it is these intervals which seem expanded when compared to the Yazoo thicknesses in the East. It seems likely that these intervals of the Yazoo Clay in the Mossy Grove core represent "healing phase" sequence stratigraphic units as defined by Posamentier and Allen (1993). Further study of the Mossy Grove benthic foraminifera and the benthic foraminiferal faunas from the Mobil-Mississippi Core Project (see Dockery et al., 1994) will help to clarify the sequence stratigraphy of the Yazoo Clay of western Mississippi.

DISCUSSION

The above results demonstrate that the Mossy Grove core contains a wealth of paleontological data. The continuous section through the Yazoo Clay and Moodys Branch Formation provides insight into late Eocene and earliest Oligocene paleoecology and biostratigraphy which had been unavailable to date. Further, the presence of bentonites in conjunction with the excellent biostratigraphic data available in the core offers the possibility of detailed correlation with the global geochronologic scale.

The paleoecologic information within the Mossy Grove core contains a record of sea level fluctuation during the Eocene-Oligocene transition. This time interval is thought to represent a transition from the "greenhouse" conditions of the Eocene to the "icehouse" conditions of the Oligocene. Understanding of this interval is important to understanding future global change.

It is clear that the Mossy Grove core is important to interpreting the late Eocene-early Oligocene geologic history of Mississippi and the eastern Gulf Coastal Plain. If the above results are an indication of what may be obtained from the Mossy Grove core and other similar cores, a significant contribution to the understanding of global Eocene-Oligocene history may be made.

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TOTAL ORGANIC CARBON (TOC) IN MOSSY GROVE CORE #1, HINDS COUNTY, MISSISSIPPI

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INTRODUCTION

Sixty-three samples were collected from Mossy Grove Core #1, Hinds County, Mississippi (Figure 1) for foraminiferal, grain-size, and total organic carbon (TOC) analyses. Results presented here include data on grain size but focus primarily on the TOC analysis. Foraminiferal results will be presented later. Samples from Mossy Grove Core #1 encompass the Yazoo, Moodys Branch, and uppermost Cockfield formations (Figure 2). Although most of this stratigraphic section is late Eocene, Grigsby and Fluegeman (1995) assigned the upper portion of the Yazoo Formation at Mossy Grove to lower Oligocene planktonic foraminiferal Zone P18.

The upper Eocene-lower Oligocene sedimentary record is of particular interest to geologists because it contains evidence of major changes in sedimentation patterns, chemistry of the oceans, oceanic circulation, biogeographic distributions, and global climate (Corliss and others, 1984). The unusually thick section of Yazoo Clay recovered at Mossy Grove may provide a nearly uninterrupted late Eocene-early Oligocene history of the southeastern U.S. continental margin. Along continental margins, there is good evidence that organic carbon fluxes and dissolved oxygen within the sediments control foraminiferal distributions (e.g., Loubere and others, 1993). Analysis of TOC, in conjunction with foraminiferal and grain-size studies, will help to interpret late Eocene paleoceanography in this region, which in turn may help to resolve conflicting sequence stratigraphic interpretations. For example, patterns in TOC concentration, planktonic foraminiferal abundances, and relative abundances of selected benthic species may pinpoint condensed sections within this thick, undifferentiated occurrence of the Yazoo Formation.

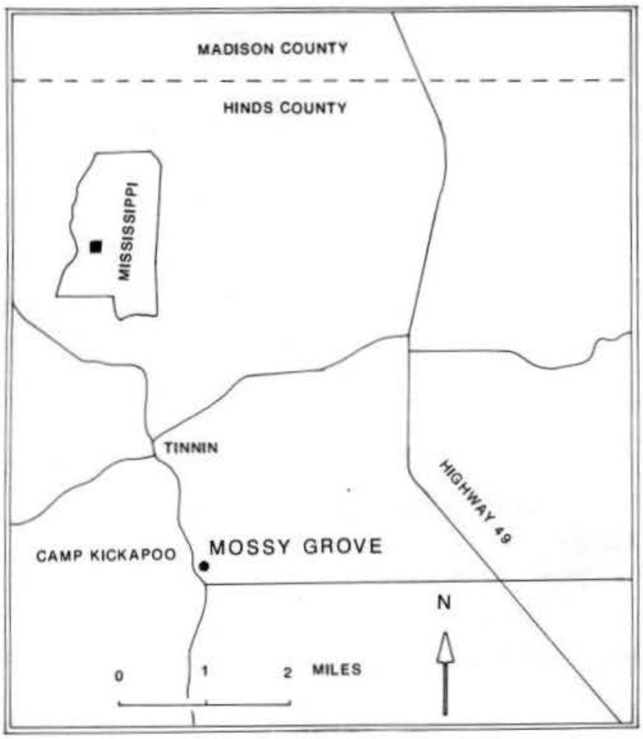

Figure 1. Location of Mossy Grove Core #1 in Pocahontas 7½ minute quadrangle, Mississippi (modified from Dockery and others, 1991).

METHODOLOGY

Grain-sizes were determined by sieving and by pipette analysis (Gee and Bander, 1972; Nelson and Sommers, 1982; Werme, 1985). To determine TOC values, every sample was analyzed in duplicate using a CHN elemental analyzer (method described in detail below). Randomly selected samples were also analyzed by the thermal partitioning method.

CHN Elemental Analyzer

TOC analysis performed using a CHN analyzer is generally preferable to analysis by thermal partitioning because results are replicable and more accurate, especially for samples with low concentrations of carbon and nitrogen. A relatively small amount of sample (<2 mg) is required for the CHN analyzer, which is an advantage when there is limited material available for analysis. The small sample size required for analysis made it possible for each sample to be analyzed in duplicate.

The sediment samples were ground to a fine powder, homogenized, dried for 48 hours at 65°C, capped, and stored in a desiccator until analyzed. Approximately 1.0 mg (weighed out to 0.1μg) of each sample was used for analysis. This is the weight measurement used to calculate total carbon and total organic carbon content. Inorganic carbon was partitioned from organic carbon by treating the sample with dilute phosphoric acid (using only enough acid to cover the sample) and sonicating for five minutes. Phosphoric acid removes calcium carbonate from the sample but leaves the organic carbon constituent unchanged. The sample was filtered at low vacuum pressure (<5 psi) onto a precombusted Whatman GF/F filter (a glass fiber filter with 0.7-μ m pore size), rinsed with carbon-free distilled water, dried at 65°C, and combusted in the CHN analyzer (Froelich, 1980; Gibbs, 1977; Kuehl and others, 1993; Environmental Protection Agency, 1994). There was no detectable loss of organic carbon during the filtering or rinsing stages.

Filter blanks composed of ashed GF/F filters were treated with phosphoric acid, dried, filtered, and then combusted in the CHN analyzer to check for carbon contamination introduced by the filter itself. These filter blanks were used on each run of the analyzer so that correction for the filter, if needed, could be applied to analyses of the sediment samples.

Filtering the sample onto a glass fiber filter and drying the filter overnight circumvented the problem of drying and re-weighing the sample for analysis. Formation of hydroscopic salts, which occurs when sediment is treated with acid (especially HCl), creates problems in obtaining an accurate weight (Verardo and others, 1990; Environmental Protection Agency, 1994).

The CHN analyzer was programmed in the following manner. The combustion and reduction furnaces were run at higher than standard temperatures (1050°C, which combusted all the volatiles, and 750°C, respectively) because of the refractive nature of the samples. The sample was combusted at 1050°C in the absence of the helium carrier gas but in the presence of oxygen, where carbon is converted to CO_2. Copper, in the form of copper wire maintained at 750°C, removed excess oxygen from the sample gases CO_2, H_2O, and N_2. Helium gas was introduced into the system to flush these gases to the instrument's detector where the amount of CO_2 was measured using a thermal conductivity bridge.

A certified reference standard material (Acetanilide, 71.09% C), as well as an internal laboratory reference material (Pamlico River Reference Material, 3.75% C) with organic carbon values more similar to the sediments from Mossy Grove Core #1, were run with the sediment samples (Table 1). These reference materials were used to calibrate the instrument and to monitor the instrument's efficiency. Several selected samples were analyzed by an outside laboratory for independent verification of our results. The CHN values determined at the University of South Carolina with a Perkin-Elmer elemental analyzer were within ±3.0% of the values determined at East Carolina University with a Control Equipment Corporation elemental analyzer.

Thermal Partitioning

Randomly selected sediment samples were analyzed, in

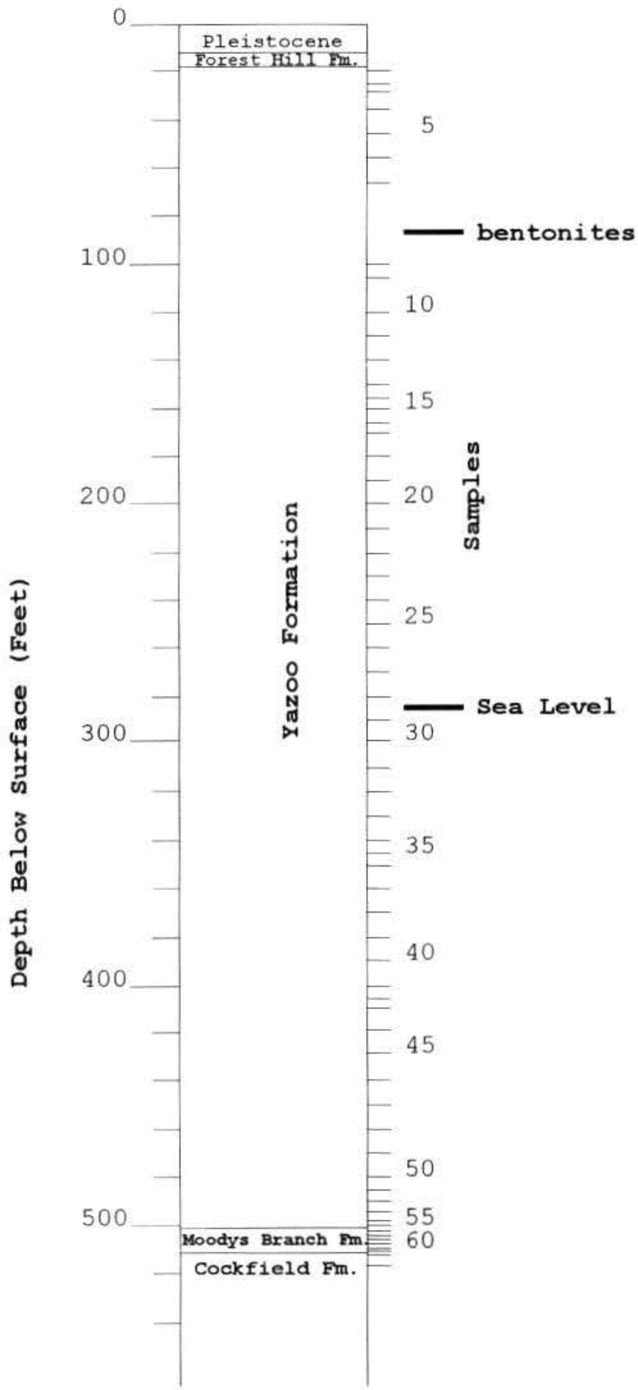

Figure 2. Generalized stratigraphic section in Mossy Grove Core #1 showing formations, depth (in feet) relative to land surface, samples used in this study, and stratigraphic position of bentonite layers (modified from Dockery and others, 1991).

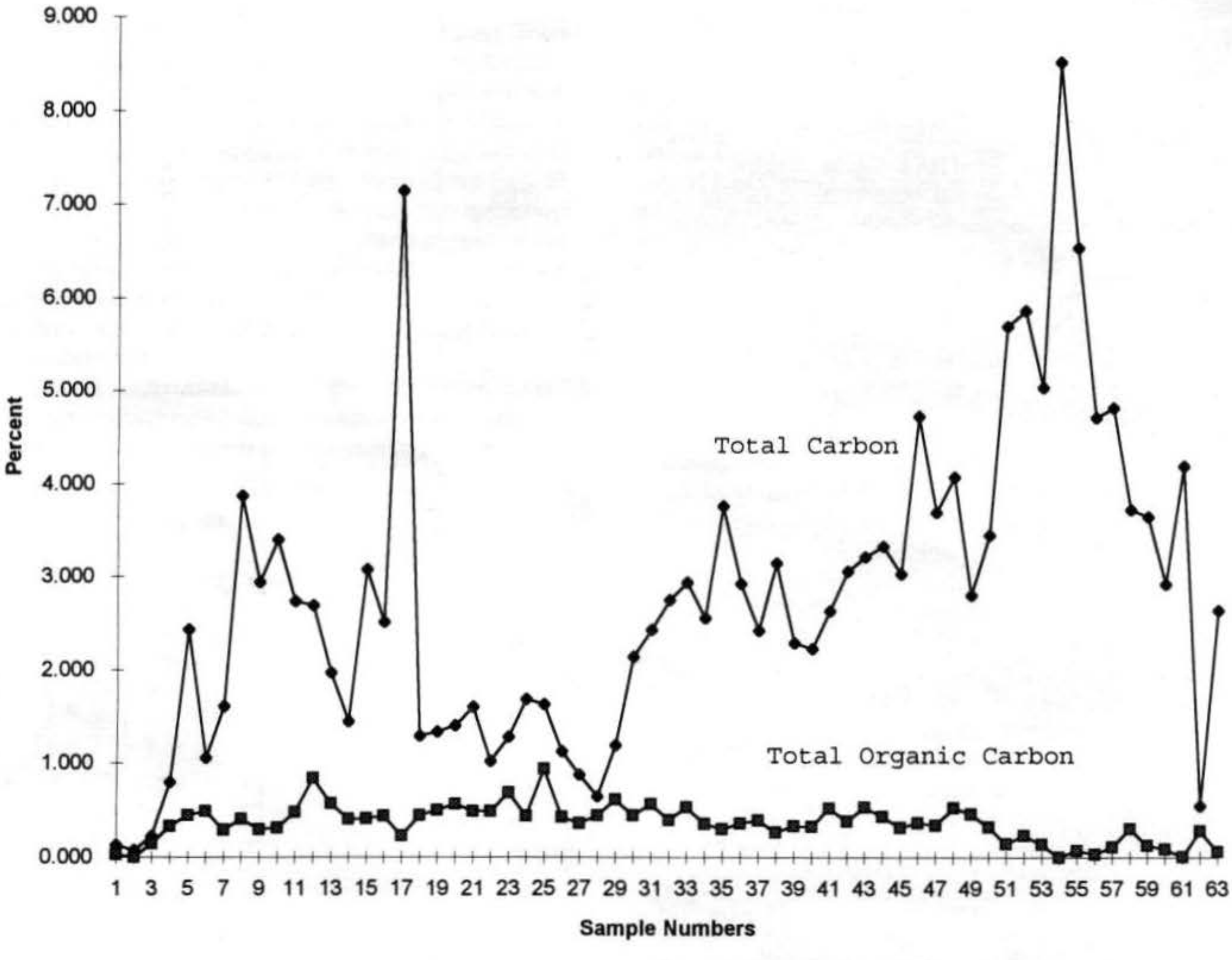

Figure 3. Percent total organic carbon (TOC) and percent total carbon (TC) for 63 samples from the Cockfield, Moodys Branch, and Yazoo formations. Sample 1 Coincides with the top of the stratigraphic section, and samples 63 with bottom. Samples 1-55 are from the Yazoo Formation, 56-61 from the Moodys Branch Formation, and 62-63 from the Cockfield Formation.

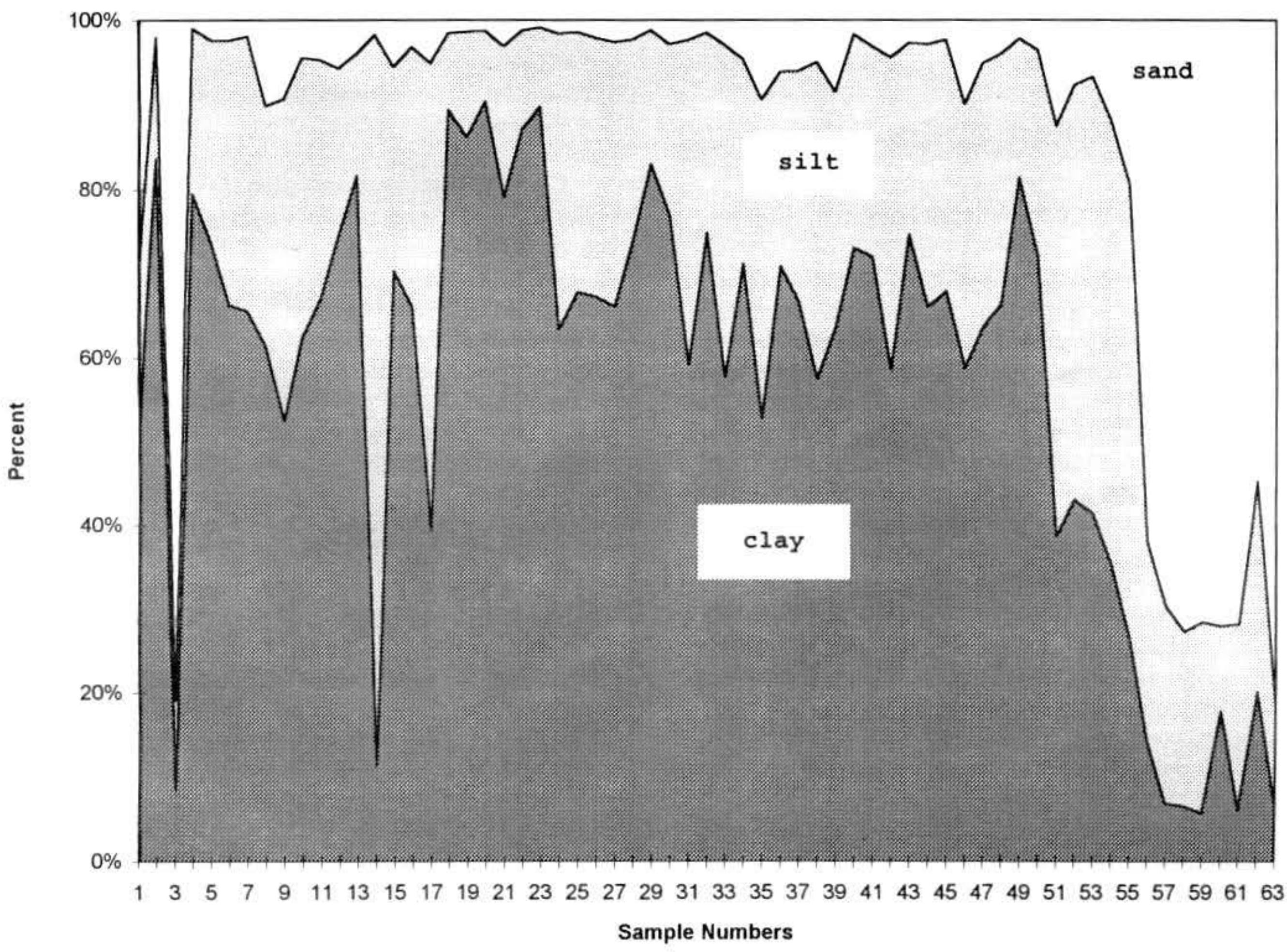

Figure 4. Percent clay, silt and sand for 63 samples from the Cockfield, Moodys Branch, and Yazoo formations. Sample 1 coincides with the top of the stratigraphic section, and sample 63 with bottom. Samples 1-55 are from the Yazoo Formation, 56-61 from the Moodys Branch Formation, and 62-63 from the Cockfield Formation.

triplicate, by thermal partitioning using a muffle furnace, where sediment is burned at several temperatures to separate (partition) organic from inorganic carbon (Nelson and Sommers, 1982). A larger amount of sample (~ 1 to 2g) is needed for this method.

Calcium carbonate and magnesium carbonate reference samples were run along with the sediment samples to monitor 1) potential loss of inorganic carbon during the organic-carbon-removal step, and 2) the complete conversion of inorganic carbon to CO_2 at the inorganic-carbon-removal step. Two temperatures were used to partition the carbon; organic carbon being removed (ignited) at 480°C and inorganic carbon being removed at 980°C. Certified reference standard material was not used in this method because of the amount of sample required and the cost of the certified reference material. The internal laboratory reference material used in the CHN method was replaced with the $CaCO_3$ and $MgCO_3$ reference materials.

RESULTS AND DISCUSSION

The TOC values determined from thermal partitioning (loss on ignition of sample in a muffle furnace) are approximately an order of magnitude higher than results from the CHN elemental analyzer. These elevated TOC values may be attributed to one or more factors. In thermal partitioning, total organic matter (TOM, which includes C, H, N, O, and other volatiles) is analyzed and is not directly related to TOC. These volatile substances, although not the object of analysis, were partitioned (lost) along with the organic carbon during the ignition process. In addition, water bound to the clay minerals may have been lost during the partitioning process (Wilum and Starzewski, 1972). Any of these factors would result in a decrease in mass of the sample, which, in turn, would inflate the organic carbon calculation based on mass differences before and after ignition. Normally, thermal partitioning yields TOM values 2 to 3 times higher than the TOC content. Allen and others (1974) determined that TOC is ¼ to ½ TOM content (content varies with sediment type and age). In contrast, the method employing the CHN elemental analyzer converts the organic carbon in the sample to carbon dioxide gas. Any other volatile substances that may exist in the sample are converted to gases, but they are not detected by the analyzer as it only recognizes the carbon dioxide (C), water vapor (H), and nitrogen gas (N). Hence, we consider data from the CHN analyzer to be more reliable, and they are all that are presented herein.

The mean TOC contents are as follows: 0.400% (0.001-0.941%, n=55, SD=0.172%) for the Yazoo Formation, 0.111% (0.004-0.303%, n=6, SD=0.105%) for the Moodys Branch Formation, and 0.170% (0.060-0.280%, n=2, SD=0.156%) for the Cockfield Formation (Table 2, Figure 3). The Moodys Branch Formation is thin in the area where the core was drilled, which accounts for the small value of n. Only the top of the Cockfield Formation was sampled; hence, only two samples were processed for TOC analysis.

The clay, silt, and sand contents of sediments in Mossy Grove Core #1 vary markedly (Figure 4), with sand-rich samples generally having the lowest TOC content and clay-rich samples generally having the highest TOC content (compare Figure 3 with Figure 4). The TOC content is low at the top of the Yazoo Formation (mean = 0.027%), increases rapidly downcore (mean = 0.437%), and then decreases near the boundary with the underlying Moodys Branch Formation to a mean of 0.072% (Figure 3). The TOC content at the top of the Moodys Branch Formation averages 0.021%, increases midway through the section to 0.303%, and then decreases to 0.004% near the boundary with the Cockfield Formation. The TOC content for our Cockfield samples ranges from 0.280% near the top of the section to 0.060% only five inches down section.

The TOC content of core samples (mean = 0.365%) is realistic considering the age of the sediments (upper Eocene and lower Oligocene) and the possibility of diagenesis. Although the TOC content of many Recent sediments is higher than that of our Eocene sediments, the differences may be attributable to different sediment types, the geologic condition of the sediment (e.g., extent of diagenesis), or the method used to determine TOC. The TOC contents of sediments from various DSDP locations (range of 0.1-0.3%) are similar to the values determined for Eocene sediments of Mossy Grove Core #1. The DSDP samples represent sediments that may have undergone diagenetic processes similar to Eocene sediments at Mossy Grove.

The amount of organic carbon appears to influence the distribution of modern foraminifera (e.g., Miller and Lohmann, 1982; Carlap, 1989; Corliss and Emerson, 1990). Both the absolute abundance of foraminifera (Snyder and Snyder, 1993) and the relative abundance of selected benthic foraminiferal morphotypes has been shown to fluctuate with the degree of organic enrichment, as reflected by percentages of P_2O_5 and TOC, in Neogene sediments (Snyder and others, 1988; Snyder, 1990).

At present, our only measure of foraminiferal abundance in the sediments of Mossy Grove Core #1 is percent total carbon (Figure 3). Because foraminifera, both benthic and planktonic, are the predominant carbonate component in the sediments analyzed, percent total carbon reflects at least an approximation of foraminiferal abundance patterns. A visual comparison of total carbon with total organic carbon (Figure 3) suggests no obvious relationship between foraminiferal abundance and TOC in the enclosing sediments. As the foraminiferal analysis of samples from Mossy Grove Core #1 continues, organic carbon content will be statistically analyzed to test for possible relationships to the abundance patterns of foraminifera and to the relative abundances of selected benthic foraminiferal morphotypes.

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Table 1

Percent recovery, actual vs. expected values for reference standards (PamRef stands for Pamlico Reference Material, an in-house reference standard).

REFERENCE STANDARD (NAME)	EXPECTED VALUE (%C)	ACTUAL VALUE (%C)	%RECOVERY
Acetanilide	71.09	70.90	99.73
Acetanilide	71.09	71.51	100.59
Acetanilide	71.09	71.03	99.92
Acetanilide	71.09	70.85	99.66
Acetanilide	71.09	70.90	99.73
PamRef	3.75	3.71	98.93
PamRef	3.75	3.70	98.67
PamRef	3.75	3.72	99.20
PamRef	3.75	3.74	99.73
PamRef	3.75	3.79	101.07
PamRef	3.75	3.73	99.47

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Table 2

Percent total carbon (TC), total organic carbon (TOC), sand, silt, and clay for 63 samples from the Cockfield, Moodys Branch, and Yazoo formations.

SAMPLE ID #	SAMPLE ID (DEPTH)	%TC	%TOC	%SAND	%SILT	%CLAY
1	Y 40'	0.127	0.027	13.29	21.07	55.26
2	Y 45'2"	0.071	0.000	1.66	11.81	68.67
3	Y 48'9"	0.222	0.145	77.84	10.15	8.21
4	Y 56'	0.796	0.325	0.87	17.01	69.09
5	Y 66'	2.433	0.445	1.94	19.92	61.12
6	Y 76'	1.060	0.489	1.95	25.5	53.98
7	Y 86'	1.614	0.288	1.83	31.52	63.43
8	Y 100'	3.873	0.402	9.45	26.75	57.48
9	Y 106'	2.942	0.291	8.02	33.18	45.28
10	Y 120'	3.402	0.308	3.98	30.05	56.42
11	Y 130'	2.738	0.478	4.24	25.55	60.74
12	Y 140'	2.691	0.841	4.49	15.57	59.42
13	Y 150'	1.972	0.570	3.7	13.48	76.11
14	Y 156'	1.449	0.404	1.62	82.16	10.61
15	Y 160'	3.078	0.411	4.91	21.77	63.04
16	Y 166'	2.515	0.437	3.24	31.88	68.47
17	Y 170'	7.150	0.229	4.73	51.99	36.91
18	Y 180'	1.297	0.444	1.36	8.04	79.51
19	Y 190'	1.341	0.501	1.2	11.01	76.25
20	Y 200'	1.407	0.567	1.04	7.16	77.43
21	Y 210'	1.608	0.488	2.83	16.56	73.32
22	Y 220'	1.022	0.485	1.08	10.33	77.66
23	Y 230'	1.286	0.689	0.78	8.51	81.65
24	Y 240'	1.688	0.438	1.48	32.89	59.57
25	Y 250'	1.632	0.941	1.26	26.92	59.32
26	Y 260'	1.129	0.425	1.94	28.43	62.43
27	Y 270'	0.882	0.358	2.25	27.37	57.67
28	Y 280'	0.647	0.444	2.16	22.56	69.64
29	Y 290'	1.199	0.613	0.9	12.08	63.55
30	Y 300'	2.141	0.442	2.69	19.2	72.66
31	Y 310'	2.429	0.564	2.02	33.63	51.52
32	Y 320'	2.750	0.393	1.36	22.25	70.3
33	Y 330'	2.940	0.533	2.7	36.79	53.65
34	Y 340'	2.560	0.352	4.14	21.94	64.51
35	Y 346'	3.766	0.301	8.59	34.95	48.52
36	Y 350'	2.931	0.362	5.59	21.14	64.93
37	Y 360'	2.428	0.396	5.44	24.74	60.71

continued

Table 2 continued

38	Y 370'	3.153	0.264	4.57	35.11	53.58
39	Y 380'	2.292	0.332	7.82	25.98	59.03
40	Y 390'	2.234	0.327	1.53	23.24	67.1
41	Y 400'	2.638	0.518	2.7	21.81	63.03
42	Y 406'	3.063	0.382	3.77	31.98	50.4
43	Y 410'	3.218	0.530	2.34	20.18	66.38
44	Y 419'1"	3.335	0.432	2.56	27.89	59.42
45	Y 428'10"	3.034	0.313	2.03	26.57	60.58
46	Y 440'	4.736	0.364	9.08	28.65	53.94
47	Y 450'	3.700	0.338	4.64	28.98	58.86
48	Y 460'	4.082	0.526	3.64	27.37	61.26
49	Y 470'	2.808	0.459	1.94	14.98	74.21
50	Y 480'	3.456	0.323	3.19	22.1	65.24
51	Y 486'	5.704	0.142	10.62	41.8	32.92
52	Y 490'	5.876	0.233	7.05	45.41	39.59
53	Y 494'	5.046	0.141	5.55	43.34	34.46
54	Y 498'	8.534	0.000	11.19	50.18	33.63
55	Y 500'	6.551	0.072	16.46	46.48	22.6
56	MB 502'	4.727	0.032	57.97	22.26	13.32
57	MB 504'	4.832	0.111	66.91	22.49	6.63
58	MB 506'	3.734	0.303	66.74	19.07	5.97
59	MB 508'	3.653	0.127	66.04	20.93	5.28
60	MB 510'	2.929	0.088	64.5	9.07	15.9
61	MB 510'1"	4.206	0.004	65.13	20.03	5.56
62	C 512'8"	0.546	0.280	49.22	22.64	18.03
63	C 517'10"	2.646	0.060	79.46	11.79	6.5

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In this issue:

- **an article about stratigraphy, by David Dockery of the Mississippi Office of Geology**
- **an article about foraminiferal biostratigraphy of the Yazoo Formation, by Richard Fluegeman of Ball State University**
- **an article about total organic carbon in a core of the Yazoo Formation, by Deborah Daniel and Scott Snyder of East Carolina University**