VOLUMES 9-10
2012-2013

JUST GEOLOGY
FROM THE PAGES OF ENVIRONMENTAL NEWS

MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY

Figure 1. Left: Exposure of Glendon Limestone on the east bank of the Mississippi River beneath the Interstate 20 bridge at Vicksburg. Right: An island of Glendon Limestone in a laterally displaced and down-thrown block, rising out of the river on the south (left) end and plunging beneath the water on the north end in front of Pier E-1 of the I-20 bridge. Here the top ledge of limestone in the adjacent river bank reappears as a doubly plunging anticline. Picture on left was taken on October 15, 2012, and the picture on the right was taken on August 14, 2012.

Figure 2. Drilling rig drilling on an island capped by Glendon Limestone in the Mississippi River at Pier E-1 of the Interstate 20 bridge at Vicksburg. At left, the Glendon Limestone plunges below the river level on the south end of an anticline. At right, the vertical pipe behind the rig contains a tiltmeter that measures lateral movement below ground. Pictures were taken on October 15, 2012.

Environmental News, January 2012, volume 9, issue 1, pages 10-16

THE VALUE OF A GEOLOGIC MAP

David T. Dockery III and David E. Thompson, Office of Geology

What if you were told of the existence of a map which held the location of treasures worth millions or billions of dollars? Would you be interested? If so, then you are among those interested in geologic maps. To illustrate this point, the geologic map of west-central Mississippi in Figure 1 includes both the Jackson Gas Field and the Tinsley Oil Field. These fields were discovered by state government geologists during the course of mapping the surface geology. The Jackson Dome, which contains the Jackson Gas Field, was discovered and first published by State Geologist Eugene Hilgard in 1860. The Tinsley Dome was discovered by Mississippi Geological Survey geologist Fred Mellen as he was mapping the surface geology of Yazoo County in 1939. Both discoveries were the result of state-funded geological work and have produced a many-thousand-fold return on the dollar. The cross section in Figure 2 shows the uplift of near-surface formations over the Jackson and Tinsley domes.

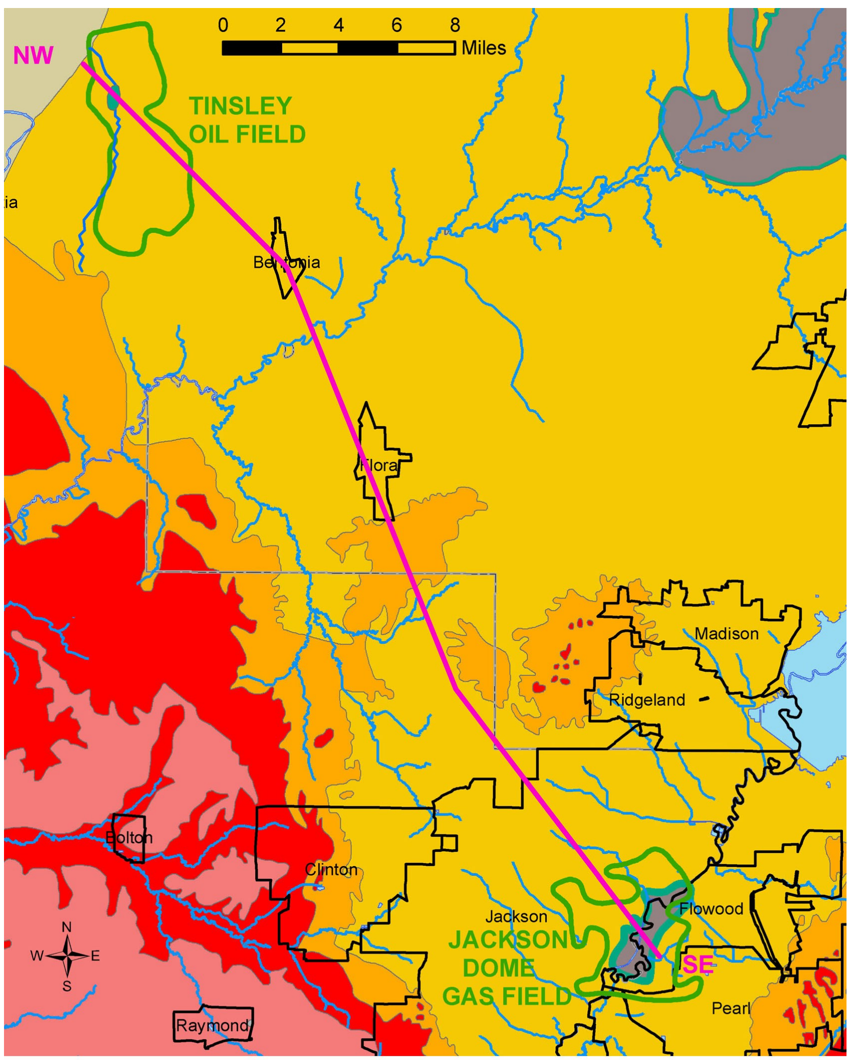


Figure 1. Geologic map of a portion of west-central Mississippi, showing a line of cross section from Tinsley Oil Field to the Jackson Gas Field (both outlined in green). Formations exposed along the line of section, beginning at Jackson and in ascending order, include the Cockfield Formation (gray), Moodys Branch Formation (turquoise), Yazoo Clay (yellow), and Forest Hill Formation (orange).

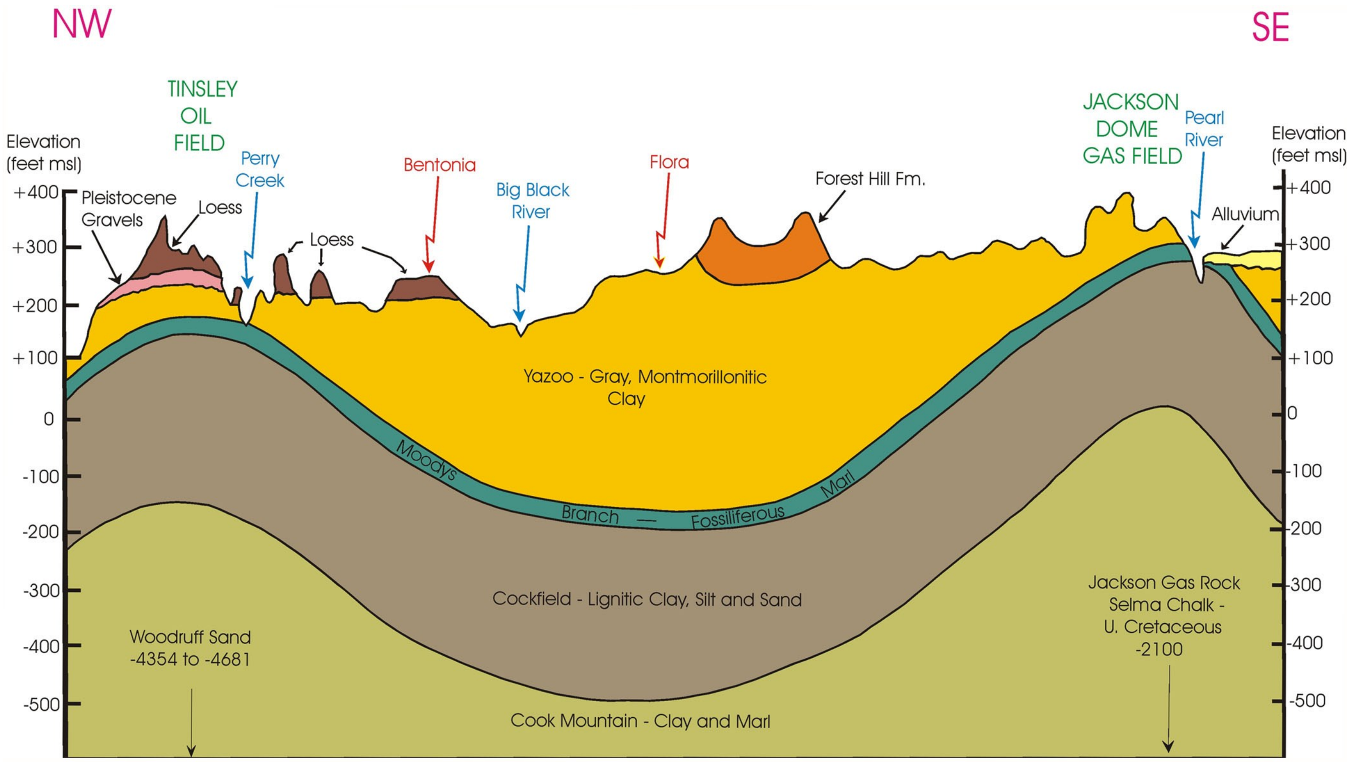


Figure 2. Schematic geologic cross section from Tinsley Oil Field to the Jackson Gas Field. The arrow below Tinsley shows the depth to the oil producing Woodruff Sand, and the arrow below Jackson shows the depth to the gas producing Jackson Gas Rock. Cross section is modified from Kolb, 1969 (Field Trip Guide, Vicksburg-Tinsley-Jackson-Vicksburg, Mississippi).

The Jackson Gas Rock, associated with the Jackson Dome, became an important exploration objective in the 1930s and produced Mississippi's first significant oil and gas boom. According to Dudley Hughes' book *Oil in the Deep South*, commerce from the Jackson Gas Field helped the city and state survive the economic downturn of the Great Depression. So great was this oil and gas boom that the State of Mississippi entered the oil and gas exploration business with State Fee wells 1-5. The lease on the State Fee #5 was sold in 1994 after the well had been shut in for fifty years. When the valve on the well head was opened, the well still produced gas (figures 3-4). The total production of the Jackson Gas Field to date is 150 billion cubic feet of gas.

Figure 3. Cragin Knox (left) and Michael Bograd (right) at the well head of the #5 State of Mississippi Fee completed in January of 1937 in the Jackson Gas Field, located behind the clubhouse at LeFleur's Bluff State Park in Jackson, Mississippi. Picture was taken on April 26, 1994.

Figure 4. Test of the #5 State Fee gas well on the Jackson Dome located behind the club house at LeFleurs Bluff State Park in Jackson, Mississippi, after the well had been abandoned intact for some 50 years. The well produces gas from the Jackson Gas Rock. Picture was taken on April 26, 1994.

Oil exploration in Mississippi began on a large scale after Mellen discovered a structural dome on Perry Creek in Yazoo County where the Moodys Branch Formation was anomalously exposed some 250 feet higher than that of the regional dip. On April 12, 1939, the Mississippi State Geological Survey issued a press release concerning this structure. On August 29, 1939, Union Producing Company's #1 G. C. Woodruff exploration well hit an oil gusher almost right on the spot where Mellen found the exposure of the Moodys Branch Formation. Tinsley Oil Field has produced more than 200 million barrels of oil, which at today's price of around $100 a barrel has a value of 20 billion dollars (as compared to the few thousands of dollars the state invested in Mellen's geologic mapping). The production of another 100 million barrels from Tinsley is possible by tertiary recovery of the remaining oil by means of carbon dioxide injection.

Five years after the discovery of oil at Tinsley, surface geologic mapping by the Mississippi Geological Survey led to the discovery of Mississippi's largest gas field, Cranfield Field in Adams County. While mapping Adams County in 1940, F. E. Vestal described a faulted area near Cranfield and recommended the location for a test well. The discovery well drilled by the California Company in 1943 produced both oil and gas. Cranfield Field has a cumulative production of over 676 billion cubic feet of gas and 39.6 million barrels of oil (numbers compiled by the Mississippi State Oil and Gas Board for 2010).

The year 1970 was the year of peak oil production in both the nation and the State of Mississippi. Mississippi's cumulative production on January 1, 1970, was 1,201,613,626 barrels of oil, and the average daily production for that year was 174,782 barrels of oil. At this time Mississippi ranked ninth among oil producing states behind: (1) Texas, (2) Louisiana, (3) California, (4) Oklahoma, (5) Wyoming, (6) New Mexico, (7) Kansas, and (8) Alaska. After peak oil production, Mississippi's production remained high. Using 1981 as a sample year, Mississippi produced 34,084,488 barrels of oil, on which the state collected $65,952,036 in severance tax, and 220,771,210 thousand cubic feet (MCF) of gas, on which the state collected $42,507,402 in severance tax.

It was in 1970 that the Mississippi Geological Survey turned its focus from mineral resources to environmental geology. In a way, this new focus was a return to the original mission of the agency. In the mid-1800s, Mississippi planters recognized the importance of geology to soil fertility and agriculture and lobbied for a state geological survey. The Mississippi Geological Survey was authorized in 1850, and the first state-wide geological survey was conducted and published by planter and naturalist B. L. C. Wailes in 1854 under the title *Report on the Agriculture and Geology of Mississippi*. A second report was published by L. Harper LL. D. in 1857, and a third report was published by Eugene Hilgard, Ph. D. in 1860. Hilgard later taught at the University of California at Berkeley and became known as the "Father of Soil Science." Geology's impact on the soil also extends to the topography of the land and to "ecoregions." The U.S. Environmental Protection Agency's level 4 *Ecoregions of Mississippi* map (Figure 5) closely follows the state's surface geology as depicted on the *Geologic Map of Mississippi* published in 1945 and 1969.

The Mississippi Office of Geology published three volumes in an Environmental Geology Series in the 1970s:

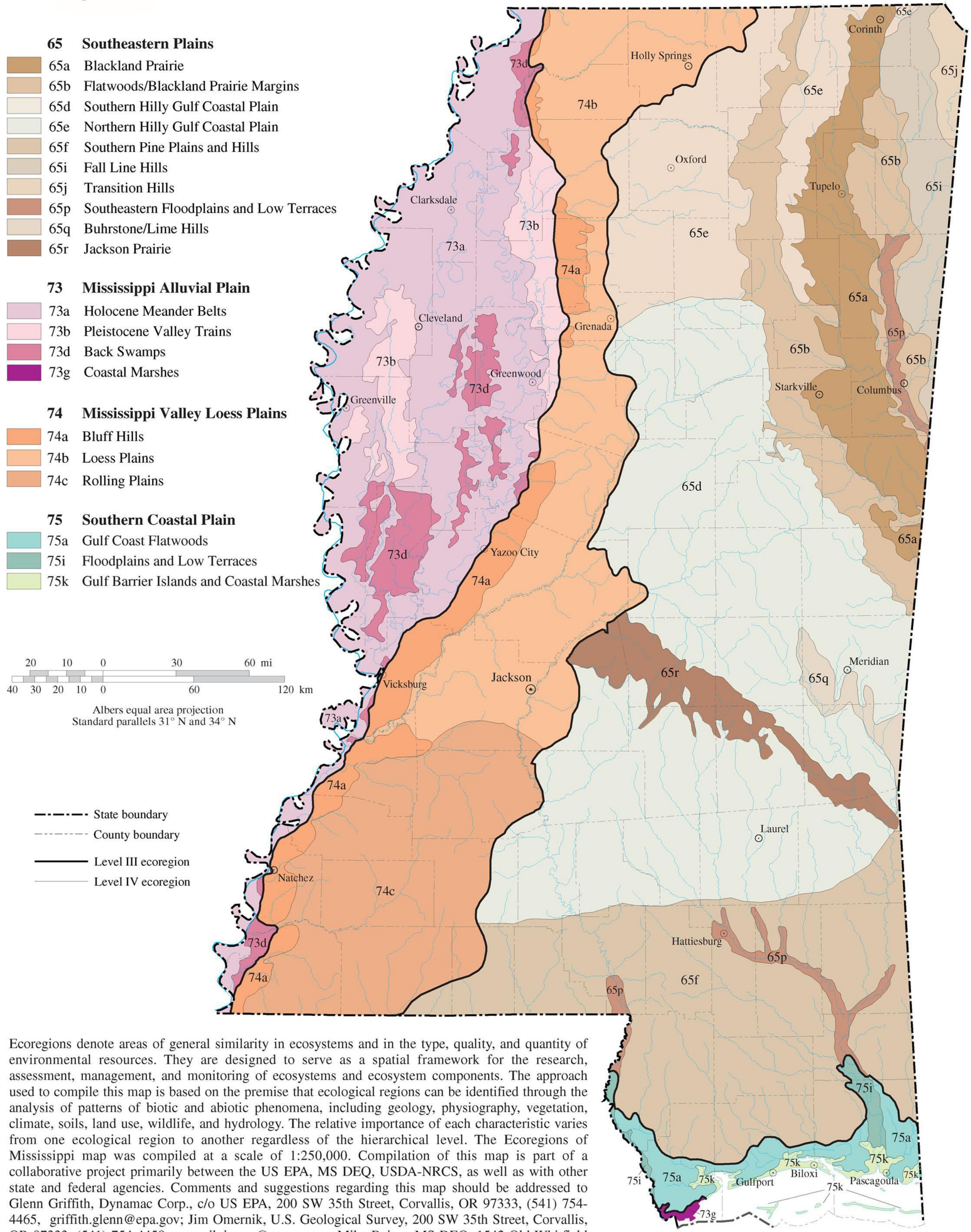
Number 1. *Environmental Geology of the Pocahontas, Clinton, Raymond, and Brownsville Quadrangles, Hinds County, Mississippi* (1973).

Number 2. *Environmental Geology of the Madison, Ridgeland, Jackson, and Jackson SE Quadrangles, Hinds, Madison, and Rankin Counties* (1974).

Number 4 (Number 3 was indefinitely postponed). *Geology and Man in Adams County, Mississippi* (1976).

Figure 5

Ecoregions of Mississippi



Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. The approach used to compile this map is based on the premise that ecological regions can be identified through the analysis of patterns of biotic and abiotic phenomena, including geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another regardless of the hierarchical level. The Ecoregions of Mississippi map was compiled at a scale of 1:250,000. Compilation of this map is part of a collaborative project primarily between the US EPA, MS DEQ, USDA-NRCS, as well as with other state and federal agencies. Comments and suggestions regarding this map should be addressed to Glenn Griffith, Dynamac Corp., c/o US EPA, 200 SW 35th Street, Corvallis, OR 97333, (541) 754-4465, griffith.glenn@epa.gov; Jim Omernik, U.S. Geological Survey, 200 SW 35th Street, Corvallis, OR 97333, (541) 754-4458, omernik.james@epa.gov; or Mike Beiser, MS DEQ, 1542 Old Whitfield Road, Pearl, MS 39208, (601) 664-3959, mike_beiser@deq.state.ms.us.

To demonstrate the value of these maps, the opening question is placed in a different context: Would you be interested in a map that could save you tens of thousands or even millions of dollars? Figure 6 is a reproduction of the Clinton Geologic Quadrangle map, and Figure 7 shows a cross section from Vicksburg through Clinton and to the crest of the Jackson Dome in Jackson. Together, the geologic map and cross section demonstrate the westerly dip of strata on the western flank of the Jackson Dome. They also display the westerly limit of the Yazoo Clay outcrop belt, which runs north-south through the City of Clinton. The Clinton Geologic Quadrangle is a valuable asset to builders and buyers in determining where specially-engineered foundations, roads, and infrastructure would be required to withstand the shrinking and swelling pressures of the Yazoo Clay, and conversely, in recognizing areas where the Yazoo Clay is sufficiently covered by the overlying Forest Hill Formation so that it does not pose a structural hazard. Figure 8 shows the construction of a discount store foundation in Clinton engineered to withstand the Yazoo Clay. The previous store on this site was torn down after the concrete floor heaved two feet out of level due to movement of clay beneath the foundation. It was replaced by a monolithic wall and beam-on-grade foundation, but not before some eight to ten feet of dirt had to be excavated from the site and replaced by a compacted select fill material.

Current geologic mapping is funded in part by Federal grants for geologic mapping (STATEMAP) and for the U.S. Geological Survey coal resources database (NCRDS). For the year 2011-2012, map products include the Deemer, House, Union East, and Post quadrangles in central Mississippi (by David Thompson) and the Lanham, Strengthford, Ovett, and Rhodes quadrangles in south-central Mississippi (by James Starnes). Selection of these quadrangles was approved by the State Mapping Advisory Committee and includes the recharge areas of important Eocene, Oligocene, and Miocene aquifers. For this reason, geologic mapping by the Office of Geology is coordinated with the work of geologists in the Office of Land and Water Resources. The Mississippi Department of Environmental Quality has identified ground-water availability as the greatest geologic concern facing Mississippi in the coming years.

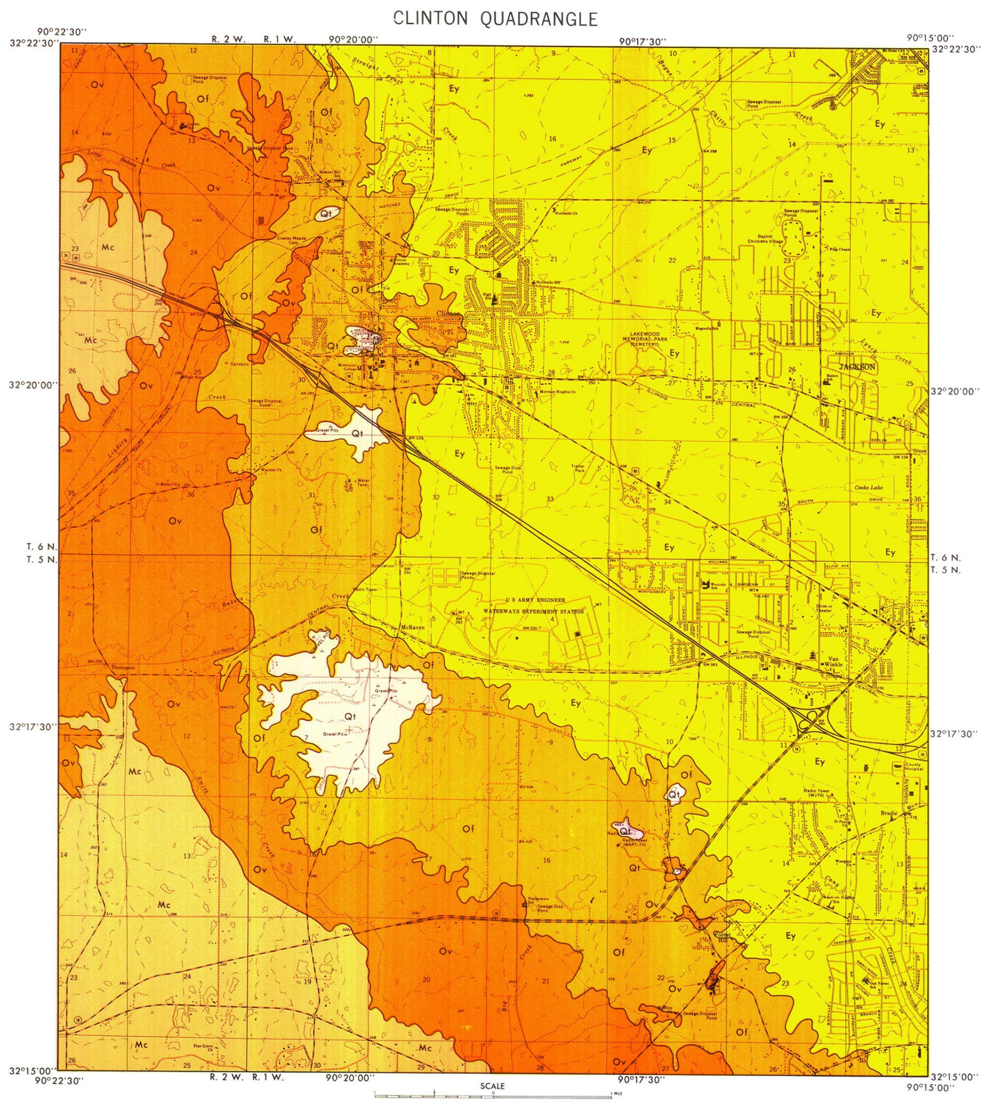


Figure 6. Geologic map of the Clinton 7.5-Minute Quadrangle. Geologic formations from east to west include the Yazoo Clay (yellow, Ey), the Forest Hill Formation (light orange, Of), Quaternary Terrace Deposits (light pink, Qt), the Vicksburg Group (dark orange, Ov), and the Catahoula Formation (pale orange, Mc). Image from *Environmental Geology Series* #1.

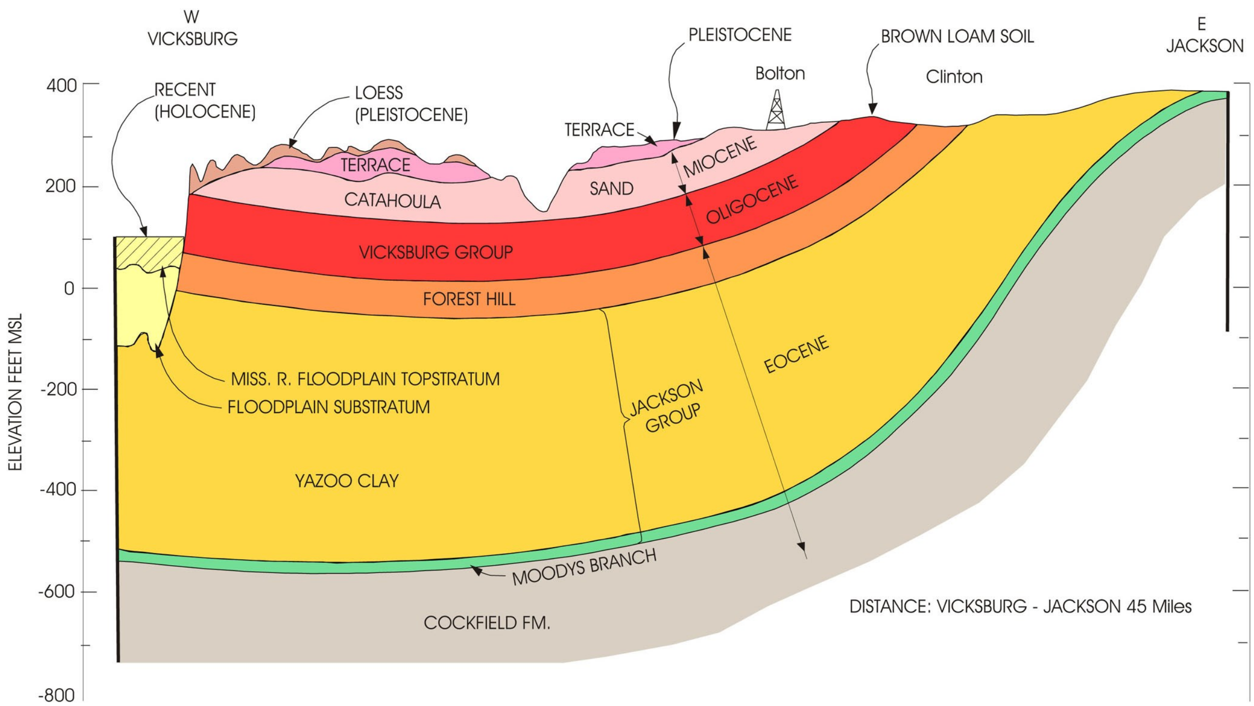


Figure 7. Schematic geologic cross section from Vicksburg to Jackson, Mississippi. The Yazoo Clay (dark yellow) outcrops from Clinton to Jackson and has a similar, but easterly dipping, structure on the Jackson Dome's eastern flank. Image is modified from Kolb et al., 1976 (Guidebook. Classic Tertiary and Quaternary Localities and Historic Highlights of the Jackson-Vicksburg-Natchez Area).

Figure 8. Monolithic wall and beam-on-grade foundation, showing the steel and form before the concrete slab was poured, for a discount store on the Yazoo Clay outcrop in Clinton, Mississippi. View at left is from front to back, and at right is from side to side. The floor of the previous building on this site had buckled two feet out of level. Pictures were taken on August 8, 2011.

MISSISSIPPI EARTHQUAKES AND THE NEW MADRID BICENTENNIAL

Michael B. E. Bograd, Office of Geology

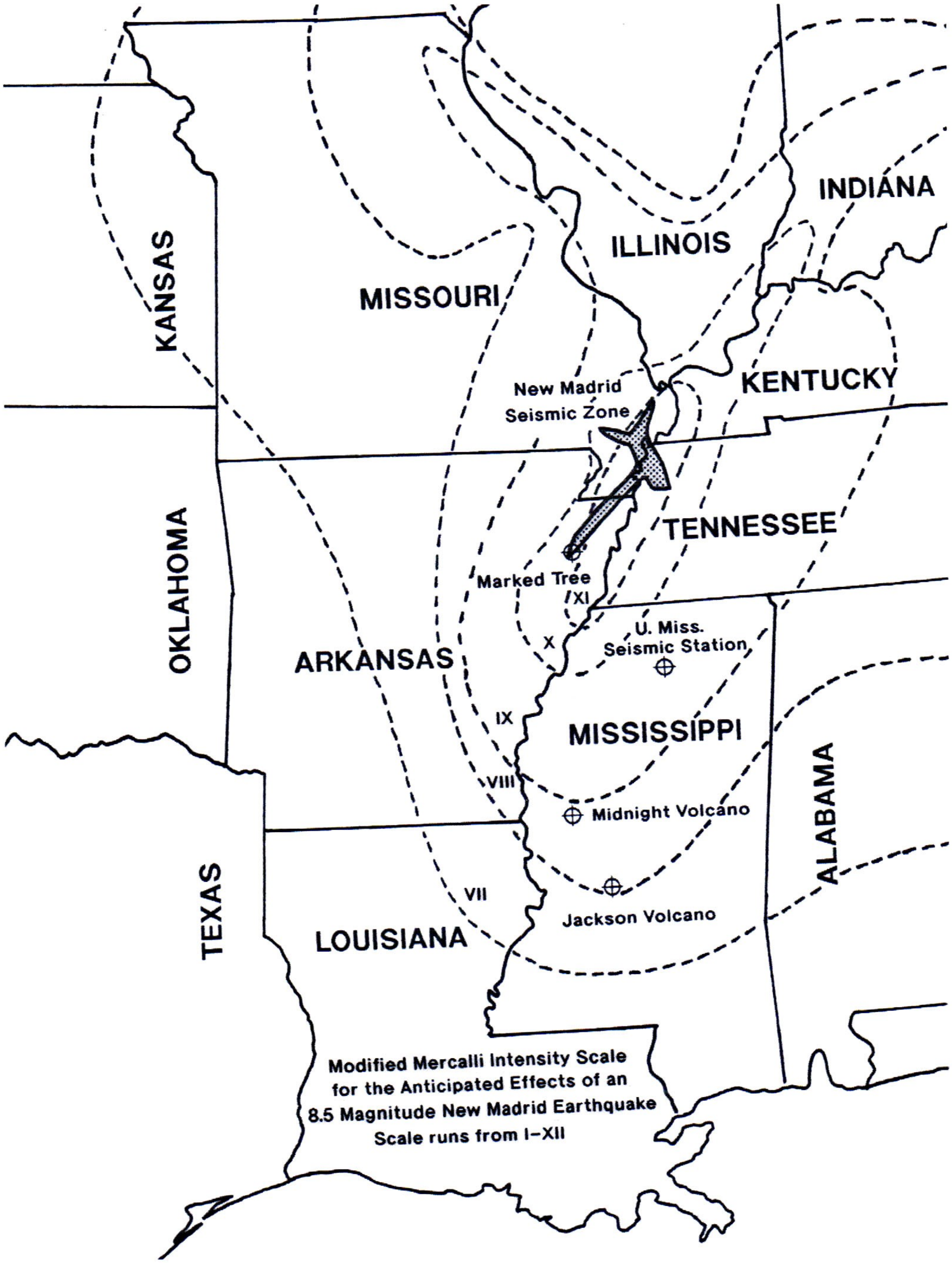
I was in Mississippi when I felt my first earthquake. On November 9, 1968, I was in my dormitory room on the campus of Mississippi State University when I felt the nine-story building shaking slightly. I made a note of the time and later heard on the radio that an earthquake of magnitude 5.3 had occurred in southern Illinois. Not everyone on campus felt the earthquake, but there were felt reports from across northern Mississippi as well as from all or parts of 22 other states. This earthquake was in the Wabash Valley Seismic Zone.

People in Mississippi have been feeling shaking from earthquakes for at least 200 years. The series of strong earthquakes in the New Madrid Seismic Zone (NMSZ) in 1811 and 1812 was felt by Winthrop Sargent, first governor of the Mississippi Territory, at his home near Natchez. He published a description of the effects of several of the shocks in the series on his home, furnishings, and cistern. I was delighted that Governor Phil Bryant proclaimed January 30 to February 3 of this year as Mississippi's Earthquake Awareness Week. This commemorates the bicentennial of the earthquakes of December 1811, January 1812, and February 1812. Also it helps raise awareness that Mississippi must be prepared to withstand the shaking from any recurrence of a strong earthquake in the NMSZ, which extends from southeastern Missouri, through western Tennessee, to northeastern Arkansas. The southern end of the zone is about 40 miles from the northwestern corner of Mississippi, but as we have seen from experience, a location can be shaken by a distant earthquake strongly enough to cause damage.

The first map shows Mississippi's location with respect to the NMSZ. The isoseismal contours depict the intensity of shaking from a hypothetical earthquake in the NMSZ. Seismologists no longer expect this zone to be capable of generating an earthquake of magnitude 8.5 (current thinking has a maximum magnitude of about 7.0 to 7.5), but the map illustrates important concepts. Earthquakes in the central U.S. generate shaking over larger areas than for similar magnitude events in other areas; the larger the area of shaking, the larger the numbers of people and structures affected. The isoseismals decrease in intensity as the distance from the epicenter increases, as one would expect, but not as a smooth bulls-eye. The shapes of the lines reflect differing geologic conditions, influenced especially by the unconsolidated sediments of major river valleys.

The two maps in color are intended to assist the emergency management community with preparations and responses to earthquake effects. The Soil Site Class map shows the relative likelihood of the various geologic formations that underlie the state to amplify the shaking as earthquake waves pass through. The scale ranges from A and B as the most stable foundation (not mapped in Mississippi) to F as the most likely to experience soil amplification. The red areas include the Mississippi River alluvial plain and the flood plains of major streams, plus other areas in southern Mississippi. The Liquefaction Susceptibility map illustrates the expectation that the areas most likely to experience liquefaction during a strong earthquake are the flood plains. Unconsolidated, water-saturated sediments of the flood plains are more likely to lose their strength and cohesion during earthquake shaking. Such maps at greater detail and higher resolution would benefit emergency managers in understanding which places are more, or less, likely to suffer damage from soil amplification or liquefaction during a strong earthquake. This can aid in planning emergency response and location of shelters, for example.

While the greatest risk to Mississippi from earthquakes is from a strong earthquake in the New Madrid Seismic Zone, it is important to note that about 50 earthquakes are known to have occurred within Mississippi. Not all were felt at the surface. The strongest was in 1931 in the Batesville to Charleston area; it caused damage in the epicentral area and was felt over 65,000 square miles in Mississippi, Alabama, Arkansas, Tennessee, and Missouri. The second strongest earthquake within Mississippi was in 1967 northeast of Greenville; it was felt over 25,000 square miles in Mississippi, Arkansas, Louisiana, and Tennessee. Southern Mississippi is not immune. An earthquake near Gulfport in 1955 was felt all along the Coast.


KANSAS
MISSOURI
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TEXAS
LOUISIANA
New Madrid
Seismic Zone
Marked Tree
XI
X
IX
VIII
VII
U. Miss.
Seismic Station
Midnight Volcano
Jackson Volcano
Modified Mercalli Intensity Scale
for the Anticipated Effects of an
8.5 Magnitude New Madrid Earthquake
Scale runs from I–XII

Soil Site Class Map

Mississippi

Soil Type

- Water
- C
- D
- E
- F

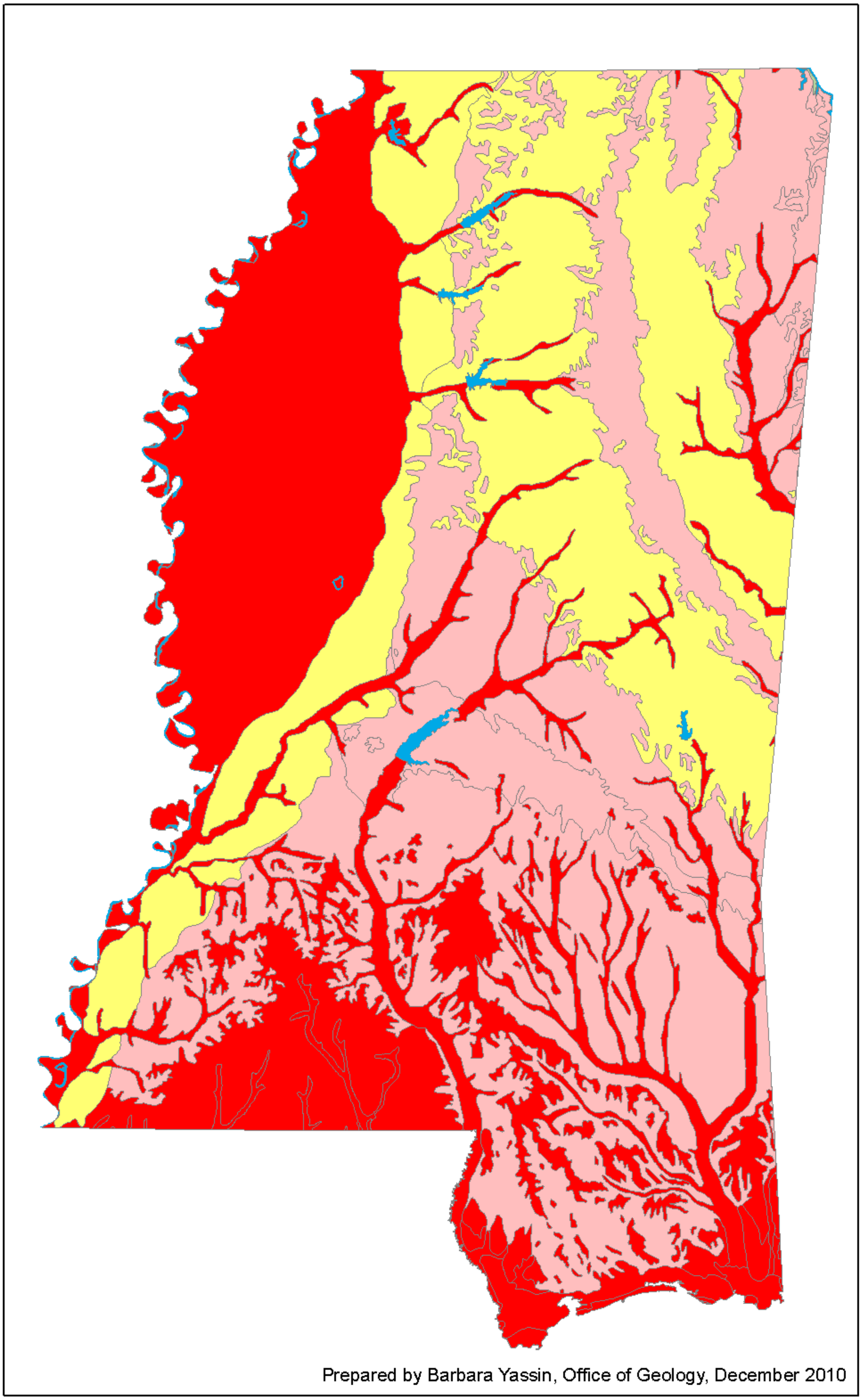
N
W E
S

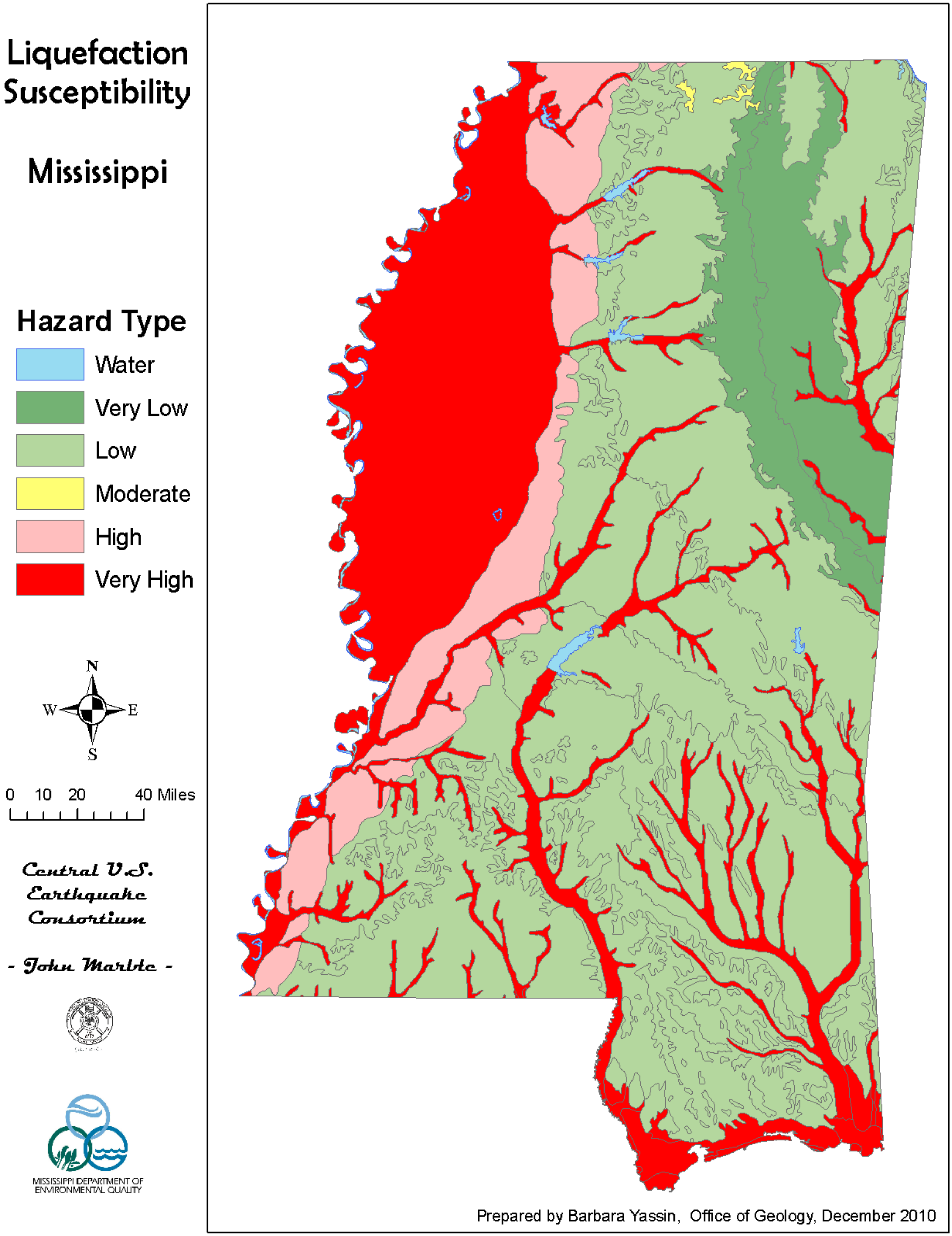
0 10 20 40 Miles

Central U.S. Earthquake Consortium

- John Marble -

MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY




Liquefaction Susceptibility
Mississippi
Hazard Type
Water
Very Low
Low
Moderate
High
Very High
N
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0 10 20 40 Miles
Central U.S. Earthquake Consortium
- John Marble -
MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY
Prepared by Barbara Yassin, Office of Geology, December 2010

THE NINTH ANNUAL FOSSIL ROAD SHOW

David T. Dockery III, Office of Geology

The ninth annual Fossil Road Show was held at the Mississippi Museum of Natural Science (MMNS) on Saturday, March 3, 2012, from 10:00 am to 3:30 pm. Walt Grayson, on WLBT news, said of one Fossil Road Show (as paraphrased here): We usually go to the Museum of Natural Science to see their fossils—now they want to see ours. George Phillips, a vertebrate paleontologist with MMNS, put together a team of experts from the MMNS staff, the Mississippi Office of Geology, Mississippi State University, the University of Mississippi, the University of Louisiana at Monroe, and elsewhere to identify fossils brought in by the public.

The special attraction at the ninth annual Fossil Road Show was a dinosaur leg bone donated to the museum by *The American Pickers*. In one episode of *The American Pickers*, a dinosaur bone was found among a room of antiques and was bought for $450. George was called in to authenticate the find as a dinosaur bone, which he did. When asked what it was worth, George said that he couldn't put a price on it, but that it was a priceless scientific find. The Pickers donated the bone to the MMNS, and, when tallying their profit, they showed the purchase price of $450, left the sale price blank, and totaled the transaction as "Priceless." The Pickers also noted that the Field Museum in Chicago paid over $8 million for the fossil *Tyrannosaurus* named Sue and that $4,000 was paid for a hadrosaur bone elsewhere. Figure 1 shows Museum Director Libby Hartfield and George Phillips in a photo shoot in front of the MMNS with their priceless dinosaur bone.

Figure 1. Libby Hartfield and George Phillips with a partial leg bone of a hadrosaur dinosaur from Mississippi. The bone was purchased for $450 by the American Pickers and donated to the Mississippi Museum of Natural Science.

The importance that Fossil Road Show attendees placed on their rock and fossil finds is illustrated by the baby stroller in Figure 2. The young couple has the stroller at a table were they are discussing their finds. On closer look, the youngest of their three young children has been replaced with a stroller full of rocks (while the child is with others without pacifier). In Figure 3 at left, James Starnes uses the state geologic map to locate the site where a couple found a tapir jaw bone with teeth. At right a young girl has brought a "dinosaur tooth" for authentication. James must report that it just a chert pebble from gravel. Figure 4 shows two interesting specimens brought for identification; at left is a rare Oligocene species of the gastropod genus *Clavilithes*, and the other is the Pleistocene tapir jaw and teeth brought in by the couple in Figure 3. In Figure 5 at left, Louis Zachos of the University of Mississippi Geology Department discusses fossil echinoids (urchins); at right, Gary Stringer of the University of Louisiana at Monroe Geology Department uses the jaws of a modern shark to explain fossil shark teeth.

Figure 2. At left is a couple with a baby stroller. At right, on closer examination, the stoller is full of rocks, while their three young children are on foot. At top on the stroller's tray is a mosasaur vertebra.

Figure 3. At left, FOX News records as James Starnes uses the state geologic map to locate the site where a couple found a fossil tapir jaw. At right, James dismisses a young lady's prize rock with the heartless verdict--(as retold with writer's license) "No 'Virginia,' it's not a dinosaur tooth."

Figure 4. Two important finds brought to the Fossil Road Show. At left is a rare marine snail of the genus *Clavilithes* from the Vicksburg Group at Cleary, Mississippi. At right is the jaw and teeth of a Pleistocene tapir from Mississippi.

Figure 5. At left, Louis Zachos of the University of Mississippi Geology Department discusses fossil echinoids (sea urchins); at right Gary Stringer of the University of Louisiana at Monroe uses modern shark jaws to discuss fossil shark teeth.

Beside a display of their newly acquired dinosaur bone, MMNS had a special display of the Red Hot Truck Stop land mammal site in Meridian, Mississippi (Figure 6), and the casts of fossil teeth from 22 different species from the site donated by the Carnegie Museum of Natural History. The October 2008 issue of *Environmental News* (page 5) has an article on one of these land mammals. It is the species *Teilhardina magnoliana*, which is believed to be the second oldest fossil primate. The Office of Geology helped arrange for the preservation of the Red Hot Truck Stop fossil site during the construction of the Super Walmart store at that location. We also assisted Chris Beard and his staff and volunteers during five excavations at the site over a ten-year period from November of 1990 to November of 2000. In thanks for this help, I have a fossil namesake among the Red Hot Truck Stop fauna, a cast of which Peter Kuchirka (volunteer preparator at MMNS) shows in Figure 6 at right.

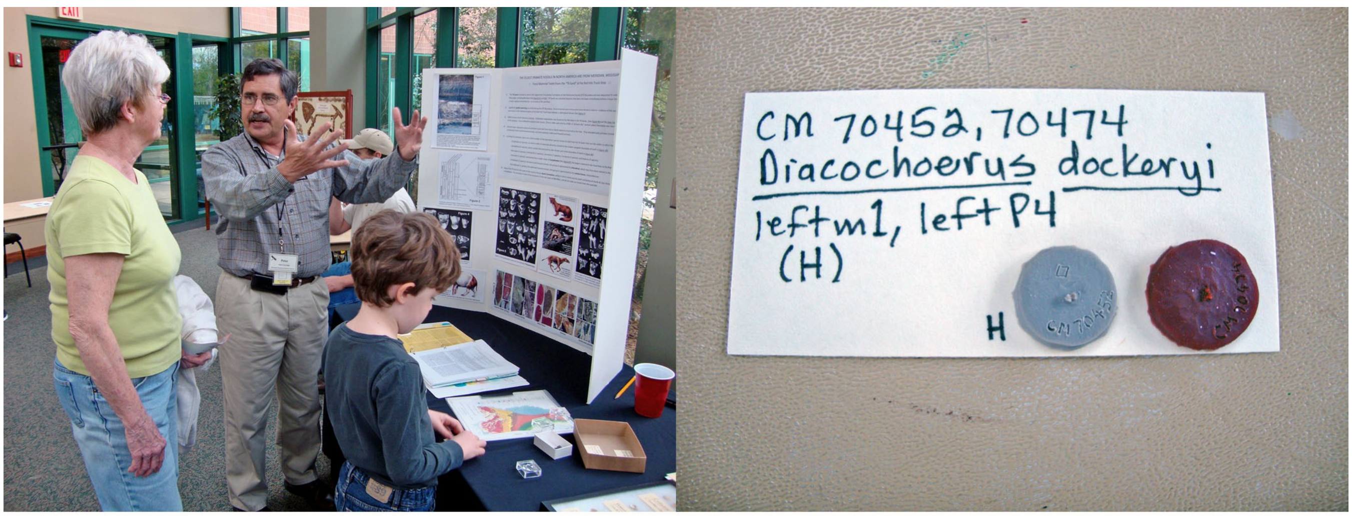

Figure 6. Peter Kuchirka, volunteer paleontology preparator with the Mississippi Museum of Natural Science, discusses fossil land mammals from the Red Hot Truck Stop locality at Meridian, Mississippi. He then showed me two casts of fossil land mammal teeth named in my honor--they are the tiny raised specks on the round disks.

Environmental News, March 2012, volume 9, issue 3, pages 22-24

THE MISSISSIPPI GEM & MINERAL SOCIETY 53RD ANNUAL "ROCK" SHOW

David T. Dockery III, Office of Geology

The annual Mississippi Gem & Mineral Society "Rock" show, which is generally held in the last weekend of February, is a big attraction for geologists and amateur rock collectors in Mississippi and neighboring states. The show has rock and fossil exhibits, touch-and-feel displays for children, and booths set up by various university geology departments, state agencies, and other geology-related organizations. It also has a number of dealers with rocks, fossils, gemstones, and jewelry for sale.

The feature exhibit for the 53rd Annual Rock Show, and a favorite from past shows, was the Rock Food Table set up by Bill and Lois Pattilo from the Gulf Coast Gem and Mineral Society in Corpus Christi, Texas (Figure 1). It is a display that the Pattilos have exhibited in rock shows nationwide since their first exhibit in Corpus Christi in 1983. Their fourth exhibit of the Rock Food Table was at the Mississippi Gem and Mineral Society's annual Jackson show in 1984. All "food" items on the two Rock Food Tables are rocks that look like food. The one exception is a bowl of rock candy. If a viewer is able to pick out the candy from the rocks, they are rewarded with a sample.

Figure 1. The feature exhibit at the 53rd Annual Rock Show included two tables set for a feast-- but all the enticing food items were rocks. At left is the dinner table, and at right is the breakfast table.

Perhaps the most fun to be had at the annual rock show is in shopping for good deals on minerals, fossils, gemstones, and jewelry. While shopping, it's always interesting to see if any of the items for sale came from Mississippi or adjoining states. A fossil crab from Mississippi (illustrated on page 14 in the January 2009 issue of the MDEQ newsletter) at a dealer's table during the 1983 Annual Show had an asking price of $495. A similar fossil crab at the 2012 Show had an asking price of $1,200 (Figure 2).

Figure 2. Fossil crab inflation. A similar fossil crab of the species *Avitelmessus grapoideus* from Union County, Mississippi, at the 1983 show cost $495 (see page 14 of the January 2009 MDEQ newsletter). This fossil crab from Tennessee cost $1,200. Specimen is in case at left and held by the dealer at right for closer examination.

The Mississippi Office of Geology has a long tradition of representing the agency with a booth at the annual Jackson rock show. This year we were joined by a booth sponsored by the Mississippi Office of Land and Water Resources, which exhibited various aquifer sands from Mississippi (Figure 3). Booths were also sponsored by the Geoscience Department at Mississippi State University (Figure 4), the geology departments of the University of Mississippi and the University of Southern Mississippi (Figure 5), the Mississippi State Board of Registered Professional Geologists, and other groups. The Annual Mississippi Gem and Mineral Show presents an opportunity for the Office of Geology staff to meet area rock and fossil collectors and to examine their interesting finds. These collectors often share valuable information on fossil localities and interesting geological sites and provide important contacts if we wish to locate property owners or need a native guide to see some out-of-the-way place for ourselves.

Figure 3. Office of Geology booth at left with Tom Ray and Michael Bograd behind the table. At right is the Office of Land and Water Resources booth with Pat Mason and Michael Shuttlesworth behind a display of aquifer sands and gravels. Picture was taken on February 25, 2012.

Figure 4. Mississippi State University Geosciences Department booth at left with a container of colorful eggs with little dinosaurs inside. At right are real dinosaur eggs from Montana. The computer screen shows a CT scan of two eggs with tiny baby dinosaur bones inside.

Figure 5. Students and faculty from Ole Miss (left) and the University of Southern Mississippi (right) represent their geology departments at their respective booths at the 53rd Annual Rock Show.

PICTURE OF THE MONTH

Taken by James Starnes, Office of Geology. Geode of chalcedony growth over quartz crystals from Pre-loess gravels, Warren County.

The Office of Geology collects geological samples for the purpose of research as the state's geological survey. The office has a large collection of representative samples from all over the state which includes cores, drill samples, electrical logs, rock outcrop specimens, minerals, and fossils. The office continually adds specimens as part of field mapping efforts and through other field exercises.

PUBLICATION OF: *RECHARGE ZONES IN THE MISSISSIPPI-YAZOO ALLUVIAL PLAIN* MAPS, DEPICTING BLUFF MARGIN ALLUVIAL FANS

James E. Starnes, Office of Geology; and Pat Mason, Office of Land and Water Resources

Alluvial fans are common in desert landscapes, where mountain streams empty into arid basins. Most people would not imagine that they also exist in a humid, coastal plain state like Mississippi. Just the same, alluvial fans form a fairly continuous chain at the foot of the highlands bordering the eastern boundary of the Mississippi-Yazoo alluvial plain (“the Delta”.) Streams crossing the Loess Hills deposit their sediment loads with conspicuous relief onto the Mississippi-Yazoo alluvial plain, much the same as mountain streams do when reaching the desert floor. Each alluvial fan possesses its own unique depositional history. Test holes drilled by the Office of Geology and Office of Land and Water Resources indicate that some of the fans may be geologically recent, and rest on top of the Mississippi River valley’s alluvial sediments. Other fans appear to be as old as the Mississippi River valley’s alluvium, and interfinger with its sediments. Some fans, as indicated by surficial archaeological sites, have experienced virtually no deposition for thousands of years, while others have seen significant deposition in recent history.

The eastern bluff margin of the Mississippi River valley was cut by ancient courses of the Mississippi River, and backfilled with the river’s alluvial sediments. The smaller streams that flow, from east to west, across Tertiary bedrock and coarse-grained Pre-Loess Terrace Deposits, carry a more coarse-grained sediment load than exists near the surface in the adjacent Mississippi River valley alluvium. During dry seasonal periods, a stream’s flow may disappear on its alluvial fan, as the flow filters through the fan’s coarse sediment. This action works to recharge the Mississippi River valley’s alluvial aquifer (MRVA), in the same way desert streams, and associated fans, recharge basin aquifers. This transfer of surface waters into the alluvial aquifer through alluvial fans has been found to be a significant and necessary factor to be considered in developing accurate aquifer models.

The natural relief of the alluvial fans, in the lower Yazoo Basin, protected some crops from flood waters in the record Mississippi River flood of 2011. Likewise, these same fan systems protected Native American sites from flooding in ancient times, and are recognized as important sites for cultural resources.

The entire reach of the fans within the state of Mississippi has been mapped and is depicted in Figures 1 and 2 (*Recharge Zones in the Mississippi-Yazoo Alluvial Plain*: Office of Land and Water Resources OLWR Hydrologic Map 2011-7, 2 sheets).

Copies of the map sheets, as well as a shapefile of the fans which G.I.S. users may use in their own work, are available for download on MDEQ’s website: www.deq.state.ms.us/MDEQ.nsf/page/L&W_Publications_List?OpenDocument.

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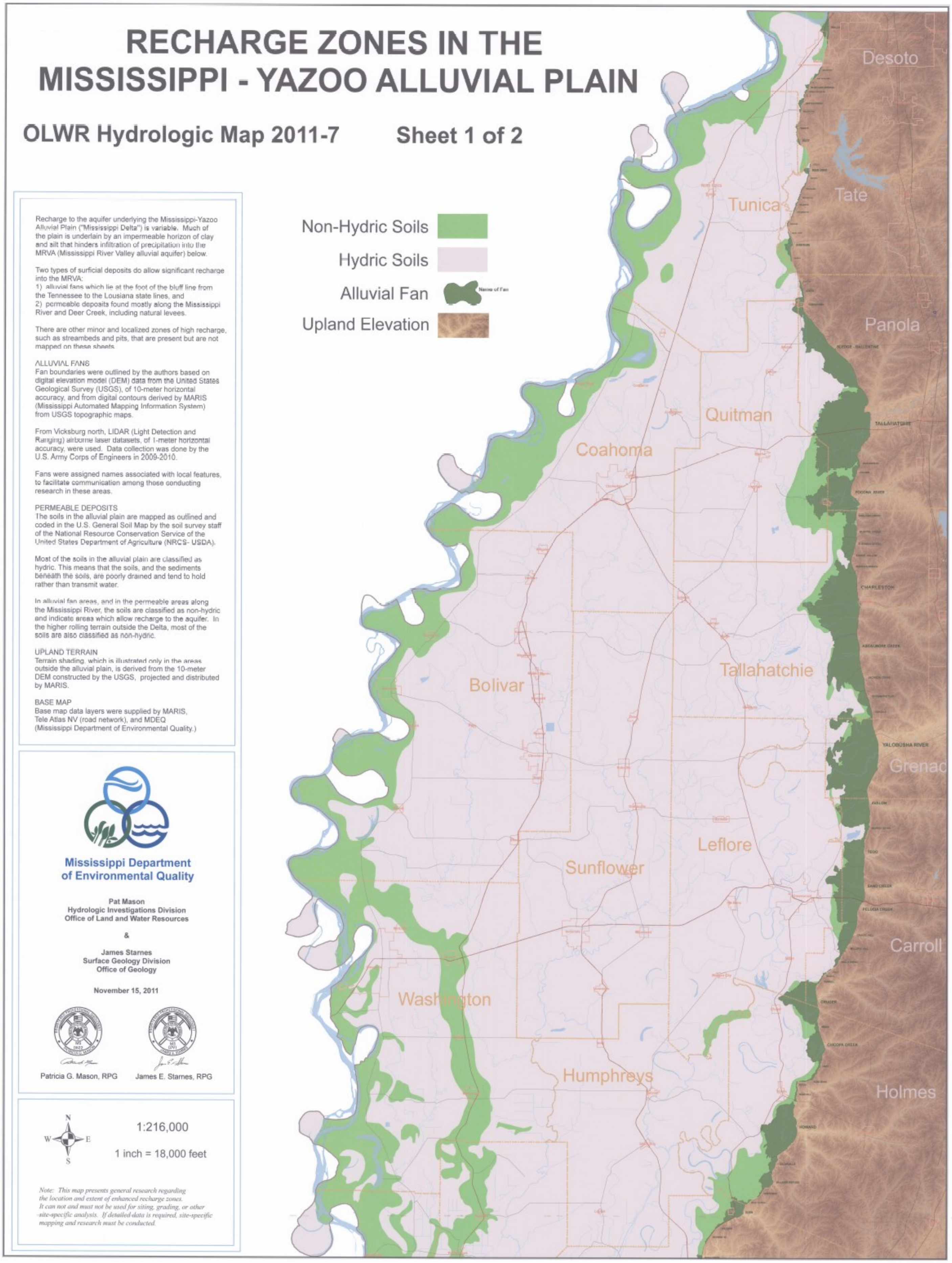
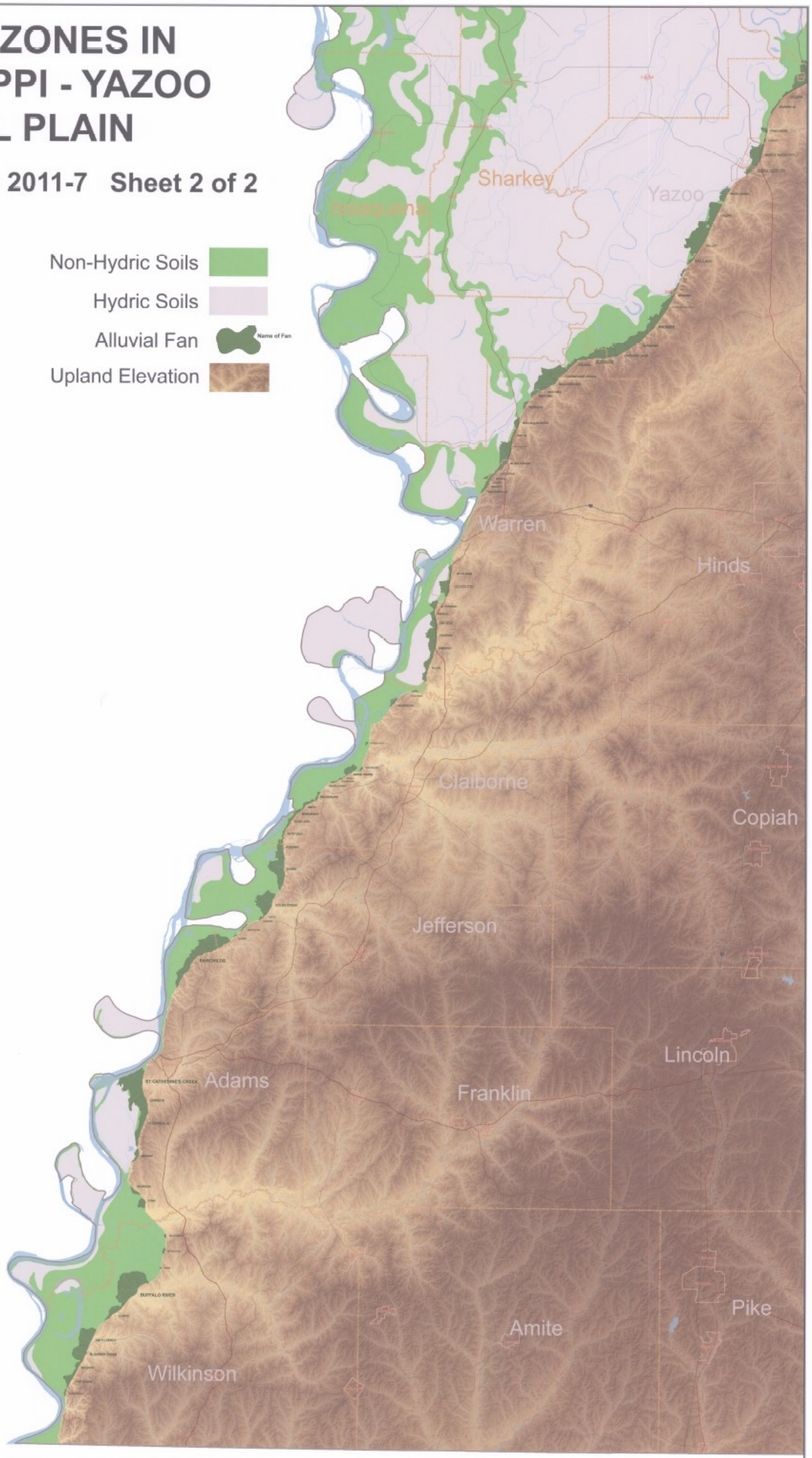

RECHARGE ZONES IN THE
MISSISSIPPI - YAZOO ALLUVIAL PLAIN
OLWR Hydrologic Map 2011-7
Sheet 1 of 2
Recharge to the aquifer underlying the Mississippi-Yazoo Alluvial Plain ("Mississippi Delta") is variable. Much of the plain is underlain by an impermeable horizon of clay and silt that hinders infiltration of precipitation into the MRVA (Mississippi River Valley alluvial aquifer) below.
Two types of surficial deposits do allow significant recharge into the MRVA:
1) alluvial fans which lie at the foot of the bluff line from the Tennessee to the Lousiana state lines, and
2) permeable deposits found mostly along the Mississippi River and Deer Creek, including natural levees.
There are other minor and localized zones of high recharge, such as streambeds and pits, that are present but are not mapped on these sheets.
ALLUVIAL FANS
Fan boundaries were outlined by the authors based on digital elevation model (DEM) data from the United States Geological Survey (USGS), of 10-meter horizontal accuracy, and from digital contours derived by MARIS (Mississippi Automated Mapping Information System) from USGS topographic maps.
From Vicksburg north, LIDAR (Light Detection and Ranging) airborne laser datasets, of 1-meter horizontal accuracy, were used. Data collection was done by the U.S. Army Corps of Engineers in 2009-2010.
Fans were assigned names associated with local features, to facilitate communication among those conducting research in these areas.
PERMEABLE DEPOSITS
The soils in the alluvial plain are mapped as outlined and coded in the U.S. General Soil Map by the soil survey staff of the National Resource Conservation Service of the United States Department of Agriculture (NRCS- USDA).
Most of the soils in the alluvial plain are classified as hydric. This means that the soils, and the sediments beneath the soils, are poorly drained and tend to hold rather than transmit water.
In alluvial fan areas, and in the permeable areas along the Mississippi River, the soils are classified as non-hydric and indicate areas which allow recharge to the aquifer. In the higher rolling terrain outside the Delta, most of the soils are also classified as non-hydric.
UPLAND TERRAIN
Terrain shading, which is illustrated only in the areas outside the alluvial plain, is derived from the 10-meter DEM constructed by the USGS, projected and distributed by MARIS.
BASE MAP
Base map data layers were supplied by MARIS, Tele Atlas NV (road network), and MDEQ (Mississippi Department of Environmental Quality.)
Non-Hydric Soils
Hydric Soils
Alluvial Fan
Upland Elevation
Mississippi Department of Environmental Quality
Pat Mason
Hydrologic Investigations Division
Office of Land and Water Resources
&
James Starnes
Surface Geology Division
Office of Geology
November 15, 2011
Patricia G. Mason, RPG
James E. Starnes, RPG
N
W
E
S
1:216,000
1 inch = 18,000 feet
Note: This map presents general research regarding the location and extent of enhanced recharge zones. It can not and must not be used for siting, grading, or other site-specific analysis. If detailed data is required, site-specific mapping and research must be conducted.
Desoto
Tate
Tunica
Panola
Quitman
Coahoma
Tallahatchie
Bolivar
Grenad
Leflore
Sunflower
Carroll
Washington
Humphreys
Holmes

RECHARGE ZONES IN THE MISSISSIPPI - YAZOO ALLUVIAL PLAIN

OLWR Hydrologic Map 2011-7 Sheet 2 of 2



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Mississippi Department of Environmental Quality

Pat Mason
Hydrologic Investigations Division
Office of Land and Water Resources

&

James Starnes
Surface Geology Division
Office of Geology

November 15, 2011

Patricia G. Mason, RPG
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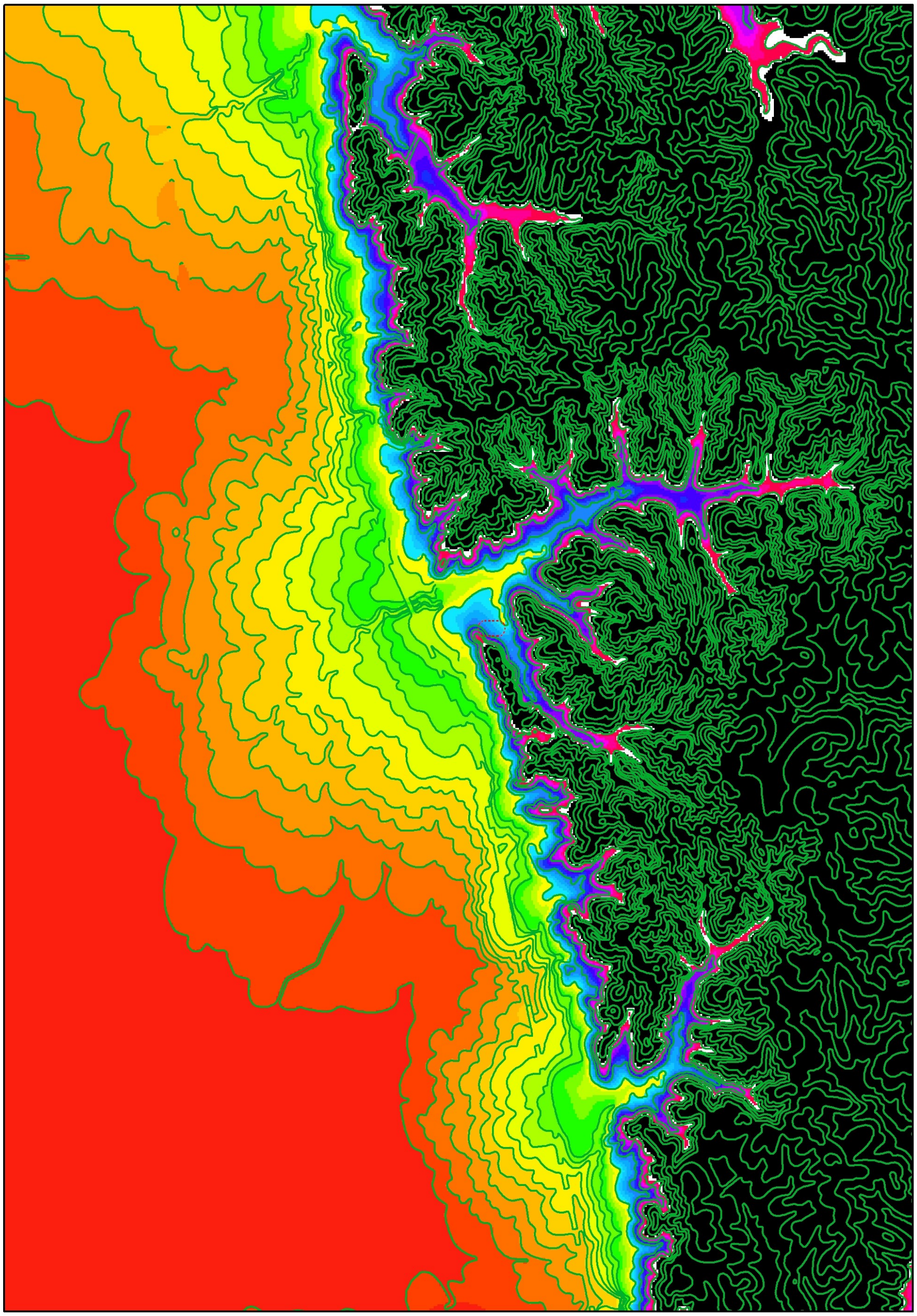
1:216,000

1 inch = 18,000 feet

Note: This map presents general research regarding the location and extent of enhanced recharge zones. It can not and must not be used for siting, grading, or other site-specific analysis. If detailed data is required, site-specific mapping and research must be conducted.

Figure 3 is an example of a color-shaded relief map produced from 10-meter DEM data. The utilization of such detailed topographic imagery allows for a series of alluvial fans in southeastern Tallahatchie County to be easily recognized and delineated.



GEOLOGIC 7.5-MINUTE QUADRANGLE MAPS GO ONLINE

David T. Dockery III and David E. Thompson, Office of Geology

We want to spread the word about an accomplishment that people have been requesting for quite some time—our geologic 7.5-minute quadrangle maps are now available online. The maps now online were supported by federal funding and published as hard copies within a 16-year period from 1996 to 2011. State geological surveys in 48 states have competed for federal funding through STATEMAP grants to map their states' surface geology. This program has contributed (through the grant year 2012) $1,512,863 in support of geologic mapping in Mississippi.

Up until the late 1980s, the Office of Geology (then the Bureau of Geology) published county geologic maps in conjunction with county geological reports (bulletins). These maps were generally at a scale of 2 miles = 1 inch or 1:126,720. Forty of Mississippi's eighty-two counties were mapped in this way. Geologic maps for the last published county bulletin, Tishomingo County Geology and Mineral Resources by Bob Merrill (now in MDEQ's Groundwater Assessment and Remediation Division) and others (1988), included a two part geologic map at a scale of 1 mile = 1 inch or 1:63,360, as well as geologic maps for the individual 7.5-minute quadrangles that covered the county at a scale of 1:24,000. This latter scale is more suitable for site-specific determination of bedrock geology.

In 1989, federal 50/50 match funding under the COGEOMAP program became available for geologic mapping in Mississippi. This money helped support the work of Wayne Stover and Phillip Weathersby (both now with the Office of Pollution Control) in mapping Mississippi's Midway and Wilcox groups in east-central Mississippi. George Puckett also joined this mapping effort before returning to the oil industry as a geophysicist. Others who worked in the geological mapping program were Don Bates, now Vice President at Thompson Engineering and an alderman for the City of Canton, and Seth Berman, now a geophysicist with Saudi Aramco.

In 1994, John Marble of the Office of Geology's Environmental Geology Division and Lindsey Stewart of the Office of Land and Water Resources received 50/50 match funding under the new STATEMAP federal program to map the Latimer and Vestry 7.5-minute quadrangles in Jackson County, Mississippi (not yet among those maps available online). In 1996, STATEMAP funding was used by the Surface Geology Division to support geologic mapping of 7.5-minute quadrangles in the outcrop belt of the Midway and Wilcox groups in northeastern Mississippi by David Thompson and in the Claiborne Group of north-central Mississippi by Steve Ingram. In 2001, a new component was added to the mapping effort, as James Starnes and Ken Davis worked to differentiate the Miocene of southern Mississippi into component formations. Geologic mapping continues today in the Midway, Wilcox, and Claiborne groups (mapped by David Thompson) and in the Oligocene and Miocene of southern Mississippi (mapped by James Starnes). This team has mapped eight quadrangles each year in recent years. Beginning in 2005 (Open-File Report OF-196 and higher), geologic quadrangle maps include a geologic cross section at the bottom of the map.

All geologic quadrangle maps are printed in house in color on single sheets and are available at the Office of Geology Map and Publication Sales office on the first floor of the 700 North State Street Building at $6 each (if requested by mail, add $5 postage for rolled, or $2 for folded).

Recently, the U.S. Geological Survey requested that all states make their federally funded STATEMAP quadrangles available online in digital form. This has been undertaken and accomplished by the Surface Geology Division's GIS specialist Dan Morse. Currently, 115 color geologic quadrangle maps can be viewed or downloaded by: (1) going to MDEQ's homepage, (2) clicking on "The Office of Geology," (3) under "Direct Links" clicking on "List of Publications," (4) under "List of Publications" clicking on "Open-File Reports," and (5) scrolling to the desired map and clicking on "Download Map (PDF)." The size of the map in MB is provided. Figure 1 shows the location of the geologic quadrangle maps available online, each identified by its Open-File Report number.

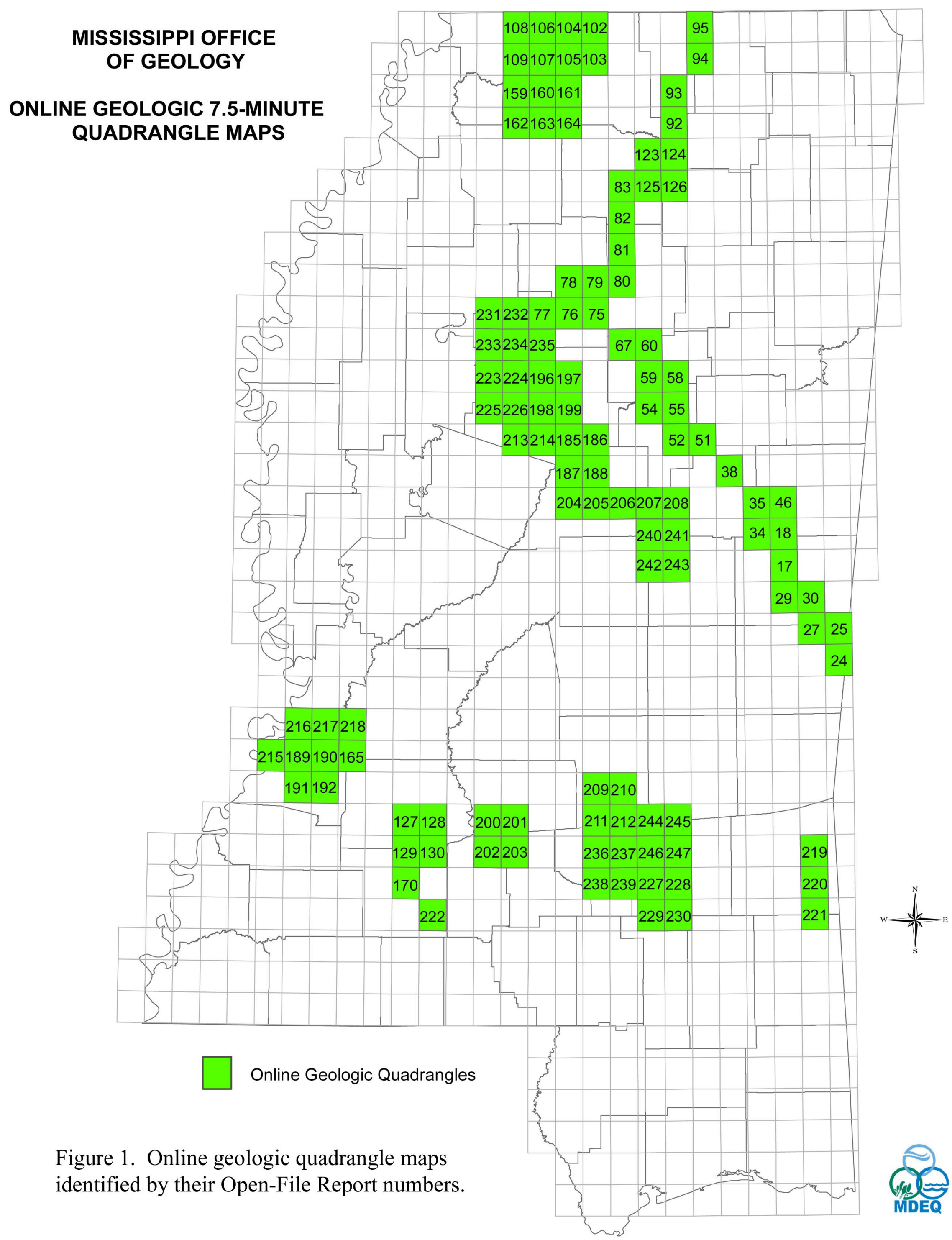


Figure 1. Online geologic quadrangle maps identified by their Open-File Report numbers.

Geologic quadrangle maps have many applications within MDEQ, including: (1) well head protection of water wells, (2) protection of aquifer recharge areas, (3) groundwater models, (4) differentiation of aquifers for regulation of water usage, (5) remediation of underground storage tank leaks, (6) remediation of Superfund and brownfield sites, (7) permitting of sanitary landfills and class I and class II rubbish sites (i.e., is the site suitable), (8) locating economic mineral resources for development, and (9) identifying geologic hazards such as slope failures and foundation problems. It is helpful that the companies and contractors planning such things as landfills, rubbish sites, and remediation projects now have readily available geologic maps produced by MDEQ. Stakeholders, as well as the regulated community, can refer to these maps for planning and research. Examples of two geologic quadrangle maps, Plattsburg and Hebron, published in 2011 are given respectively in figures 2 and 3.

Geologic maps of additional areas or at different scales (including the state geologic map) are available currently in hard copy at the Map and Publication Sales office.

(see next two pages for figures 2 and 3).

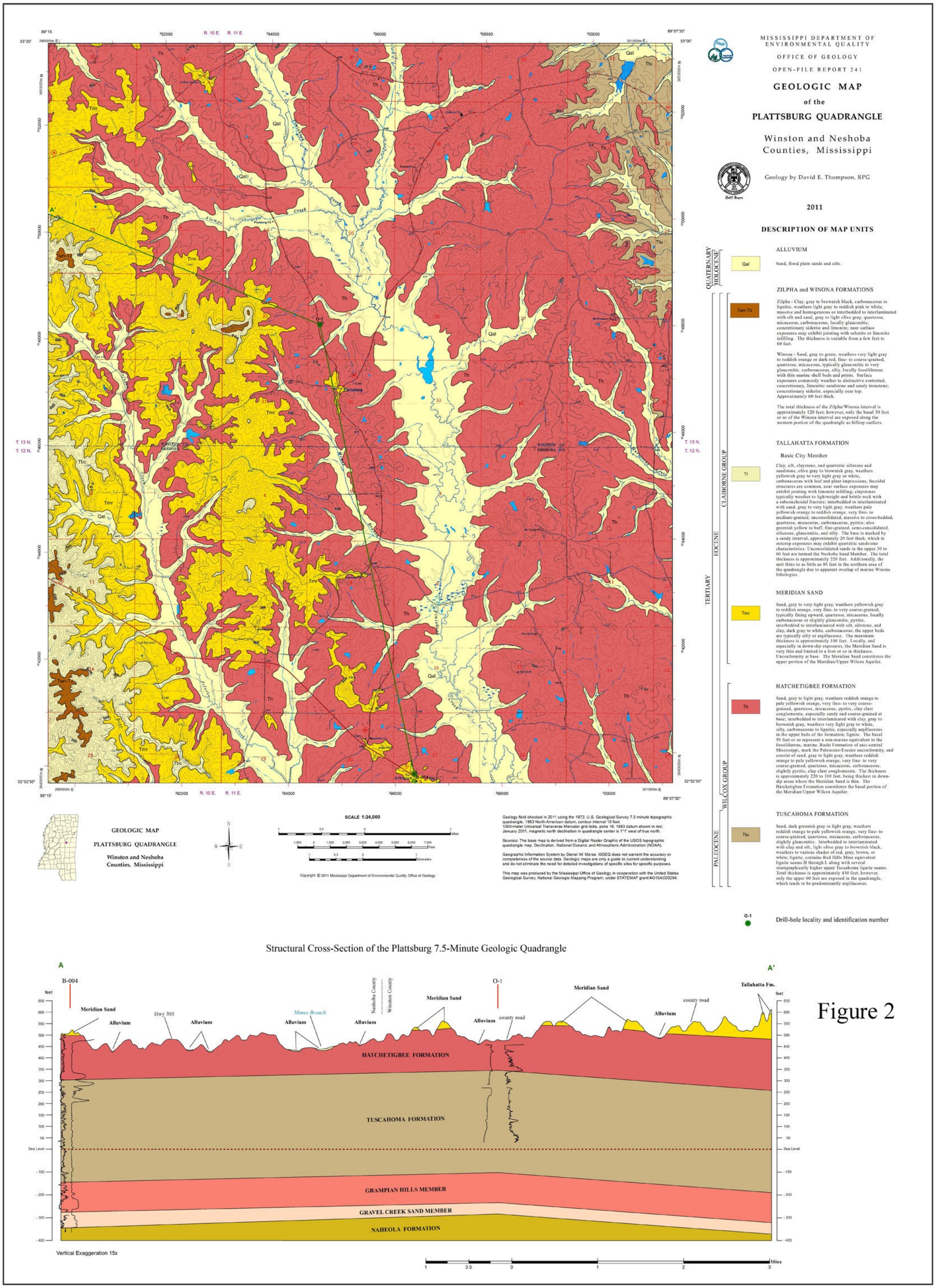

MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF GEOLOGY
OPEN-FILE REPORT 241
GEOLOGIC MAP
of the
PLATTSBURG QUADRANGLE
Winston and Neshoba Counties, Mississippi
Geology by David E. Thompson, RPG
2011
DESCRIPTION OF MAP UNITS
QUATERNARY
HOLOCENE
ALLUVIUM
Qal
Sand, flood plain sands and silts.
ZILPHA and WINONA FORMATIONS
Twn-Tz
Zilpha - Clay, gray to brownish black, carbonaceous to lignitic, weathers light gray to reddish pink to white, massive and homogeneous or interbedded to interlaminated with silt and sand, gray to light olive gray, quartzose, micaceous, carbonaceous, locally glauconitic; concretionary siderite and limonite; near surface exposures may exhibit jointing with selenite or limonite infilling. The thickness is variable from a few feet to 60 feet.
Winona - Sand, gray to green, weathers very light gray to reddish orange or dark red, fine- to coarse-grained, quartzose, micaceous, typically glauconitic to very glauconitic, carbonaceous, silty, locally fossiliferous with thin marine shell beds and prints. Surface exposures commonly weather to distinctive contorted, concretionary, limonitic sandstone and sandy ironstone; concretionary siderite, especially near top. Approximately 60 feet thick.
The total thickness of the Zilpha/Winona interval is approximately 120 feet; however, only the basal 50 feet or so of the Winona interval are exposed along the western portion of the quadrangle as hilltop outliers.
TERTIARY
EOCENE
CLAIBORNE GROUP
TALLAHATTA FORMATION
Basic City Member
Tt
Clay, silt, claystone, and quartzitic siltstone and sandstone, olive gray to brownish gray, weathers yellowish gray to very light gray or white, carbonaceous with leaf and plant impressions, fucoidal structures are common, near surface exposures may exhibit jointing with limonite infilling; claystones typically weather to lightweight and brittle rock with a subconchoidal fracture; interbedded to interlaminated with sand, gray to very light gray, weathers pale yellowish orange to reddish orange, very fine- to medium-grained, unconsolidated, massive to cross-bedded, quartzose, micaceous, carbonaceous, pyritic; also greenish yellow to buff, fine-grained, semi-consolidated, siliceous, glauconitic, and silty. The base is marked by a sandy interval, approximately 20 feet thick, which in outcrop exposures may exhibit quartzitic sandstone characteristics. Unconsolidated sands in the upper 30 to 60 feet are termed the Neshoba Sand Member. The total thickness is approximately 220 feet. Additionally, the unit thins to as little as 80 feet in the northern area of the quadrangle due to apparent overlap of marine Winona lithologies.
MERIDIAN SAND
Tmr
Sand, gray to very light gray, weathers yellowish gray to reddish orange, very fine- to very coarse-grained, typically fining upward, quartzose, micaceous, locally carbonaceous or slightly glauconitic, pyritic, interbedded to interlaminated with silt, siltstone, and clay, dark gray to white, carbonaceous; the upper beds are typically silty or argillaceous. The maximum thickness is approximately 100 feet. Locally, and especially in down-dip exposures, the Meridian Sand is very thin and limited to a foot or so in thickness. Unconformity at base. The Meridian Sand constitutes the upper portion of the Meridian/Upper Wilcox Aquifer.
WILCOX GROUP
HATCHETIGBEE FORMATION
Th
Sand, gray to light gray, weathers reddish orange to pale yellowish orange, very fine- to very coarse-grained, quartzose, micaceous, pyritic, clay clast conglomerate, especially sandy and coarse-grained at base; interbedded to interlaminated with clay, gray to brownish gray, weathers very light gray to white, silty, carbonaceous to lignitic, especially argillaceous in the upper beds of the formation; lignite. The basal 50 feet or so represent a non-marine equivalent to the fossiliferous, marine, Bashi Formation of east-central Mississippi, mark the Paleocene/Eocene unconformity, and consist of sand, gray to light gray, weathers reddish orange to pale yellowish orange, very fine- to very coarse-grained, quartzose, micaceous, carbonaceous, slightly pyritic, clay clast conglomerate. The thickness is approximately 220 to 310 feet, being thickest in down-dip areas where the Meridian Sand is thin. The Hatchetigbee Formation constitutes the basal portion of the Meridian/Upper Wilcox Aquifer.
PALEOCENE
TUSCAHOMA FORMATION
Ttu
Sand, dark greenish gray to light gray, weathers reddish orange to pale yellowish orange, very fine- to coarse-grained, quartzose, micaceous, carbonaceous, slightly glauconitic. Interbedded to interlaminated with clay and silt, light olive gray to brownish black, weathers to various shades of red, gray, brown, or white; lignite, contains Red Hills Mine equivalent lignite seams H through L along with several stratigraphically higher upper Tuscahoma lignite seams. Total thickness is approximately 430 feet; however, only the upper 60 feet are exposed in the quadrangle, which tends to be predominantly argillaceous.
O-1
Drill-hole locality and identification number
GEOLOGIC MAP
PLATTSBURG QUADRANGLE
Winston and Neshoba Counties, Mississippi
SCALE 1:24,000
Copyright © 2011 Mississippi Department of Environmental Quality, Office of Geology
Geology field checked in 2011 using the 1972, U.S. Geological Survey 7.5-minute topographic quadrangle, 1983 North American datum, contour interval 10 feet.
1000-meter Universal Transverse Mercator grid ticks, zone 16; 1983 datum shown in red; January 2011, magnetic north declination in quadrangle center is 1°1' west of true north.
Sources: The base map is derived from a Digital Raster Graphic of the USGS topographic quadrangle map. Declination, National Oceanic and Atmospheric Administration (NOAA).
Geographic Information System by Daniel W. Morse. MDEQ does not warrant the accuracy or completeness of the source data. Geologic maps are only a guide to current understanding and do not eliminate the need for detailed investigations of specific sites for specific purposes.
This map was produced by the Mississippi Office of Geology in cooperation with the United States Geological Survey, National Geologic Mapping Program, under STATEMAP grant #G10AC00294.
Structural Cross-Section of the Plattsburg 7.5-Minute Geologic Quadrangle
A
A'
B-004
O-1
Meridian Sand
Alluvium
Hwy 395
Mines Branch
Neshoba County
Winston County
county road
Tallahatta Fm.
HATCHETIGBEE FORMATION
TUSCAHOMA FORMATION
GRAMPIAN HILLS MEMBER
GRAVEL CREEK SAND MEMBER
NAHEOLA FORMATION
Sea Level
feet
Vertical Exaggeration 15x
Miles

Figure 2

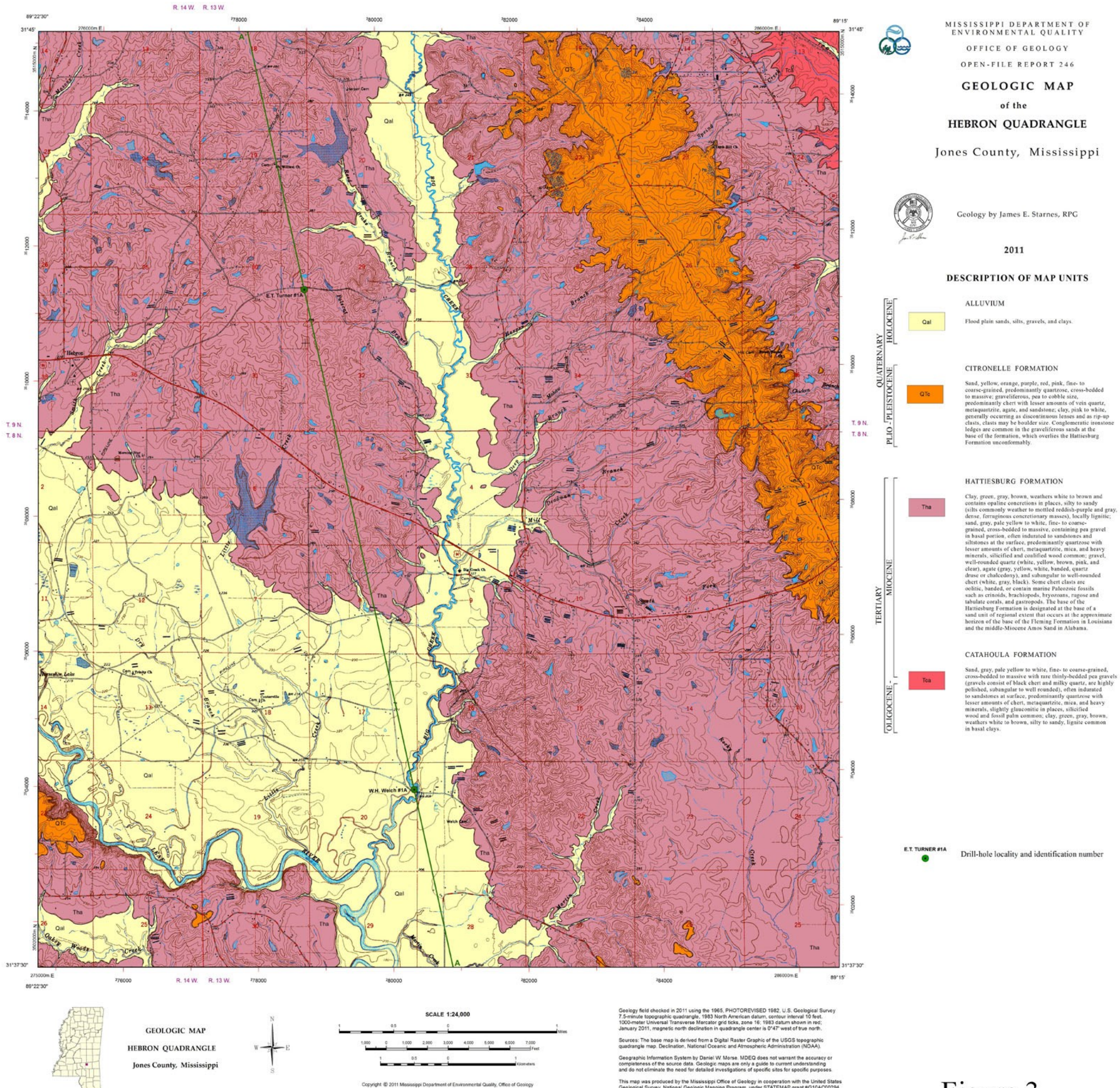
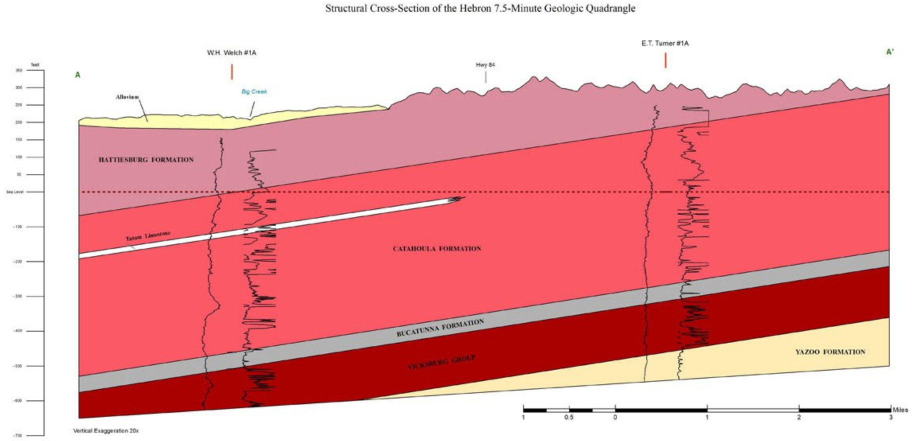


Figure 3

Structural Cross-Section of the Hebron 7.5-Minute Geologic Quadrangle



Environmental News, May 2012, volume 9, issue 5, pages 15-19

THE GEOLOGY OF THE MISSISSIPPI CHILDREN'S MUSEUM

David T. Dockery III, Office of Geology

The Mississippi Office of Geology assisted with the first and second Mississippi Children's Educational Fairs in April of 2008 and 2009 and with the design of geological exhibits for the Mississippi Children's Museum (MCM) in Jackson (Figure 1), which opened on December 4, 2010. In its first year of operation, MCM saw more than 230,000 visitors; it was named the 2011 Travel Attraction of the Year by the Mississippi Tourism Association. The late Preston Myers Hays (passed on March 11, 2012) was the Chair of the first Educational Fair in 2008 and, as a Board Member of MCM, was a driving force in the museum's early development. She and other members of the Junior League of Jackson and the Mississippi Children's Museum Partners solicited the help of MDEQ with the Educational Fairs and solicited the Office of Geology for help with museum exhibit designs.

Figure 1. Mississippi Children's Museum, Jackson, Mississippi. Picture was taken on April 27, 2012.

In January of 2010, while the MCM building was under construction, work began in earnest of the geological exhibits. The museum's largest exhibit is a raised map of Mississippi, with selected attractions on the topside and with geological attractions in the underground. John Apanites and Michael Damschroder with Kraemer Design & Production, Inc., in Cincinnati, Ohio, were the designers and manufacturers of the geology exhibits. The Mississippi underground was to have: (1) a correct geologic section and stratigraphy displayed in the walls, (2) a buried volcano beneath the State Capitol Building complete with seismic monitoring devices, (3) a display case with a collection of sedimentary, metamorphic, and igneous rocks, (4) an oil and gas exploratory drill hole, (5) a soil profile with Indian artifacts in the lower soil and historical materials in the upper soil, and (6) a gopher tortoise burrow (and more). Above ground were the fossil whale dig, real fossil whale bones, and Mississippi's highest peak, Mt. Woodall. Jamie Harris, Chairman of the Millsaps College Geology Department, worked with the Office of Geology in helping with geological designs, and even went to the corporate headquarters to monitor work on the final production.

Figure 2 shows the fossil whale vertebrae in the touch-and-feel exhibit and the fossil whale dig, where replica whale bones of the small whale *Zygorhiza* are partially covered in a granular material, waiting to be dug out. The Office of Geology donated two fossil whale vertebrae for the touch and feel exhibit. The smaller one on the left in Figure 2 was found during the construction of the dam for the Ross Barnett Reservoir. The discovery made the front page headlines of the April 19, 1962, issue of the *Rankin County News*: "Skeleton of Huge Prehistoric Monster Uncovered by Workmen at Reservoir." A follow up article in the April 26, 1962, issue dubbed the fossil "Willie the Whale." The larger vertebra at the right in Figure 2 was found during work on the geology of Clarke County (Figure 3).

Figure 2. At left: fossil whale bones. The one on the left, "Willie the Whale," was found in the Yazoo Clay during construction for the dam at the Ross Barnett Reservoir; the one on the right was found in the "bone yard" in the Pachuta Marl Member of the Yazoo Formation in Clarke County, Mississippi. At right: fossil whale dig with replica bones of the genus *Zygorhiza*. Pictures were taken on January 4, 2012.

Figure 3. At left: David Williamson holding a basilosaur vertebra weathered from the Pachuta Marl Member of the Yazoo Formation at the "bone yard" in Clarke County, Mississippi (MGS locality 47). At right: fossil whale vertebrae scattered on the surface give the site its name, the bone yard; the vertebra at left is on display at the Mississippi Children's Museum. Picture was taken on taken on August 26, 1976.

On April 1, 2010, my Invertebrate Paleontology class at Millsaps College and Zach Musselman's Geomorphology class took a combined field trip to Lee County, Mississippi, to collect Cretaceous fossils from the Birmingham Ridge Lime Quarry for use in MCM exhibits (Figure 4). Selected fossils from this field trip were placed in the Selma Chalk layer of the Mississippi underground exhibit. The Mississippi underground stratigraphy is shown in Figure 5. From bottom to top, the layers include: (1) the Eutaw Group of Cretaceous age, represented by the Tombigbee Sand, with impressions of the fossil clam *Inoceramus*, (2) the Selma Group of Cretaceous age, represented by the Bluffport Member of the Demopolis Chalk, with the fossil oyster shells *Exogyra cancellata* and *Pycnodonta mutabilis*, (3) the Midway Group of Paleocene age, represented by the Clayton Formation, and (4) soil resting on bedrock. The soil of layer 4 contains Native American artifacts donated by James Starnes in its lower part, and historical artifacts provided by Robert Seyfarth in its upper part. At left in Figure 5 is a monitor, showing how oil wells are drilled; a string of drill pipe and bit penetrate the strata of the wall at far right. At right is a display case of sedimentary, igneous, and metamorphic rocks.

Figure 4. At left: Millsaps College Invertebrate Paleontology class and Geomorphology class field trip to collect fossils for the Mississippi Children's Museum from the Bluffport Marl Member of the Demopolis Chalk at the Birmingham Ridge Lime Plant quarry in Lee County, Mississippi. At right: concentration of fossil oyster shells of the species *Exogyra cancellata*. Pictures were taken on April 1, 2010.

Figure 5. At left: strata in the Mississippi underground, with a drill stem and bit at far right and a video of oil-well drilling displayed on the monitor. At right: a display case showing sedimentary, metamorphic, and igneous rocks. Pictures were taken on January 4, 2012.

The Volcano Room under the State Capitol Building at Jackson (displayed above ground) is shown in Figure 6. At left in the figure is a red-hot-lava path leading to the buried Jackson Volcano, which has an incandescent throat with upturned strata on each side. At right is a push-pump device, where children can put pressure on the lava to create an eruption. Also in the room is a video on plate tectonics and a seismograph-earthquake machine (Figure 7, left), where children can feel earthquakes of varying magnitudes. If things get too "hot" in the Mississippi underground, children can always have a view of the world above (Figure 7, right).

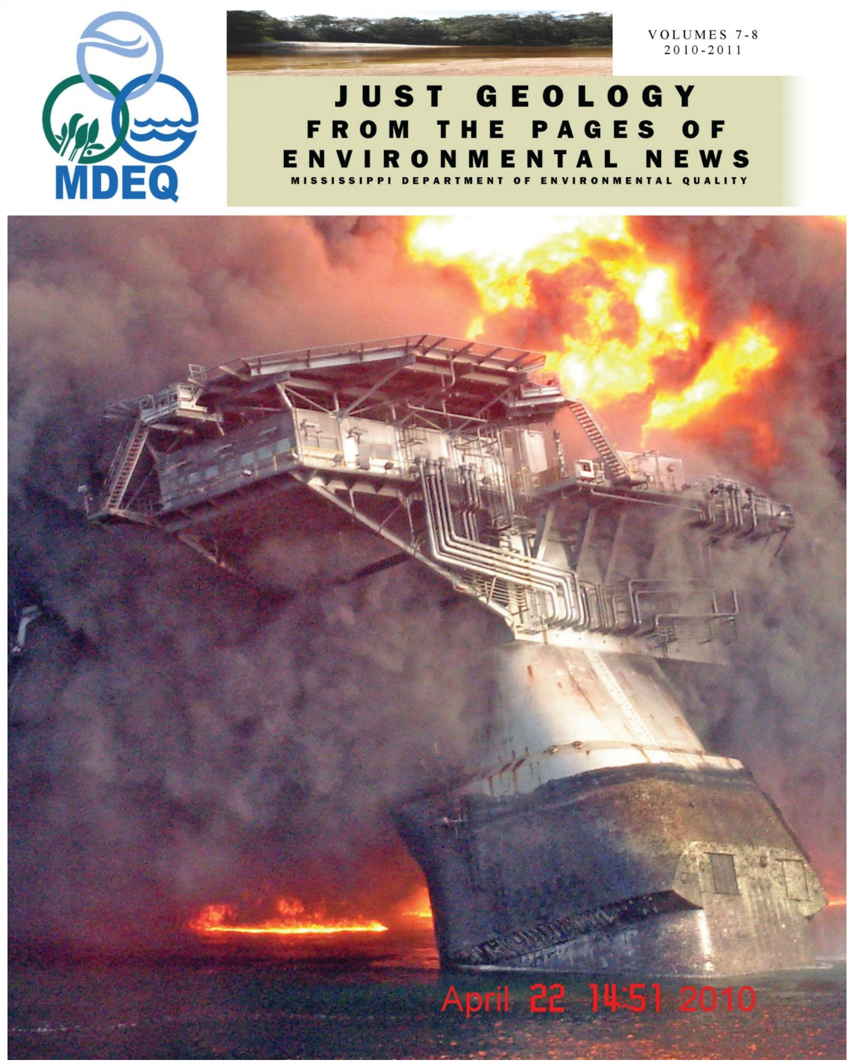
Figure 6. The Volcano Room. At left is the red-hot-lava path, the incandescent throat, and the upturned strata of the buried Jackson Volcano, located below the State Capitol Building. At right is a lava pump, where children can push on the lava to create an eruption. Pictures were taken on January 4, 2012.

Figure 7. At left: Seismograph where children can feel earthquakes of varying magnitudes. At right: Children in the Mississippi underground look through a window to see the world above. Pictures were taken on January 4, 2012.

JUST GEOLOGY 2010-2011

Just Geology 2010-2011 is a collection of the geology articles from the MDEQ newsletter for the years given. It is available on the MDEQ web site under the Surface Geology Division and then under Downloadable Publications:

http://www.deq.state.ms.us/MDEQ.nsf/pdf/Geology_JustGeology20102011/$File/Just%20Geology%202010_2011High%20Rez.pdf?OpenElement.



PICTURE OF THE MONTH

Taken by James Starnes, Office of Geology. The late Cretaceous ammonite *Discoscaphites iris* from the Late Cretaceous age Owl Creek Formation, Tippah County.

The Office of Geology collects geological samples for the purpose of research as the state's geological survey. The office has a large collection of representative samples from all over the state which includes cores, drill samples, electrical logs, rock outcrop specimens, minerals, and fossils. The office continually adds specimens as part of field mapping efforts and through other field exercises.

The mission of the Mississippi Department of Environmental Quality is to safeguard the health, safety, and welfare of present and future generations of Mississippians by conserving and improving our environment and fostering wise economic growth through focused research and responsible regulation.

2011 HIGH-WATER MARK COMMEMORATED AT VICKSBURG

David T. Dockery III, Office of Geology

The City of Vicksburg and the U.S. Army Corps of Engineers commemorated the anniversary of the high-water mark of the 2011 Mississippi River flood at Vicksburg with a ceremony at City Front at 10:00 a.m. on May 18, 2012. The river crested here on May 19, 2011, at 57.1 feet, some 14.1 feet above flood stage and nine-tenths of a foot above the previous record high-water mark of the 1927 flood. This crest followed an unprecedented rise in river level of 13 feet in just 19 days. MDEQ staff logged many hours preparing for this historic flood and in overseeing environmental regulations in the flood's aftermath. Figure 1 shows the commemoration ceremony at Vicksburg. The right side of Figure 2 shows a press interview at the floodwall following the ceremony, with the bathtub ring of the high-water mark clearly visible above the crowd. The left side of the figure shows the high-water mark in 2011.

Figure 1. Press and audience (left, note the high-water mark half-way up the flood wall) to hear the U. S. Army Corps of Engineers and Vicksburg officials (right) commemorate the anniversary of the 2011 Mississippi River high-water mark. Pictures were taken on May 18, 2012.

Figure 2. View north along the Vicksburg Flood wall at the high-water mark (left) and view of the same area on the anniversary commemoration as a reporter interviews Warren County Sherriff, Martin Pace. The newly-painted 2011 high-water mark is in the distance just over the sherriff's head and the high-water mark's "bathtub ring" is behind him. Pictures were taken May 19, 2011 (left) and May 18, 2012 (right).

OFFICE OF GEOLOGY OUTREACH

The Office of Geology was part of a geology academic outreach program for Cub Scouts and Webelos at the Flowood Nature Center in June. They assisted the boys with their Geology awards—the Geology Beltloop, the Geology Academic Pin, and the Geologist Webelos Activity Pin.

Geology's James Starnes

James Starnes also identified rocks and fossils for the public at the Union County Heritage Museum Mineral and Fossil Show on June 9.

Did you know that earthquakes can affect Mississippi?

Unknowingly to the general public, approximately 250 earthquakes occur each year in the New Madrid Seismic Zone. The central United States is vulnerable to damaging earthquakes, and has the highest level of seismicity in the country east of the Rocky Mountains. Because earthquakes occur with little to no warning, it is important that individuals, schools, businesses, and communities be prepared to minimize the effects of earthquakes. In addition to the more than 30 earthquakes on record that have occurred within Mississippi boundaries, which is outside of the New Madrid Seismic Zone, an earthquake along that zone has the potential to impact northwestern Mississippi.

The Central U.S. Earthquake Consortium, Mississippi Emergency Management Agency, Mississippi Office of Geology, and the Tunica Museum are pleased to present a free, open to the public seminar entitled "The Central U.S. is Earthquake Country."

This seminar will introduce or familiarize you to the basic principles of earthquake hazards, in Mississippi and the central U.S., and provide you information on how you can help yourself and your community be better prepared for disasters.

Who: Are you involved or interested in emergency services, disaster preparedness, or community service? This is a free seminar and open to anyone who wishes to attend. Concerned citizens, educators, business leaders, first responders, volunteers, and local government are welcome to participate. No prior knowledge of earthquakes is required. Presenters will include local, state, and regional experts in earthquake and disaster preparedness; interaction with presenters is highly encouraged. Light refreshments will be provided to attendees.

What: The seminar will introduce or familiarize you with the following topics:

- Earthquake Hazard Basics & Earthquakes in Mississippi
- Consequences of Earthquakes
- Community Preparedness - What you can do to prepare
- State and Local Earthquake Resources
- Mississippi Earthquake Program Development

Where: The seminar will be held at the Tunica Museum.

When: July 17, 2012 from 1:00PM - 4:00PM

Please email cusec@cusec.org or call the Central U.S. Earthquake Consortium at (800) 824-5817 for more information about this seminar. Register online at http://www.cusec.org/register/register.php?id_evt=122.

Environmental News, July 2012, volume 9, issue 7, page 11-12

Mangrove roots anchor sediments along tropical coastlines such as these in Puerto Rico.

MANGROVE TREES AND CLIMATE

David T. Dockery III, Office of Geology

Mississippi's geologic history helps put a recent news story into perspective. Ben Raines reported (July 9, 2012, on AL.com) the recent appearance of black mangrove trees at the mouth of the big lagoon on Horn Island, Mississippi, the most northerly occurrence of mangroves in the Gulf of Mexico. He titled the report, "Mangrove trees showing up on Horn Island may indicate climate change." The Horn Island mangroves include one bush-sized tree and three smaller ones. These trees are many miles north of the closest group of mangroves, which inhabit the Chandeleur Islands off Louisiana. The occurrence of mangroves in the Chandeleurs is also a recent phenomenon attributed to recent warm winters. There is some concern that the mangroves might interfere with the growth of spartina and juncus marsh grasses on Horn Island, but mangroves have colonized the area before only to be wiped out in particularly cold winters. The present Horn Island mangroves have also died back a couple of times only to rebound, the cold weather killing the tops but not the roots. Figure 1, at left, shows scientists from the Dauphin Island Sea Lab, the U.S. Fish & Wildlife Service, and the National Park Service studying a black mangrove bush (flowering in the foreground) on Horn Island, and, at right, mangroves along the tropical shoreline of Puerto Rico.

Figure 1. At left in foreground, black mangrove tree with blossoms at the mouth of the big lagoon on Horn Island, Mississippi (from Ben Raines, Al.com, published July 9, 2012); at right, a mangrove swamp on the Caribbean Coast of Puerto Rico (picture taken in February of 1977).

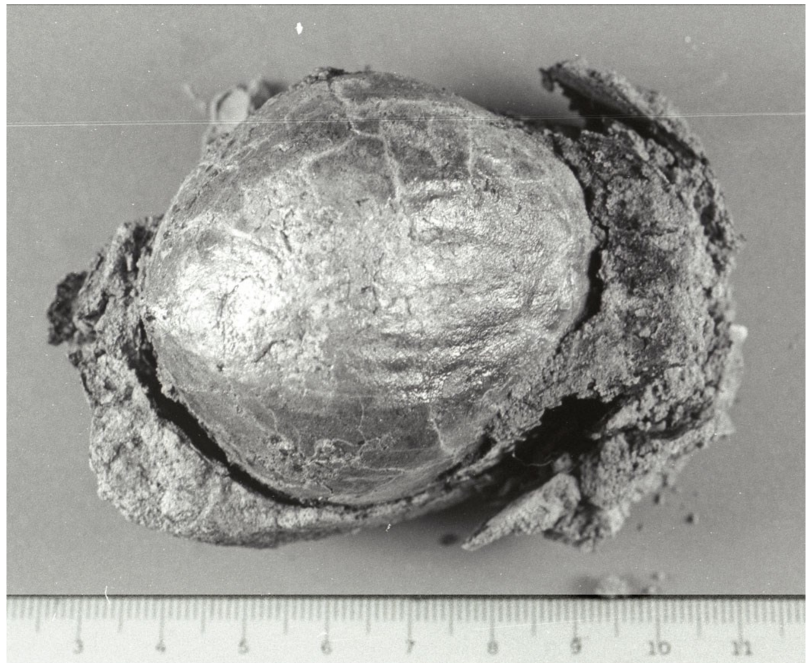


Figure 2. Internal mold of a fossilized *Nypa* nut from the Cook Mountain Formation at Newton, Mississippi. The gap between the mold and the surrounding matrix was once occupied by the shell of the nut, which when originally found had a coconut-like husk. This specimen is now on display in the *Stories in Stone* exhibit at the Mississippi Museum of Natural Science. The picture was taken around January 1999; scale in centimeters.

In the Middle Eocene Epoch some 40 million years ago, Mississippi's climate was much warmer than it is today, and most of the state was covered by a tropical sea. Along the sea margin in the northeastern part of the state was a mangrove-forested shoreline. One interesting inhabitant of these mangrove swamps was a palm tree of the genus *Nypa*, the only palm adapted to life in a mangrove forest. Today *Nypa* palms are native to the tropical coastlines and estuaries of the Indian and Pacific Oceans, from Bangladesh to the Pacific Islands. This palm has a sugar-rich sap that can produce 6,480-15,600 liters per hectare of fuel (ethanol or butanol) per year, as compared to only 5,000-8,000 liters for sugarcane. Figure 2 shows a fossil *Nypa* nut found by James K. Smith in the Cook Mountain Formation at Newton, Mississippi, during the construction of Interstate 20. Figure 3, at left, shows the modern *Nypa* palm species *Nypa fruticans* growing in a mangrove swamp, and, at right, a *Nypa* palm nut. Fossil *Nypa* nuts are also known from the Middle Eocene sand beds of Branksome, England, and in the London Clay on the Isle of Sheppey, Kent, indicating a much warmer climate in the British Isles at that time.

Figure 3. At left, *Nypa fruticans* (*Nypa* palms) growing in a mangrove swamp in Bohol, Philippines; at right, *Nypa fruticans* nut.

Environmental News, July 2012, volume 9, issue 7, page 14

James Starnes
Office of Geology

Geology Outreach

James Starnes recently provided a Mississippi rocks and fossils program at the Eudora Welty Library for their Children's Summer Reading Program.

Environmental News, July 2012, volume 9, issue 7, pages 16-19

Yazoo Clay problems, Fitzhugh Hall, Belhaven Univ.., Jackson.

MORE SLOPES TOO STEEP AND OTHER YAZOO CLAY PROBLEMS

David T. Dockery III, Office of Geology

The July 2010 issue of the MDEQ newsletter contained an article entitled "A slope too steep: slumps in the Yazoo Clay in central Mississippi." The slumps mentioned were those along Interstate 20 and 220 in the Jackson area and the slope behind the Farmer's Market in Jackson. These slope failures have now been repaired. However, other slope and foundation problems have taken their place, some of which are chronicled below.

On May 21, 2005, the final two gaps in the Natchez Trace Parkway, a two-lane federal roadway between Natchez, Mississippi, and Nashville, Tennessee, were opened to traffic. These newly completed segments were: (1) the Jackson bypass connecting Interstate 55 and Interstate 20 and (2) a segment connecting Liberty Road in the city of Natchez and U.S. Highway 61 near Washington, Mississippi. Just seven years after opening, a portion of the Jackson bypass route was closed on March 15, 2012, due to a slope failure on the Yazoo Clay near milepost 94.8 just south of where the Trace crosses West County Line Road. In 2011, the roadway at this point developed a large crack that separated the two lanes of traffic. Several repairs were made to the road surface that year, but movement along the crack continued to the point that the road was deemed unsafe for vehicular traffic (Figure 1). Some 13,000 cars per day travel the Natchez Trace between Jackson and Clinton; it was feared such heavy traffic could contribute to the road problem. Repairs were estimated to take about a year and to cost about one million dollars.

Figure 1. Failed road surface on the Natchez Trace Parkway along a steep slope near the County Line Road overpass in Jackson, Mississippi. Pictures were taken on March 14, 2012, the day before the road was closed to traffic.

The west slope bounding the Clinton Walmart parking lot on Highway 80 began a slow and progressing failure at the beginning of 2012. At first, warning cones were placed around the failure; added to this was a concrete curb offset some 15 feet from the failed curb (Figure 2). The toe of the slump filled in part of the store's storm-water runoff basin, and the scarp on the south flank deflected the original curb and water line at a 30 degree angle (Figure 3). The scarp on the north flank of the slump pulled on optical fiber cables (communication lines), displaced the power pole, and displaced a gas line (Figure 4).

Figure 2. Progressive slope failure on the west end of the Walmart parking lot on Highway 80 in Clinton, Mississippi. The picture on the left was taken on March 14, 2012, and the picture on the right with the addition of a set-back concrete curb was taken on April 9, 2012.

Figure 3. The toe of the slump at left fills part of the store's storm-water runoff basin. The scarp on the slump's south flank has deflected the original curb and water line at a 30 degree angle. The picture on the left was taken on April 10, 2012, and the picture on the right was taken on April 9, 2012.

Figure 4. At left, the scarp on the slump's north flank cuts at the base of a telephone cable box, displaces a power pole, and (at right) cuts across a buried gas line. Pictures were taken on April 9, 2012.

The Mississippi Department of Public Safety headquarters building near the intersection of Interstate 55 and Woodrow Wilson Drive underwent repairs this year after the Yazoo Clay closed the crawl space under the floor and lifted the floor and its 20-foot-deep pilings and lifted and sheared the exterior wall from its pilings. New pilings were constructed for the exterior walls, and a new crawl space was dug under the floor. Figure 5, at left, shows an exterior wall set on new pilings, and, at right, a conveyer belt removing weathered Yazoo Clay as workers dig a new crawl space. Figure 6, at left, shows the remains of one of the original exterior pilings and, at right, shows the offset between the floor slab, which was lifted by the Yazoo Clay, and the exterior walls.

Fitzhugh Hall on the Belhaven University campus in Jackson has endured the Yazoo Clay under its foundation for a hundred years but now is in need of major renovations. Wall cracks were the norm for the administrative staff who occupied the hall's east wing, but, in December of 2011, a crack between the interior and exterior wall moved as much as six inches within a four week period. The sudden movement came after a leak in a six-inch fire line was discovered adjacent to the building.

Figure 5. At left, the exterior wall of the Department of Public Safety building rests on new pilings; a water cooler rests on the nearest piling, which is marked with the number 5 above. At right, a conveyer belt removes Yazoo Clay as workers dig a new crawl space beneath the floor slab. Pictures were taken on May 7, 2012.

Figure 6. At left is the remains of one of the original exterior wall pilings. At right is the floor slab, which has been lifted about half a foot above its original position in relation to the exterior wall. Pictures were taken on May 7, 2012.

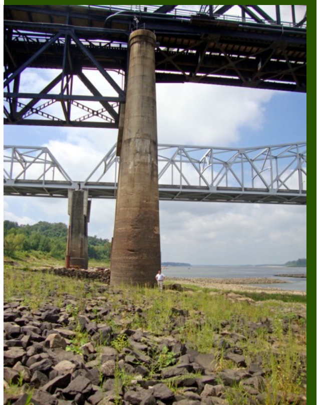
The school hired an engineering firm, which reported to school president Dr. Roger Parrott that something dramatic had happened and that the south wall of Fitzhugh Hall's east wing was in danger of buckling. Parrott reported to WAPT News in Jackson (on December 15, 2011): "You can see that wall is starting to really come out, and the fear, of course, is that it's going to collapse." The structural engineer who examined the building told Dr. Parrott, "You need to move out now." Dr. Parrott asked, "Yeah, what do you mean by now?" The engineer replied, "Now! No, I mean now. Tomorrow, you've got to be out of the building."

The staff of Fitzhugh Hall's east wing made a hurried exit, moving their files and equipment to other spaces on campus. By the next day, the east wing was abandoned. New locks were placed on entrances to the east wing to keep out all the maintenance crews. Figure 7 shows the damaged walls of the east wing on December 16, 2011, a day after the hall was evacuated. As the buckled exterior wall was a load-bearing wall, engineers decided that the east wing was beyond saving and scheduled it for demolition. On June 29, 2012, with a little help from two trackhoes, the east-wing walls "came tumbling down." Figure 8 shows the demolished wing the day after, as the trackhoes were loading debris to be hauled to a rubbish landfill.

Figure 7. The buckled and cracked south wall of the east wing of Belhaven University's Fitzhugh Hall; at right, the exterior wall is separated from the interior wall. Pictures were taken on December 16, 2011.

Figure 8. Demolition of the East Wing of Fitzhugh Hall at Belhaven University after the exterior south wall buckled. View of south wall is at left with the original cracks visible in what remains of the first floor; view of north wall is at right. Pictures were taken on June 30, 2012.

Environmental News, September 2012, volume 9, issue 8, pages 16-12



Moving west, Pier 2 of the Highway 80 Bridge and Pier E2 of the Interstate 20 Bridge (background) at Vicksburg.

HOLDING THE BLUFF AT VICKSBURG

David T. Dockery III and David E. Thompson, Office of Geology

There is more than 150 feet of relief between the bank of the Mississippi River and the hilltops at Vicksburg. Such relief in the Loess Hills has created a number of slope failures along the Highway 61 corridor and some locations at Vicksburg are still active. Of particular concern are the moving piers on the eastern end of the Highway 80 and Interstate 20 bridges. The Highway 80 Bridge has experienced significant movement since the time of its construction in the 1930s. In December of 1938, the bridge's eastern piers moved west some 9 inches. The bridge moved again about 4 inches in December of 1993 and continued moving until it reached a cumulative movement of 23 inches by December of 2004. At this time, the newly constructed Ameristar Casino and parking lot (Figure 1) shifted on the property's southern end, and there was movement on the two eastern piers of the I-20 Bridge. The top of Pier E-2 of the Interstate 20 Bridge moved westward some 6 inches between December of 2000 and May of 2001; at this same time, Pier E-1 moved westward some 6 to 9 inches. In response to this displacement, bridge modifications were undertaken from March to June of 2004 to open bridge joint PP 15 approximately 9 inches. These piers have moved another inch this year in response to the low river level. Superintendent of the Vicksburg Bridge Commission, Herman Smith, gave the following explanation to WAPT News (August 6, 2012), "Every time the river dries up, the water moves away from the banks, and we have movement to the west."

Figure 1. Retaining wall for the Ameristar parking lot. The wall consists of slotted steel piers fitted with treated wood planks. Pictures were taken on September 9, 2009.

Glendon Limestone island (with riprap on top) in front of Pier E3 of the Interstate 20 Bridge at Vicksburg.

Figure 2 (at right in the right picture) shows John Marble and Meg Myers logging a test hole in the Mississippi River beside the Interstate 20 and Highway 80 bridges. The geophysical logs on this test hole were run with the logging van on land and the wireline tools ferried to the barge. An earlier test hole, borehole B4, was logged with the van operating from the Interstate 20 bridge, blocking one lane of traffic, and with a spotter at the well head on the barge below. Figure 3 shows the location of the Interstate 20 and Highway 80 bridges and the location of the cross section in Figure 4. The “creep surface” causing movement of the bridge piers is in the upper clay-rich section of the Forest Hill Formation. Above this plane, faulted horsts and grabens have developed in the Vicksburg Group section.

Figure 2. John Marble and Meg Myers (at right) logging a test hole drilled through a “creep surface” beneath the Mississippi River at the Interstate 20 and Highway 80 bridges at Vicksburg, Mississippi. Pictures were taken by Mark Teague in the summer of 2003.

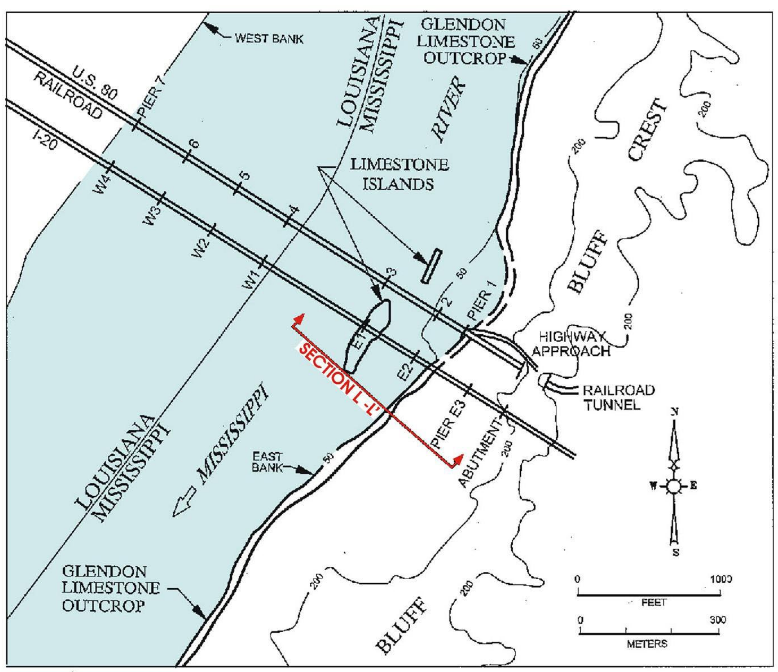


Figure 3. Location of Mississippi River bridge piers and cross section of “creep surface” at Vicksburg as prepared by Richard J. Lutton, geological engineer for Burns Cooley Dennis, Inc.

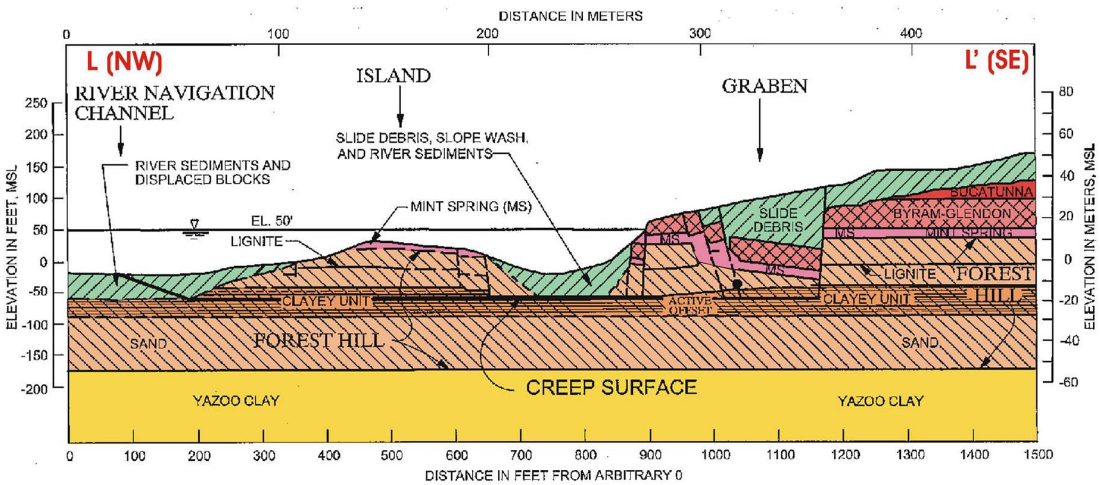


Figure 4. Cross section of "creep surface" on the Mississippi River and bluff line at the Interstate 20 and Highway 80 bridges at Vicksburg, Mississippi. Cross section was prepared by Richard J. Lutton, geological engineer for Burns Cooley Dennis, Inc.

A new concrete retaining wall is under construction to hold the southern end of the Ameristar Casino property in place (Figure 5). The concrete footing in front of the wall is anchored by closely spaced 70-foot-deep steel piers. Higher up, 200-foot-long post-tension anchors are drilled along the base of the main structure at an angle of about 10 degrees. The 200-foot length allows the anchors to penetrate layers of bedrock in the Glendon Limestone for a more secure hold.

Figure 5. Left, construction of the new retaining wall at the south end of the Ameristar property. Right, drilling a 200-foot-long anchor into the base of the retaining wall. The Highway 80 and Interstate 20 bridges are in the background Pictures were taken on July 30, 2012.

Environmental News, September 2012, volume 9, issue 8, pages 26-30

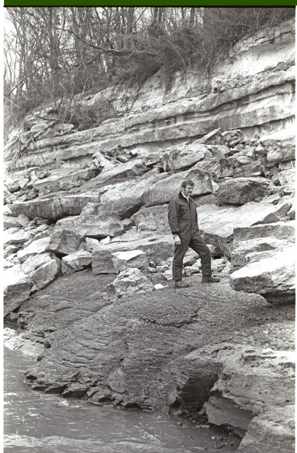
THE DROUGHTS OF 2012, 1988, 1980-1982, AND 1956

David T. Dockery III, Office of Geology

Seventy-year-old red oak shows its rings.

The Midwestern drought of 2012 is the worst drought in 50 years, since the drought of 1956. It has created a reduction in corn and soybean supplies and a low flow on the Mississippi River that rivals that of the drought of 1988. The record of past droughts is "remembered" by trees and is preserved in the thicknesses of tree rings. Dendrochronology is the scientific method of dating wood by the analysis of tree-ring patterns. The study of dendrochronology has applications in: (1) climate and paleoecology, (2) in archaeology in dating old buildings, and (3) as a calibration for radiocarbon dating. When a large red oak fell next to my house (but missed) after a rain event on March 22, 2012, I thought it might contain a tree-ring record extending back some 100 to 150 years. To my surprise, the tree was only a little older than I was. Even so, it was old enough to record drought years back to the drought of 1956. Oaks are a good source of tree-ring information because annual rings are rarely missed in oak and elm trees. The only known instance of a missing ring in oaks is for the year 1816, which is known as the "Year without a summer." This event followed the eruption of Mount Tambora in Indonesia in 1815, the largest known eruption in over 1,300 years.

Figure 1 shows the process of cutting up the fallen tree and a cross section of the trunk with rings labeled by decades from 1950 to 2010. The drought years of 1956 and 1988 are also labeled. The last decade of tree growth was slower with smaller rings probably due to an area of growing rot at the base of the tree. The 1988 ring stands out as much smaller that the rings before or after. Drought years of 1980-1982 affected the northern part of the state and are not recorded in this tree's rings. Even so, the effect of the 1980-1982 drought on Mississippi agriculture led to the creation of an entirely new water law in 1985 (House Bill 762 and 149). The ring for the drought year of 1956 is unremarkable, while the 1955 ring is very small.



Jim May standing on the Forest Hill Formation during low water on the Mississippi River in January of 1981.

Figure 1. Red oak tree in northwestern Hinds County that fell on March 22, 2012, with leaves fully grown; the last ring on the tree was made in 2011. The bottom picture was taken on June 22, 2012, and has the rings marked by decades from 1950 to 2010. Also marked are the drought years of 1956 and 1988.

The small 1955 ring marks a local drought in Mississippi. It was part of a severe drought in the Mississippi Delta region from 1951-1954, which spurred a rush to drill water wells for crop irrigation. According to the Mississippi Board of Water Commissioners Bulletin 56-1 (page 8), by the end of 1955 more than 900 wells had been constructed. At this time the Mississippi Geological Survey had a cooperative agreement with the U. S. Geological Survey to conduct a statewide study of groundwater resources. This continued from September 1953 till July 1, 1956, when the Mississippi Board of Water Commissioners (a board created in response to the drought, and which in 1978 became the Office of Land and Water Resources) by legislative act became the state cooperator with the U. S. Geological Survey. The Mississippi Geological Survey helicopter (and Mississippi was the only state geological survey to have one at that time) was used during the drought to search for stream flow in north Mississippi streams (Figure 2). As for stream flow in the watershed containing the red oak in Figure 1, Mississippi Board of Water Commissioners Bulletin 61-1, page 3, recorded “Zero Flow Observed” on Bogue Chitto Creek at Tinnin, Mississippi, for the years 1952-1955.

Fossil seashells in the basal Mint Spring Formation.

Figure 2. The Mississippi Geological Survey helicopter at Ole Miss (left) and at airport (right).

Mississippi drought years of 1980-1982 (northern Mississippi), 1988, and 2012 also correspond to near record low river levels on the Mississippi River at Vicksburg. High-water levels at Vicksburg can be compared with floods of previous years by the historical flood crests marked on the Vicksburg floodwall. But how does one compare low water marks with those from previous year (apart from having access to the river gage)? The geologic section exposed on the Mississippi River just north of the Ameristar Casino provides points of comparison. The section in descending order consists of: (1) hard ledges of Glendon Limestone, (2) a soft layer of Marianna Limestone, (3) fossiliferous, glauconitic sand of the Mint Spring Formation, including a concentration of seashells at the base of the formation, and (4) clays of the upper Forest Hill Formation. All of these formations were exposed in late January and early February of 1981 when the Mississippi River fell below the zero mark on the Vicksburg river gage (Figure 3). Figure 4 shows the basal shell lag of the Mint Spring Formation (left) and the underlying clay of the upper Forest Hill Formation (right).

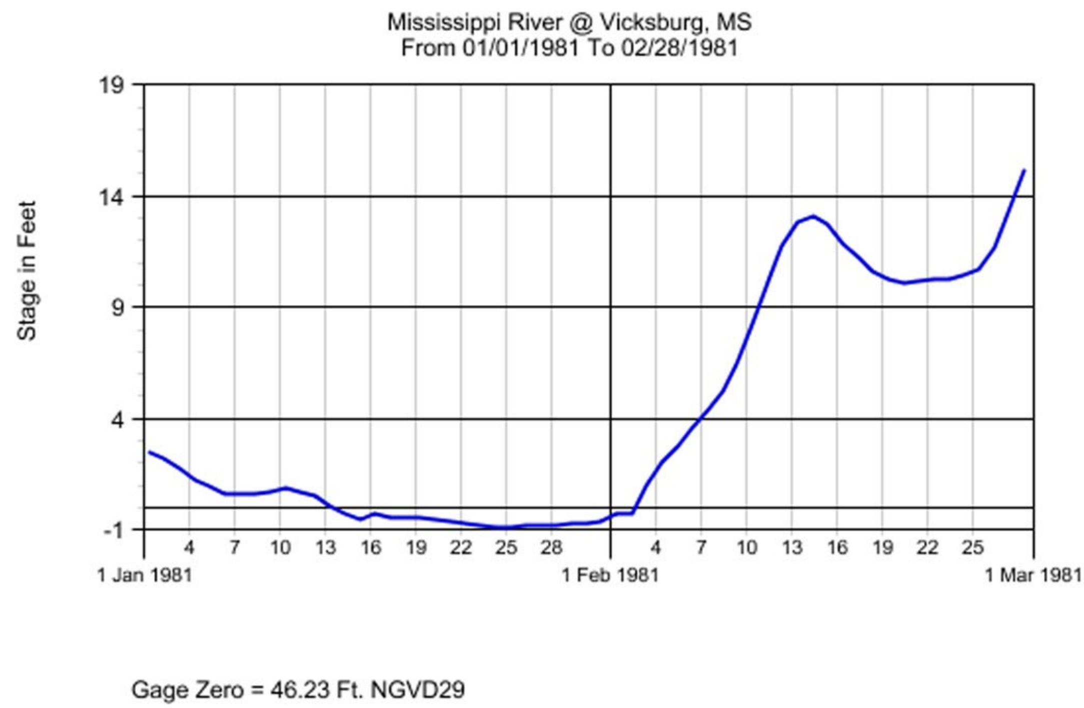


Figure 3. USGS Mississippi River gage at Vicksburg, showing river levels below the zero mark in January and February of 1981.

Figure 5 shows low water on the Mississippi River at Vicksburg, Mississippi, during the drought of 1988. At left in the figure, Michael Bograd stands on an exposed section of Glendon Limestone; at right, he is at river level on the basal shell concentration of the Mint Spring Formation. Figure 6 shows pictures of the same section at a river stage of 1.6 feet on July 30, 2012. The Forest Hill-Mint Spring contact shown in these figures is only seen at very low water (Two feet or less at the Vicksburg gage). Low river stages allow geologists to study and map formations that cannot be seen most of the time and also reveal structures such as large slump blocks that might impact buildings, bridges, and other infrastructure.

Figure 4. Left, shell lag deposit at the base of the Mint Spring Formation with clay ripup clasts from the underlying Forest Hill Formation on the Mississippi River at Vicksburg. Right, clay of the upper Forest Hill Formation seen only at very low river levels. Pictures were taken in January of 1981.

Figure 5. At left, Michael Bograd with survey rod standing on the Glendon Limestone during low water on the Mississippi River at Vicksburg during the drought of 1988. The Marianna Limestone is exposed below the lower ledge of Glendon Limestone. At right, Michael Bograd standing at river level on the basal shell lag of the Mint Spring Formation. Pictures were taken on June 28, 1988.

Figure 6. Left, James Starnes kneeling on the basal shell lag of the Mint Spring Formation on the Mississippi River at Vicksburg, with the overlying Marianna and Glendon limestone section to the left. At right, James Starnes standing on the basal shell lag of the Mint Spring Formation on the Mississippi River at Vicksburg, with the Highway 80 and Interstate 20 bridges at right. The river stage was at 1.6 feet at Vicksburg. Pictures were taken on July 30, 2012.

Lorax, October 2012, volume 9, issue 10, pages 11-12

CHARLOTTE BRYANT-BYRD RETIRES AFTER 25 YEARS WITH THE OFFICE OF LAND AND WATER RESOURCES

David T. Dockery III, Office of Geology

When I first came to work full time for the Mississippi Geological Survey (MGS) in July of 1978, I had the opportunity to teach an evening class in Invertebrate Paleontology at Millsaps College's Geology Department for seven semesters from the fall of 1978 to the fall of 1984. These classes provided unpaid field hands for collecting and preparing fossils for MGS research projects and collections and turned out ten students who worked as geologists for the offices that now comprise MDEQ. In alphabetical order, these included: Charlotte Rae Bryant, James Crawford, James C. Crellin, William Davy Easom, Stephen Lee Ingram, Samuel Cragin Knox, Michael Alan Noone, Charles Osborne Moyer Peel, James O. Sparks, and Phillip Weathersby.

Charlotte Bryant was a student in the spring 1982 class. Figure 1 shows Charlotte on the class' paleontology field trip to St. Stephens Quarry in Washington County, Alabama. On the second part of the field trip, the class collected fossils from the Gosport Sand at Little Stave Creek in Clarke County, Alabama. Charlotte graduated from Millsaps in 1983 and attended graduate school at Northeastern Louisiana University (now the University of Louisiana at Monroe) from 1983-1986, until she finished her master's thesis. In 1988, Charlotte began her professional career at the Office of Land and Water Resources (OLWR). Most of Charlotte's time at OLWR was spent doing geologic and hydrologic research on the Mississippi River Valley alluvial aquifer in the Delta. The Mississippi River Valley Alluvial aquifer is third among the top producing aquifers in the United States. While doing field work, Charlotte was able to stay overnight at her family's Indianola home. She said that she learned a lot, including learning that she doesn't know much (however, her peers will say that no one knows more about the alluvial aquifer than Charlotte). For the past seven years, Charlotte has served as Chief of OLWR's Surface Water Division and has been integral to the agency's efforts regarding Delta groundwater issues.

Figure 1. Millsaps College Geology Department's Invertebrate Paleontology Class field trip to St. Stephen's Quarry in Washington County, Alabama, on February 7, 1982. At top, Charlotte Rae Bryant is at middle left in blue; Mary Dockery is at middle right in red. At bottom, Charlotte is at right petting the head of the student petting the dog.

Figure 2. Charlotte Bryant-Byrd at her desk in the 700 North State Street Building. Picture was taken on August 28, 2012.

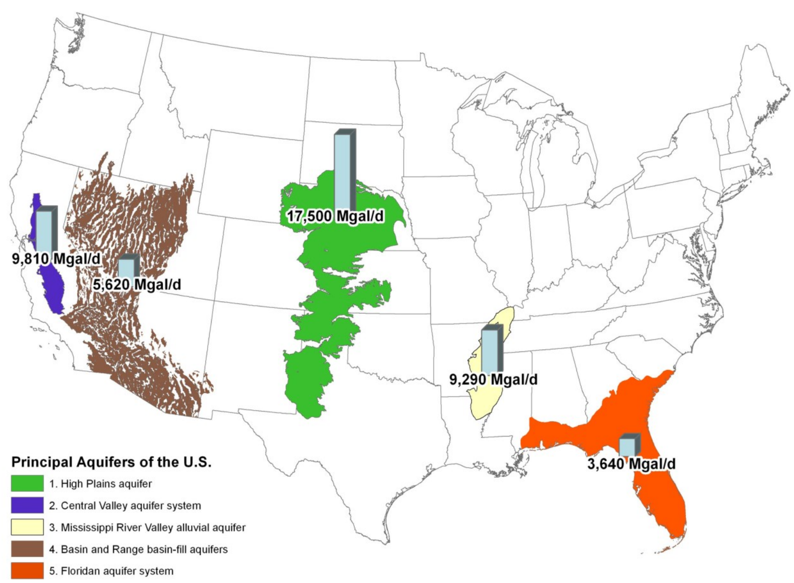


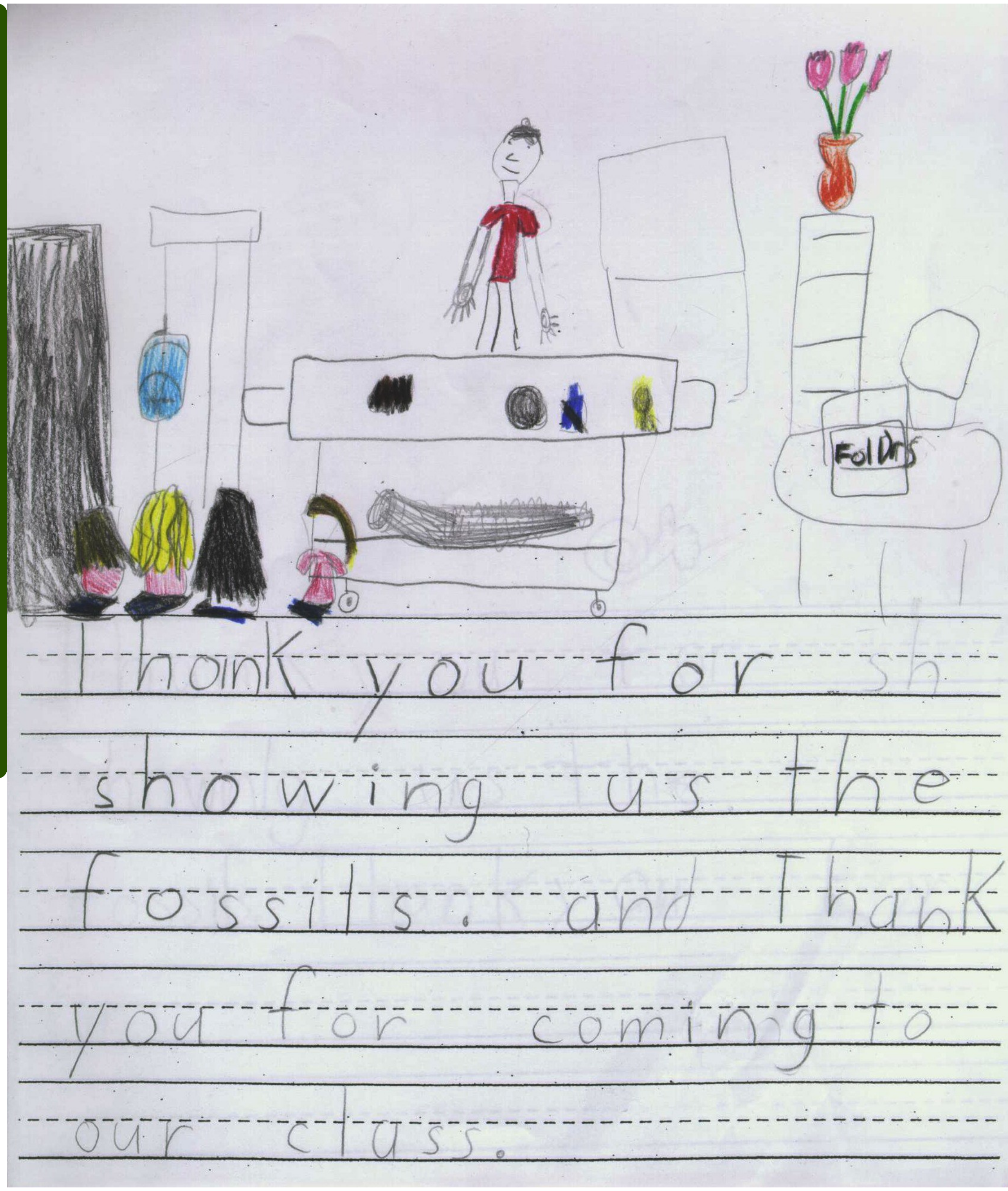
Figure 3. Principal aquifers of the United States, showing the Mississippi River Valley alluvial aquifer as third among top aquifers in producing 9,290 million gallons of ground water per day. Illustration from Jeanie Barlow, U. S. Geological Survey.

Environmental News, October 2012, volume 9, issue 9, page 15 (top) and page 25 (bottom)

Not a photo exactly, but a rendering of the Office of Geology's James Starnes speaking to first graders at St. Richard Elementary School in Jackson. (top)

PICTURE OF THE MONTH

(bottom)



A cast of a fossil whale skull (Mississippi's state fossil) that James brought to show the class is drawn in gray on the lower shelf of the cart in front.

Panorama shot of Mississippi River Bridge, Vicksburg. Taken by James Starnes, Office of Geology, 2012.

Environmental News, October 2012, volume 9, issue 9, pages 17-21

Governor Phil Bryant unveiled his energy policy, *Energy Works: Mississippi's Energy Roadmap*.

OCTOBER--GEOLOGY MONTH: ENERGY SUMMIT AND EARTH SCIENCE WEEK

David T. Dockery III, Office of Geology

October is the month for the Mississippi energy summit and the national Earth Science Week. Governor Phil Bryant, who was selected as Chairman of the Southern States Energy Board on September 25, unveiled his energy plan on October 4 at an energy summit with the theme "Energy and Economic Development in the 21st Century." The one-day summit brought together industrial experts to discuss Mississippi's energy future. Former New York City Mayor Rudy Giuliani was featured speaker. A press release for the summit stated that: "Mississippi has been named the top spot in the world for oil and gas investment and is home to diverse energy resources." The summit was organized by the Mississippi Development Authority and the Mississippi Energy Institute and took place at the Jackson Convention Complex.

The governor's economic plan is a continuation of the state's long history of geological research. An article in the January 2012 issue of *Environmental News* entitled "The value of a Geologic Map" took note that the early establishment of a state geological survey in Mississippi in 1850 led to the discovery of the Jackson Dome and later the Jackson Gas Field and to the discovery of Tinsley Dome and the Tinsley Oil Field (Figure 1).

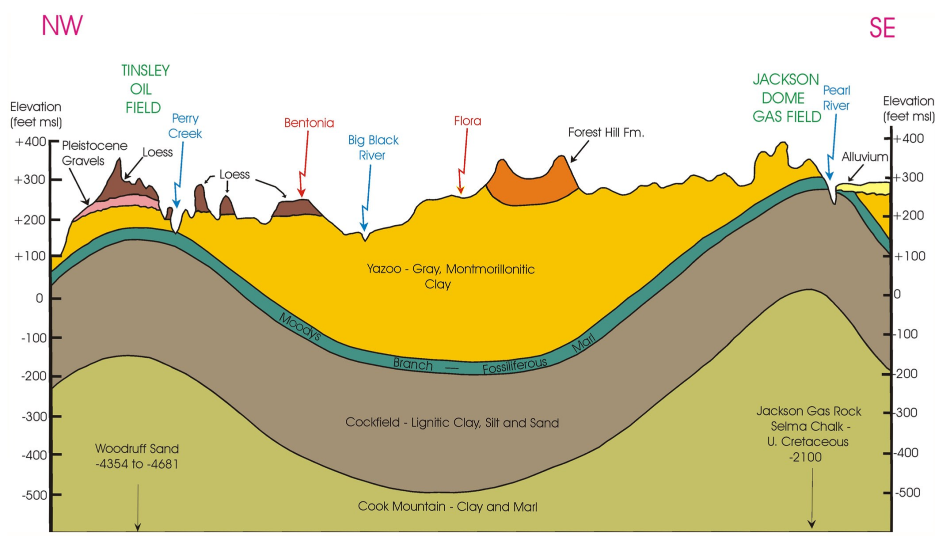


Figure 1. Schematic geologic cross section from Tinsley Oil Field to the Jackson Gas Field. The arrow below Tinsley shows the depth to the oil producing Woodruff Sand, and the arrow below Jackson shows the depth to the gas producing Jackson Gas Rock. Cross section is modified from Kolb, 1969 (Field Trip Guide, Vicksburg-Tinsley-Jackson-Vicksburg, Mississippi).

The core bit that discovered Tinsley Oil Field in 1939.

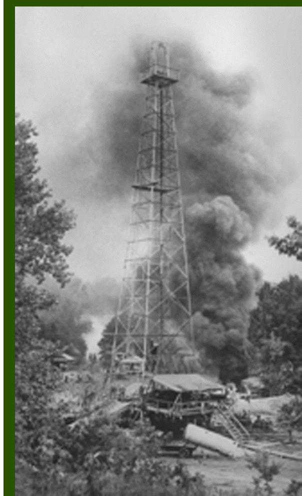
In February of 1939, while mapping the geology of Yazoo County, Mississippi Geological Survey geologist Fred Mellen discovered a small exposure of the Moodys Branch Formation on Perry Creek near Tinsley at an elevation of 250 feet above its normal position. Survey Director Dr. Morse issued a press release about the structure on April 12, 1939. Immediately after the release, Union Producing assembled a lease block near Tinsley, and, on July 18, 1939, began drilling exactly at the spot where Mellen reported the Moodys Branch outcrop. The Union Producing No. 1 Woodruff hit oil on August 29, 1939, leading to the discovery of Tinsley Oil Field, the largest oil field in the state. By the time of peak oil production in the nation and also in the state of Mississippi in 1970, Mississippi ranked ninth among oil-producing states behind Texas, Louisiana, California, Oklahoma, Wyoming, New Mexico, Kansas, and Alaska.

Geological data that led to oil and gas discoveries in Mississippi is the same kind of data needed to protect the environment. Surface geology maps are needed by municipalities to prevent the placement of sewage lagoons or garbage dumps on the recharge area of their groundwater supplies. Rudyard Kipling addressed this problem in his poem *Natural Theology*:

My privy and well drain into each other
After the custom of Christendie ….
Fevers and fluxes are wasting my mother.
Why has the Lord afflicted me?

Kipling concludes the poem with:

Thou art delivered to thine own keeping.
Only Thyself hath afflicted thee!



Testing the #1 Woodruff in Tinsley Field for the first time in 1939.

The governor's energy plan also calls for student training in the energy sector in both conventional energy resources and in renewable energy resources. Honored at the Energy Summit were: (1) the Newton County Career and Technical Center's solar car team, (2) the Choctaw Central High School Solar Car Team, the only Native American solar car team, (3) the Houston Solar Race Team, a high school team that captured first place in the 2012 Solar Car Challenge in Ft. Worth, Texas, (4) the Mississippi State University EcoCAR 2 Team, winner of the EcoCAR 2012 Competition in Los Angeles, California, last May, bringing home $13,000 in prize money, and (5) the University of Southern Mississippi Research Team, which used nanotechnology to improve the conversion efficiency of polymer-based solar cells. Figure 2 shows the Houston Solar Race Team with their car and trophies.

Figure 2A. Kristen Marsh (left) and Kristen Black beside the "girl's" solar car for the Houston (High School) Solar Race Team, founded in 1994.

Figure 2B. The Houston Solar Race Team's "boy's" solar car.

Figure 2C. The Houston Solar Race Team (now in its 19th year) trophies. Last year the Sundancer I and Sundancer II solar cars captured first place in the 2012 Solar Car Challenge in Ft. Worth, Texas.

Figure 3(A-B) shows the Choctaw Central High School Solar Car Project Team with their car and trophies. Figure 3C is of Jim Fairly, one of thirty Jackson State University engineering students invited to the Energy Summit. Jim worked for MDEQ as an intern in 1997-1998 and worked with me washing fossils from sediment samples.

Figure 3A. The Choctaw Central High School Solar Car Project Team, standing beside their car, is the only Native American team.

Figure 3B. The Choctaw Central High School Solar Car Team's car won the Advanced Division title in the 2012 High School Solar Car Challenge at the Texas Motor Speedway in Ft. Worth, Texas, and set a new track record for the most laps (450) and fastest speed (59 miles per hour).

Figure 3C. Thirty Jackson State University engineering students were invited to the Governor's Energy Summit. One of these was Jim Fairly (at left). Jim was an intern with MDEQ in 1997-1998 and worked with me in washing fossils. He went on to study meteorology and is now in civil engineering at JSU.

Earth Science Week is October 14-20 with a different emphasis each day from Monday to Friday as follows:

October 15: Earth Science Literacy Day

October 16: No Child Left Inside Day (i.e. go outside and experience earth science firsthand)

October 17: National Fossil Day

October 18: Women in Geoscience Day

October 19: Geologic Map Day

For Geologic Map Day, the MDEQ Office of Geology has published a 6 x 4.25 inch postcard with a small version of the *Geologic Map of Mississippi* (Figure 4). These postcards are available at the Publication Sales Office on the first floor of the 700 North State Street building. The first card is free; additional cards are fifty cents each.

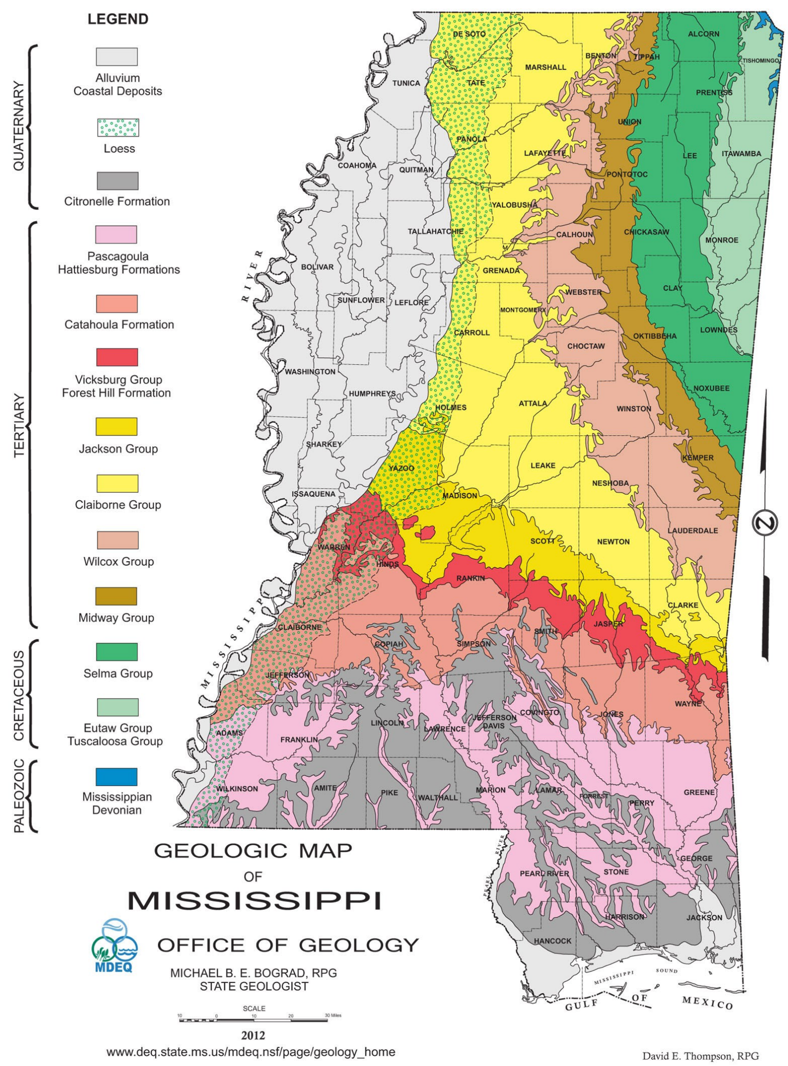


Figure 4. State geologic map postcard.

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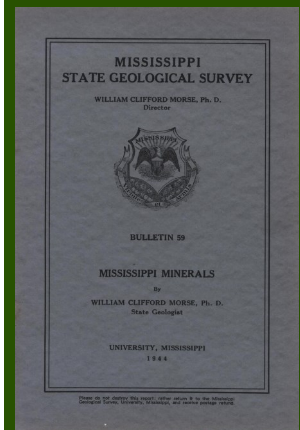


THE PUBLICATIONS OF THE MDEQ OFFICE OF GEOLOGY

James Starnes, Office of Geology

Geology is the basis of our environment. The MDEQ Office of Geology is the state's geological survey, charged with the documentation of Mississippi's abundant natural resources. Since the middle of the 19th Century, our office has published a long list of reports, publications, cross-sections, and maps that detail many aspects of our state's geology, geologic hazards, and mineral resources. This large collection of literature is used regularly by a wide range of industries, institutions, offices, firms, and individuals to make educated decisions about the conservation, use, and assessments concerning our natural resources. Work is ongoing to make these publications more widely available to the public and interested parties by making them available online for download in a PDF format. Many of these publications are still available through our Publication Sales Office, or can be viewed in our library as some are out of print. The following are links to some examples of our resources that are currently available. Please check out our website to see the wide variety of resources we have to offer and to see what publications are available for download.

From the Bulletin series:

http://bit.ly/Wpz5Ob

From the Circular series:

http://bit.ly/TMw1ET

From the Information Series:

http://bit.ly/ZYZXEy

An example of a geologic quadrangle map, from the Open-File Reports series:

http://bit.ly/QpzrCS

Environmental News, October 2012, volume 9, issue 10, page 8

LOOK AROUND MISSISSIPPI FOR FOSSILS

The Office of Geology participated in a fossil hunt with the Mississippi Museum of Natural Science and Mayor Cary Estes for Ice Age bones on the Mississippi River gravel bar at Rosedale. WLBT's Walt Grayson filmed the expedition.

Environmental News, October 2012, volume 9, issue 10, pages 9-12

Rock bit used to drill through 15 feet of Glendon Limestone

DRILLING ON THE RIVER

David T. Dockery, III

The September 2012 MDEQ newsletter contained an article entitled "Holding the Bluff at Vicksburg," which mentioned recent movement on piers E-1 and E-2 of the Interstate 20 bridge over the Mississippi River. Figure 1 (at left) shows the Glendon Limestone in place below the Interstate 20 bridge on the Mississippi River's west bank. At right in Figure 1 is a natural island (exposed only at lower water) on the east side of Pier E-1. This island is composed of a doubly-plunging, north-south-oriented anticline capped by 15 feet of Glendon Limestone. The picture is a view of the anticline from the southern side. The top ledge of limestone on the island is roughly the top ledge of limestone in the river bank. Low water has afforded the opportunity to drill this island for information concerning possible shear surfaces associated with movement on Pier E-1. The rock comprising the island has moved laterally to the west and is some 15 feet lower than the rock in the neighboring river bank. Drilling on the island began on Monday, October 15 and continued to October 22, 2012. Oriented Shelby tube samples (samples that could reveal shear planes) were taken at five-foot intervals and shipped to a laboratory for examination. The goal of this study is to find a way to stop the formation and the Interstate 20 bridge piers from moving.

Figure 1. Left: Exposure of Glendon Limestone on the east bank of the Mississippi River beneath the Interstate 20 bridge at Vicksburg. Right: An island of Glendon Limestone in a laterally displaced and down-thrown block, rising out of the river on the south (left) end and plunging beneath the water on the north end in front of Pier E-1 of the I-20 bridge. Here the top ledge of limestone in the adjacent river bank reappears as a doubly plunging anticline. Picture on left was taken on October 15, 2012, and the picture on the right was taken on August 14, 2012.

Figure 2 shows the drilling rig on the island. At left in the figure, the drilling rig is shown from the view of the jack-up barge anchored next to the island. The Glendon Limestone can be seen plunging below water level on the south end of the anticline. At right in the figure, a large vertical metal pipe stands above a platform of rip-rap behind the drilling rig. Men are standing around an opening in the base of the pipe in which a ladder leads to an instrument called a tiltmeter. The tiltmeter records subsurface movement along shear planes. Movement of less than an inch has been recorded over the last several years at a depth of 120 feet. Figure 3, at left, shows the drilling rig as photographed from the rip-rap platform on the island. At right is a close up view of the rig, showing the portable mud pit, and at bottom center, Shelby tube core barrels for taking oriented samples.

Figure 2. Drilling rig drilling on an island capped by Glendon Limestone in the Mississippi River at Pier E-1 of the Interstate 20 bridge at Vicksburg. At left, the Glendon Limestone plunges below the river level on the south end of an anticline. At right, the vertical pipe behind the rig contains a tiltmeter that measures lateral movement below ground. Pictures were taken on October 15, 2012.

Figure 3. At left, the jack-up barge and drilling rig are left and center. At right, a crane can be seen on the jack-up barge (upper left) and at bottom center are Shelby tubes used for core samples. Pictures were taken on October 15, 2012.

Figure 4. Structure in the Glendon Limestone along the east bank of the Mississippi River at Vicksburg. Pictures were taken on October 15, 2012.

Figure 4 shows geological structures in the Glendon Limestone south of the Interstate 20 bridge. From top to bottom, these structures include: (1) an anticline, with limestone layers cresting above river level, (2) a syncline between two anticlines, with limestone layers sagging below river level, (3) an oblique view of a rising anticline and sagging syncline, and (4) a monoclinal southward dip of limestone strata, sloped like a boat ramp into the river. The latter is the last appearance of the Glendon Limestone along the Mississippi River before it dips beneath younger strata in the southern part of Mississippi. Going north from this southern-most river exposure, the Glendon Limestone makes a gentle rise to exposures in the road cuts along Business Highway 61 in north Vicksburg south of the Vicksburg National Military Park. Further north, the Glendon Limestone was once quarried in the hills along Highway 3 north of Redwood for the manufacture of Portland cement (Figure 5). Folding in the Glendon Limestone south of the Interstate 20 bridge indicates movement of the formation from its original horizontal position.

Figure 5. Michael Bograd (left) and Jim Coleman standing on the upper ledge of the Glendon Limestone at the Mississippi Valley Portland Cement Company quarry on Highway 3 north of Redwood in Warren County (MGS locality 112). The Byram Formation with some loess cover outcrops above the Glendon Limestone. Picture was taken on June 12, 1976.

Environmental News, January 2013, volume 10, issue 1, pages 8-12

SHALE OIL AND GAS TRENDS IN MISSISSIPPI

David T. Dockery III, Office of Geology

A *USA Today* Opinion Editorial (Game changer: 'Fracking.' November 26, 2012) noted that fracture enhanced production of underground shale formations has unlocked such large supplies of new oil and gas in the United States that our country might become virtually energy independent by 2035. The Paris-based International Energy Agency (IEA) projected that new oil and gas recovered by hydraulic fracturing will lead the USA to overtake Russia as the largest natural gas producer by 2015 and become a larger oil producer than Saudi Arabia by 2017. So much new gas is on the market that gas prices have dropped from a high of $13 per thousand cubic feet in 2008 to $2 earlier this year, rebounding to $3.50 at present. A cheap supply of natural gas allows for more gas-powered electric generation and a cleaner environment. At the same time hydraulic fracturing has raised concerns of how to protect fresh groundwater supplies from hydraulic-fracturing fluids. The following is a short account of fracture enhanced production and important exploration trends in Mississippi where the practice is used.

The first commercial use of hydraulic fracturing was on an oil well about 12 miles east of Duncan, Oklahoma, on March 17, 1949. Another successful hydraulic fracturing job was completed later that day on a well in Holliday, Texas. Hydraulic fracturing proved so successful that by 1988 it had been used nearly one million times.

Chapter 22 of Alan Cockrell's book *Drilling Ahead* (University Press of Mississippi, 2005), entitled "Looking for Gas in All the Tight Places," accounted how Browning and Welch "achieved legend status" in their pioneering work with fracture enhanced production techniques to release gas in the hard rocks of the Black Warrior Basin in northeastern Mississippi. In 1989, Browning and Welch applied this technique to the Selma Chalk in East Heidelberg Field. Their first 4,000-foot test yielded a million cubic feet of gas per day. They then used the same technique with success in Baxterville Field. Today, Tellus and Penn Virginia have more than 400 Selma Chalk wells in Baxterville Field that have been fracture stimulated.

Lindsey Stewart worked with Browning and Welch in their chalk initiatives. At a time that the Selma Chalk was virtually untapped, Lindsey steered geologist John Cox and his Paramount Blackstone affiliate team to a widespread porosity zone near the top of the Selma Chalk. Paramount sold a chalk-play deal in Gwinville Field in Jefferson Davis County to Enron Oil and Gas of Tyler, Texas. With the use of hydraulic fracturing, the field vaulted in rank from tenth to fifth in Mississippi gas production. In 2000, it was the largest methane gas producer in Mississippi with almost 10 billion cubic feet of gas for that year. The Selma Chalk, and associated hydraulic fracturing fluids, is separated from freshwater zones by the Porters Creek Clay, which has a thickness of several hundred feet.

Today important hydraulic fracturing trends in Mississippi include the Floyd-Neal Shale of the Black Warrior Basin in northeastern Mississippi (Figure 1) and the Tuscaloosa Marine Shale in southwestern Mississippi (Figure 2). Figure 3 is an illustration of a well in the Bakken Shale of North Dakota, showing the vertical drill hole, the horizontal lateral hole, and an enlargement of the production casing and frack port. This image was chosen to illustrate fracturing in the Tuscaloosa Marine Shale as both the Bakken and Tuscaloosa are oil-producing shales. Glynda Phillips, in an article entitled “Drilling for Oil in Southwest Mississippi” in the November/December 2012 issue of *Mississippi Farm Country*, placed the volume of oil in the Tuscaloosa Marine Shale in Mississippi at 7 billion barrels. She noted the formation to range from 9,000 to 14,000 feet in depth and to have thicknesses between 300 and 800 feet.

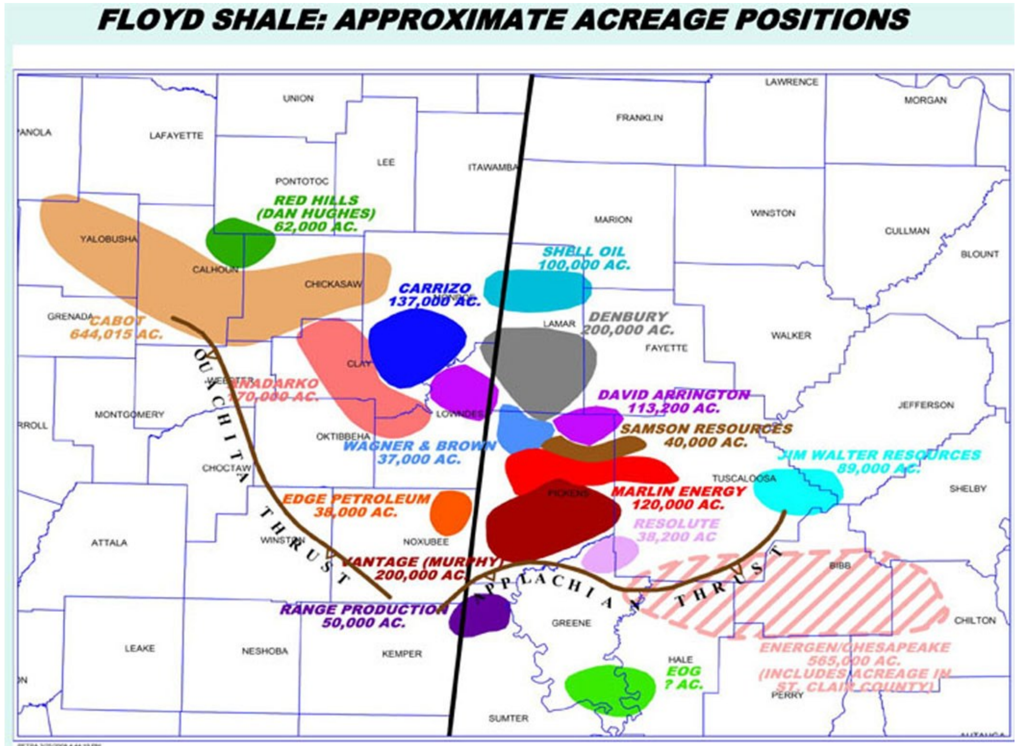


Figure 1. Lease acreage for Floyd Shale fracking prospects in Mississippi and Alabama (Kent A. Bowker, 2008, Recent Activity in the Floyd, Neal, and Chattanooga Shale Plays, Black Warrior Basin, Alabama and Mississippi: Search and Discovery Article #10162, posted October 31, 2008).

Figure 2. The Tuscaloosa Marine Shale trend in Mississippi and Louisiana (Richard Thompson, 2011, Central Louisiana area drawing interest for its oil and gas: The Times Picayune, published Sunday, July 3, 2011).

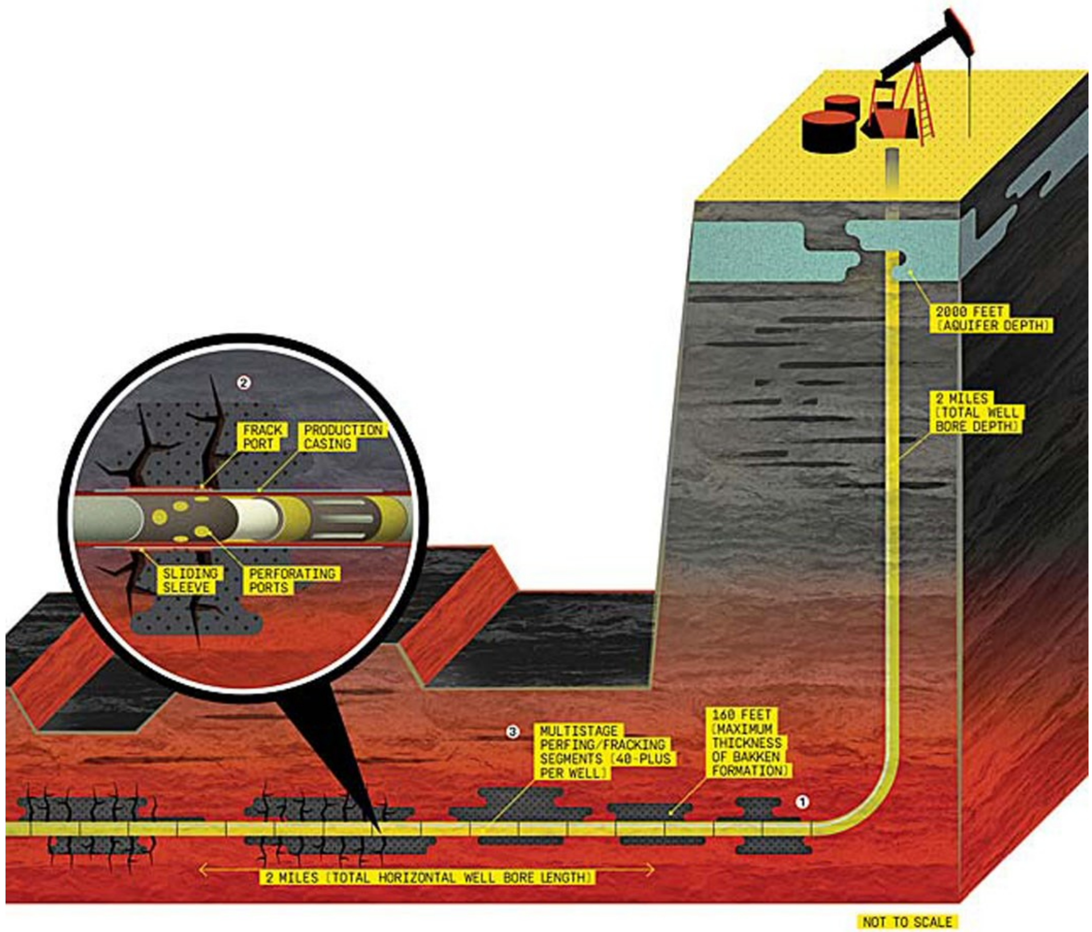


Figure 3. Diagram of a fracture enhanced production well (James Vlahos, 2012, Fracking Illustrated: A Guide to Shale Oil Extraction: Popular Mechanics, June 13, 2012).

Figure 4 shows the Brown Dense Smackover trend in Arkansas and Louisiana, where oil is produced in Arkansas and gas is produced in Louisiana as far east as the Monroe Uplift. The Brown Dense continues eastward across Mississippi, Alabama, and Florida, and underlies much of the northern Gulf of Mexico. Steve Walkinshaw of Vision Exploration stated (AAPG *Explorer*, October 2011) that the Brown Dense was "the most prolific source rock [for oil and gas] in the Gulf Coast." Figure 5 shows a core of the upper Smackover Limestone with porosity and traces of oil within spherical grains called ooids, the oil derived from the Brown Dense. In 2010, the U.S. Geological Survey estimated means of 147.4 trillion cubic feet of undiscovered natural gas, 2.4 billion barrels of undiscovered oil, and 2.96 billion barrels of undiscovered natural gas liquids in the Jurassic (including the Brown Dense) and Cretaceous (including the Tuscaloosa Marine Shale and Selma Chalk) strata of the Gulf Coast.

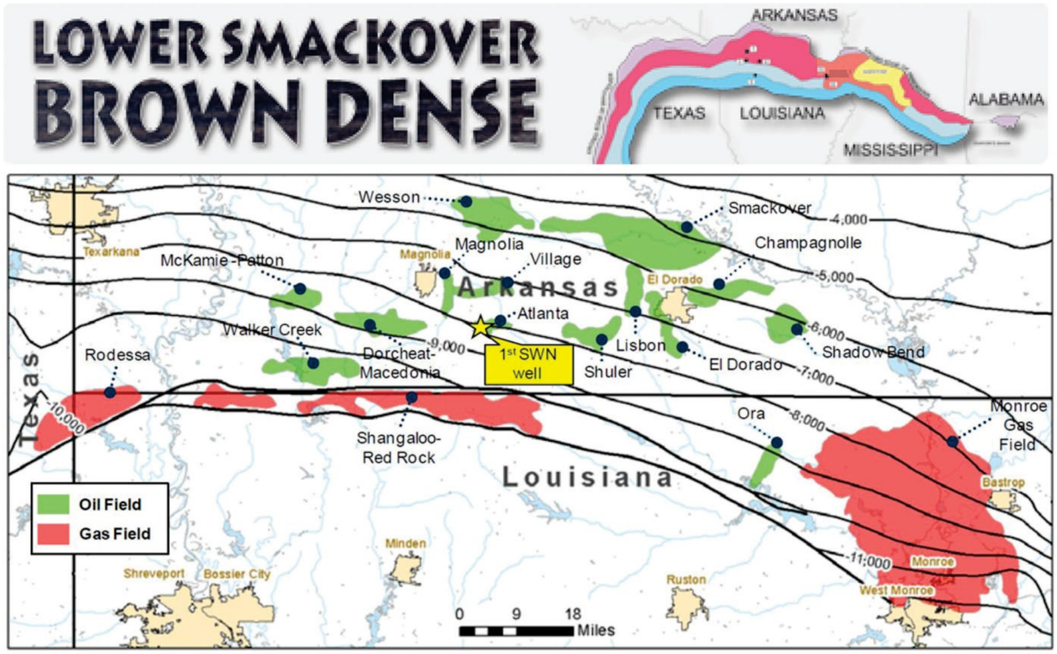


Figure 4. The Lower Smackover Brown Dense trend in the northern Gulf Coastal Plain (top) and hydraulic fracturing enhanced oil and gas production in Arkansas and Louisiana. (Top: Core Laboratories Exploration Reconnaissance Study. Bottom: Haynesvilleplay.com, Thursday, July 28, 2011).

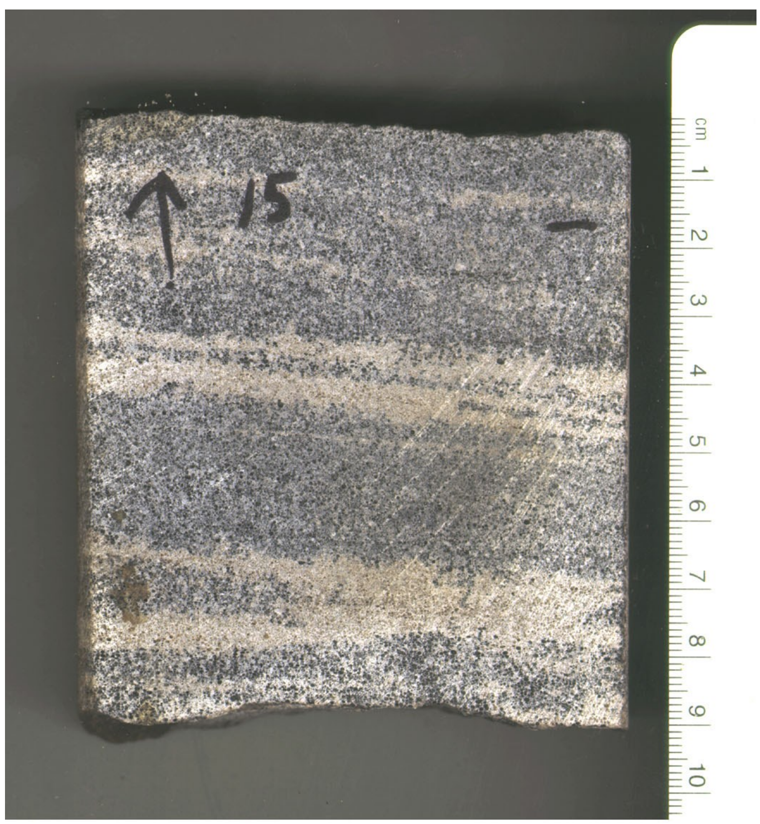


Figure 5. Oil in ooids in an oolitic limestone in the Smackover Formation at 15,486 feet in the Pruet & Hughes #1 Unit 14-10 in Section 14, T. 10 N., R. 8 W., Wayne County (MGS core box C-478.0). Picture scanned on a flatbed scanner by James Starnes.

Environmental News, January 2013, volume 10, issue 1, pages 18-21

Warning sign on fence around a hazardous waste containment cell at the Southeastern Wood Preserving site.

GEOLOGY AND GROUNDWATER AT THE SOUTHEASTERN WOOD PRESERVING SUPERFUND SITE IN CANTON

David T. Dockery III and David E. Thompson, Office of Geology

The Southeastern Wood Preserving (former King Lumber Industries and then Canton Treating Company) Site is a 25-acre property located in the northern part of the City of Canton, Mississippi. It was operated from 1928 to 1979 as a creosote wood preserving facility. Coal tar creosote and pentachlorophenol (PCP) were used as wood preservatives. The site included three unlined wastewater treatment surface impoundments constructed for disposal of wood preserving treatment sludges and process wastewater. Before the 1977 Clean Water Act was enacted, the facility reportedly discharged approximately 50,000 gallons of wastewater directly into Batchelor Creek.

The site has contaminated soil, sediment, and groundwater with creosote and creosote-related compounds. Groundwater sampling at the site identified 17 chemicals above EPA's Safe Drinking Water Act Maximum Contaminant Levels. Creosote is heavier than water and may accumulate in alluvial sediments or in fractured bedrock. In 2009, when creosote was discovered entering Batchelor Creek from fractures in the Yazoo Clay along the creek bottom and banks (Figure 1), the EPA designated the creek a Time Critical Removal site. Federal money was used to excavate the creosote permeated section of Batchelor Creek as deep as 40 feet until no contaminate was found (Figure 2). In March 2012, the Southeastern Wood Preserving site was finalized on EPA's National Priorities List as a Superfund site.

Figure 1. Creosote oozing from fractures in the Yazoo Clay in the bottom of Batchelor Creek (left) and from the alluvium and Yazoo Clay of the creek banks (right) in Canton, Mississippi. Pictures were taken by Richard Ball on October 20, 2009.

Core of lower Moodys Branch Formation at left (60-70 feet) and core of the upper Cockfield Formation at right (70-

Figure 2. Excavation of creosote contaminated bedrock (Yazoo Clay) along Batchelor Creek in Canton, Mississippi, and backfilling with fill dirt. Pictures were taken by Richard Ball on January 27, 2010.

One of the first steps in the Superfund process is soil testing and coring activities at the Southeastern Wood Preserving site, with the objective of testing surface soils, subsurface strata and groundwater to determine the nature and extent of contamination at the site. This will provide the needed information to design and implement a remediation plan for the site. The first of these drill tests was conducted from November 6-7, 2012, by a Geoprobe rotary sonic drilling rig (Figure 3) and found creosote contamination in fill dirt at 10-15 feet below ground level. The drill test then encountered Yazoo Clay at 15-40 feet, Moodys Branch Formation at 40-70 feet, and the upper clay of the Cockfield Formation (Figure 4) at 70 feet to the bottom of the hole at 170 feet. Additional drill tests will sample strata for contamination and test the first aquifer sands for possible groundwater contamination.

Figure 3. Full view of the Geoprobe rotary sonic drilling rig at left and core retrieval at right, during drilling of the core hole at the Southeastern Wood Preserving Superfund site at Canton, Mississippi. Pictures were taken on November 7, 2012.

Photographing the core.

Figure 4. Geologists from Black & Veatch Special Projects Corp. examine a five-foot core of dark-brown clay from the upper Cockfield Formation from a depth of 115-120 feet below ground level. Pictures were taken on November 7, 2012.

The Office of Geology has an interest in cores from this site as they include the contact between the Moodys Branch Formation and underlying Cockfield Formation. This contact is also the boundary between the Jackson and Claiborne groups and represents a time 38 million years ago when a worldwide rise in sea level flooded organic-rich delta clays of the Cockfield Formation and deposited the overlying fossiliferous marine sands of the Moodys Branch Formation. To help with the coring project, the office correlated the geophysical logs of four of the City of Canton's water wells, which line up from west to east along Batchelor Creek (figures 5-6). These logs show the location of aquifer sands in both the Cockfield and underlying Kosciusko formations in the same area in which future coring will be done. The stratigraphic sequence here, in descending order, consists of: (1) alluvium, (2) Yazoo Clay, (3) Moodys Branch Formation, (4) Cockfield Formation, (5) Cook Mountain Formation, (6) Kosciusko Formation, and (7) Zilpha Clay. Aquifer sands in both the Cockfield and Kosciusko formations are better developed toward the east within the cross section, while an upper Cockfield sand is developed in the two western wells.

The cross section in Figure 6 shows the aquifer sands in the Cockfield Formation to be protected by a hundred-foot-thick layer of dense clay at the top of the formation, which serves as an aquitard. An additional aquitard, the Cook Mountain Formation and the upper clay interval of the Kosciusko Formation, protects the underlying Sparta aquifer system. MDEQ's source water assessment of the Canton System ranked all of the wells as "Lower" in regards to their relative susceptibility to groundwater contamination.

Fossil leaf print in the upper Cockfield core.

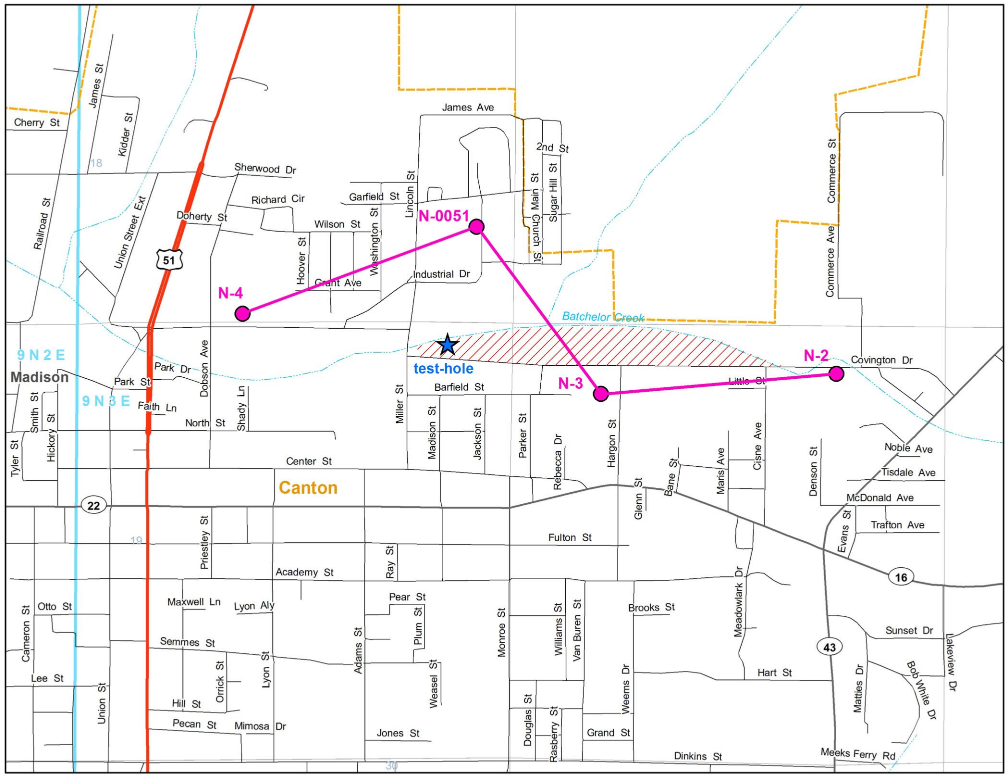


Figure 5. Location map for the Southeastern Wood Preserving Superfund site (shaded area), the recent Geoprobe test hole, and the cross section through four City of Canton water wells. Well N-3 is not in service and is scheduled to be sealed with grout.

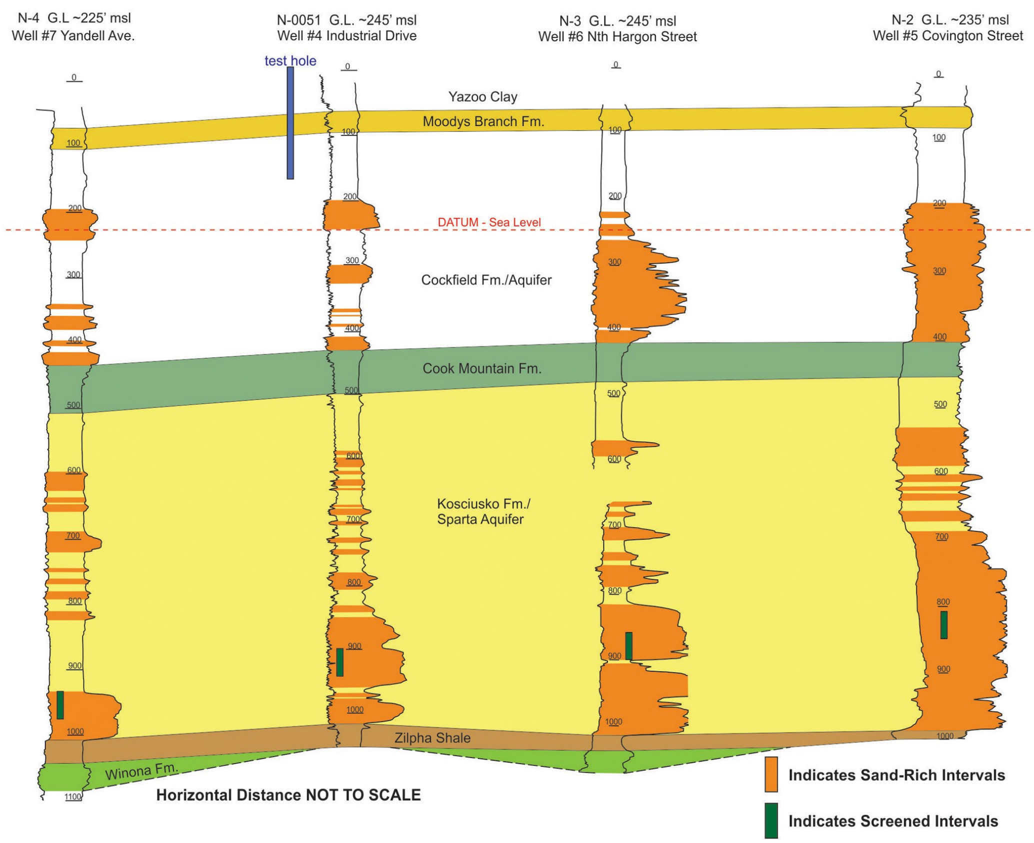


Figure 6. Structural cross section through four City of Canton water wells, showing sea-level datum, formations, aquifer sands, and screened intervals for water wells. The Geoprobe drilling rig test hole is projected due north to the line of section.

Environmental News, February 2013, volume 10, issue 2, pages 18-22

Direct push 5-foot cores from the Sonford site. Buff-colored cores on the left are from the Pearl River alluvial sand; dark-gray cores on the right are from the Moodys Branch Formation.

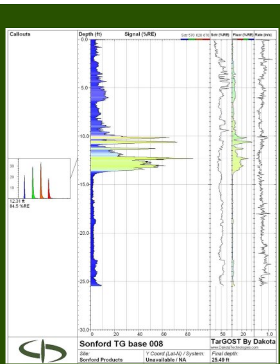
GEOLOGY AND GROUNDWATER AT THE SONFORD SUPERFUND SITE, FLOWOOD, MISSISSIPPI

David T. Dockery III and David E. Thompson, Office of Geology

The Sonford Products Superfund Site is located at 3506 Payne Drive in Flowood in Rankin County, Mississippi. Two chemical processing plants, Sonford International and Sonford Products, were operated on the site from 1972 to 1985. Both operations involved turning solid pentachlorophenol (PCP) into liquid formulations. From 1972 to 1980, Sonford International produced sodium pentachlorophenate, a water-soluble product used for the short-term protection of wood products from mildew. From 1980 to March 1985, Sonford Products produced an oil-soluble PCP product used for the long-term protection of wood products and also produced products for pest control and products to control the growth of mold and sap stains in freshly cut wood. Sonford Products closed in April of 1980 due to allegations that an employee died as the result of poisoning from high exposure levels of PCP.

On April 18, 1985, approximately 2,000 gallons of PCP were spilled into the wetland south of the property when valves to the storage tanks were turned on during the night. The first Bureau of Pollution Control responder was the Bureau Head, Charles Chisolm, who turned the valves off. The wetland was found to be contaminated with PCP, mercury, lindane, and phenylmercuric acetate. EPA took responsibility for remediation at the Sonford site on April 21 and 22, 1985. Some 2,500 cubic yards of contaminated soil were transported to the chemical waste facility at Emelle, Alabama, and 10,000 gallons of oil and treating solution were incinerated at a waste facility in South Carolina. Some 100,000 gallons of wastewater on the site were treated and disposed. EPA remedial action for the 2,000 gallon PCP release was completed on May 10, 1985.

In 2010, the plume of PCP contaminated groundwater in the Pearl River alluvial aquifer (Figure 1) was mapped, and, in 2011, a pilot study was conducted for treating the groundwater with chemical injections. These injections included: (1) a surfactant to disperse the PCP-solvent mix in the groundwater, (2) the oxidizer sodium persulfate, an oxidant that has a high solubility in water and leaves less harmful side products, and (3) caustic soda (sodium hydroxide) to increase the groundwater pH to 14 or 15 and react out the sodium persulfate to release oxygen.



LIF log shows PCP contaminants in the Pearl River alluvial aquifer at 10-15 feet.

This reaction changes the PCP plume in the groundwater into a chloride (salt) plume, which is much less toxic.

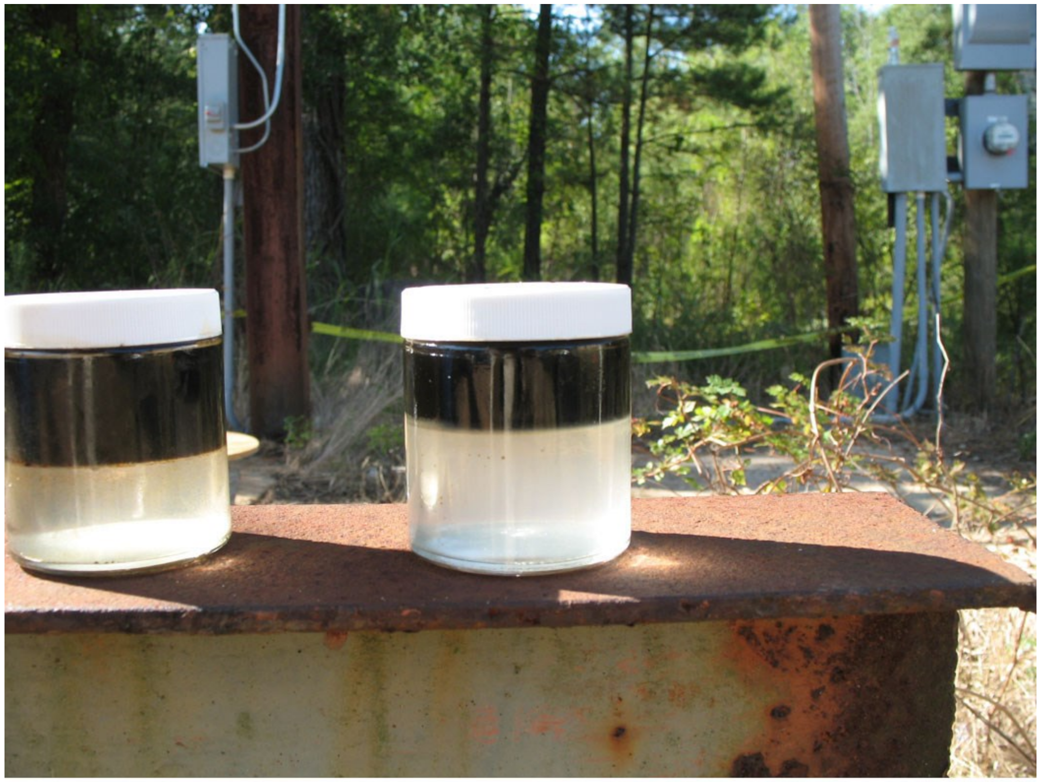


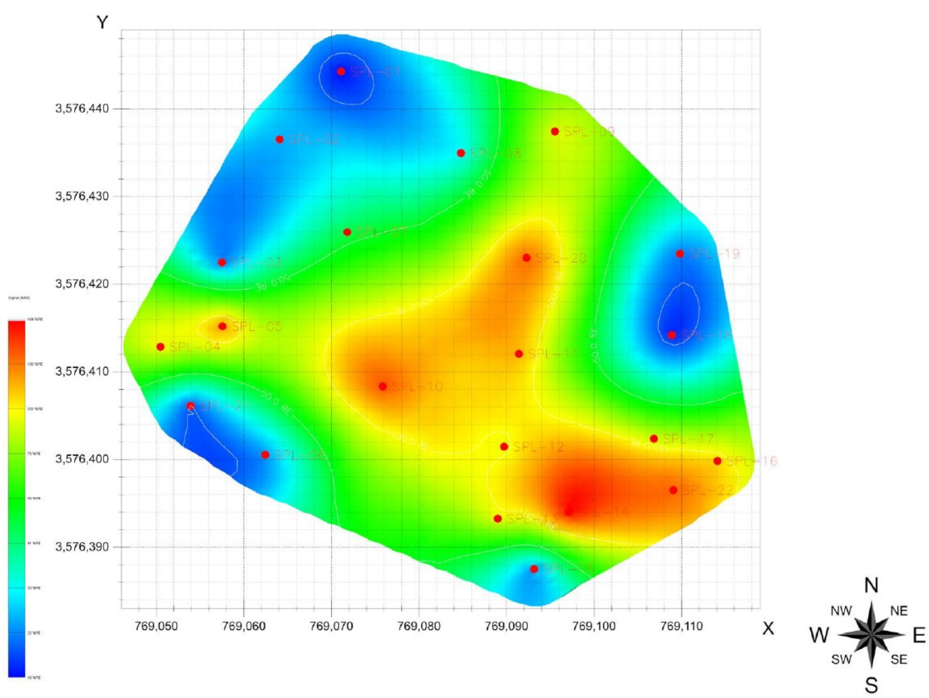
Figure 1. Water samples taken before the injection of surfactant into the Pearl River alluvial aquifer. The black liquid at top is a pure pentachlorophenol (PCP) and solvent mix floating on groundwater. Picture was taken by Richard Ball on September 22, 2011.

In December of 2012, a new survey was made of the pentachlorophenate plume at the Sonford site. To accomplish this, a team was assembled at the site with equipment and personnel from across the Southeast. A track-mounted direct-push-technology rig with a laser-induced fluorescence (LIF) probe was used to detect PCP in the groundwater column. Once the LIF log was completed for a location, a track-mounted direct-push-coring rig sampled the alluvial section at the same spot for laboratory analysis. Figure 2 shows the operation of the direct-push LIF rig. Figure 3 shows a LIF probe and a core from a depth of 10-15 feet with dark bands of PCP contaminants. Figure 4 is a location map of the Sonford site and line of cross section, with contours on the top of the Moodys Branch Formation, which rises close to the surface beneath the site. Figure 5 is an east-west cross section across the eastern flank of the Jackson Dome anchored by two public water well logs at each end with a test hole in the middle; the western-most well is close to the Sonford site.

Figure 2. At left, a track-mounted direct-push device has hammered through the concrete slab of a metal shed and is now hammering a LIF probe through the Pearl River alluvium at the Sonford Superfund site at Flowood, Mississippi. At right, site engineer Darci Scherbak checks the 2010 plume map against the "real time" LIF log for 2012. Pictures were taken on December 5, 2012.

Figure 3. At left, laser-induced fluorescence (LIF) probe; the green laser light is shining through a sapphire window in the middle at top. At right, a LIF log at bottom, showing contaminants at depths of 10-15 feet, and the 10-15-foot core just above, showing dark bands at high levels of PCP concentrations. The "sweet" smell of PCP in the core is very strong. Pictures were taken on December 5, 2012.

PCP plume in the Pearl River alluvial aquifer at the Sonford site as measured in 2010 (see page 18). Scale at lower left shows low concentrations in blue and higher concentrations in red. Plume map underlies the site as located in Figure 4 near well #1.



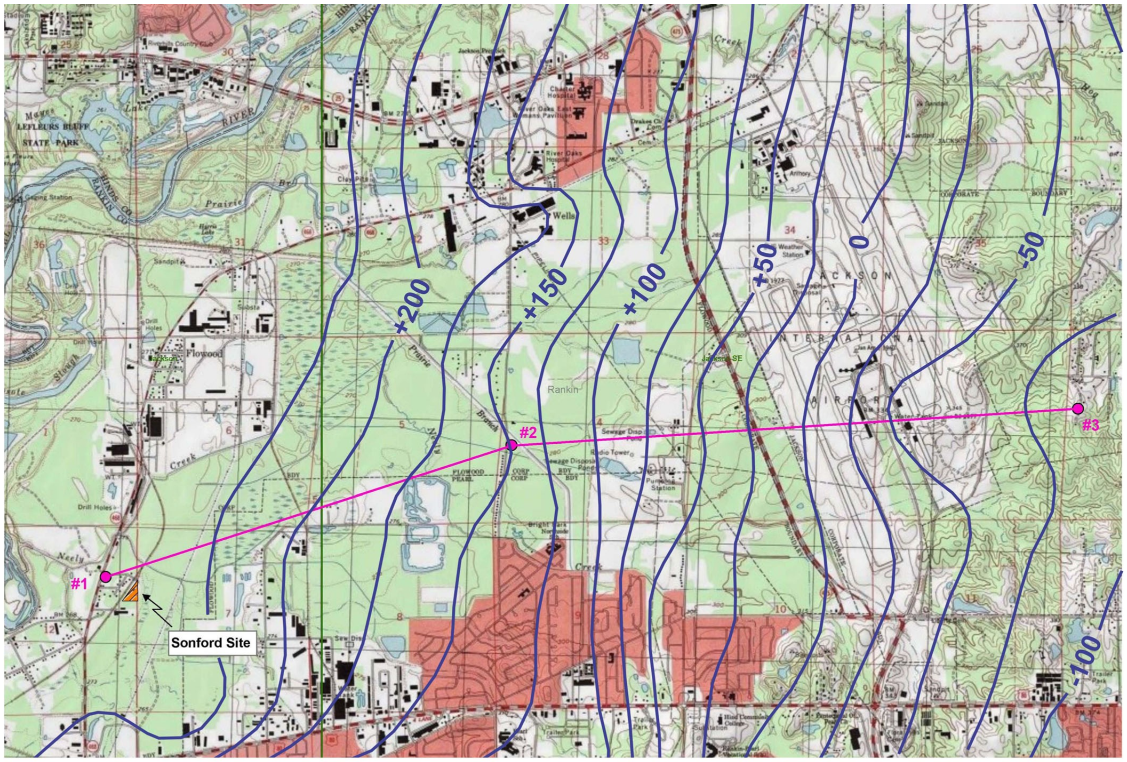


Figure 4. Location map of cross section and the Sonford Superfund site on portions of the Jackson and Jackson SE 7.5-minute topographic quadrangle maps. Contours on the top of the Moodys Branch Formation are shown in blue with the "0" contour at sea level; contours rise from 100 feet below sea level (east) to 225 feet above sea level (west) for a total rise in this map view of 325 feet. West of the 225 contour, the base of the Yazoo Clay is truncated beneath the Pearl River alluvium, and the Moodys Branch Formation is either difficult to pick on geophysical logs or is missing due to erosion. The base of the Pearl River alluvium at the Sonford site is about 240 feet above sea level. Contours are from Wilbur T. Baughman (1971, Plate 3, in *Rankin County Geology and Mineral Resources*: Mississippi Geological Survey, Bulletin 115).

Figure 5 shows the Yazoo Clay to be absent under the Sonford site due to uplift and erosion over the Jackson Dome. The Cockfield aquifer is protected at this site by a hundred-foot-thick section of clay in the upper part of the formation as shown in the core in Figure 6. The Sparta aquifer system, the groundwater supply for the Town of Flowood, is protected by an additional section of clay in the Cook Mountain and upper Kosciusko formations. Remediation of the PCP plume in the Pearl River alluvial aquifer is ongoing. One contractor told me they were going to clean the aquifer to such a high quality that I could drink water from it.

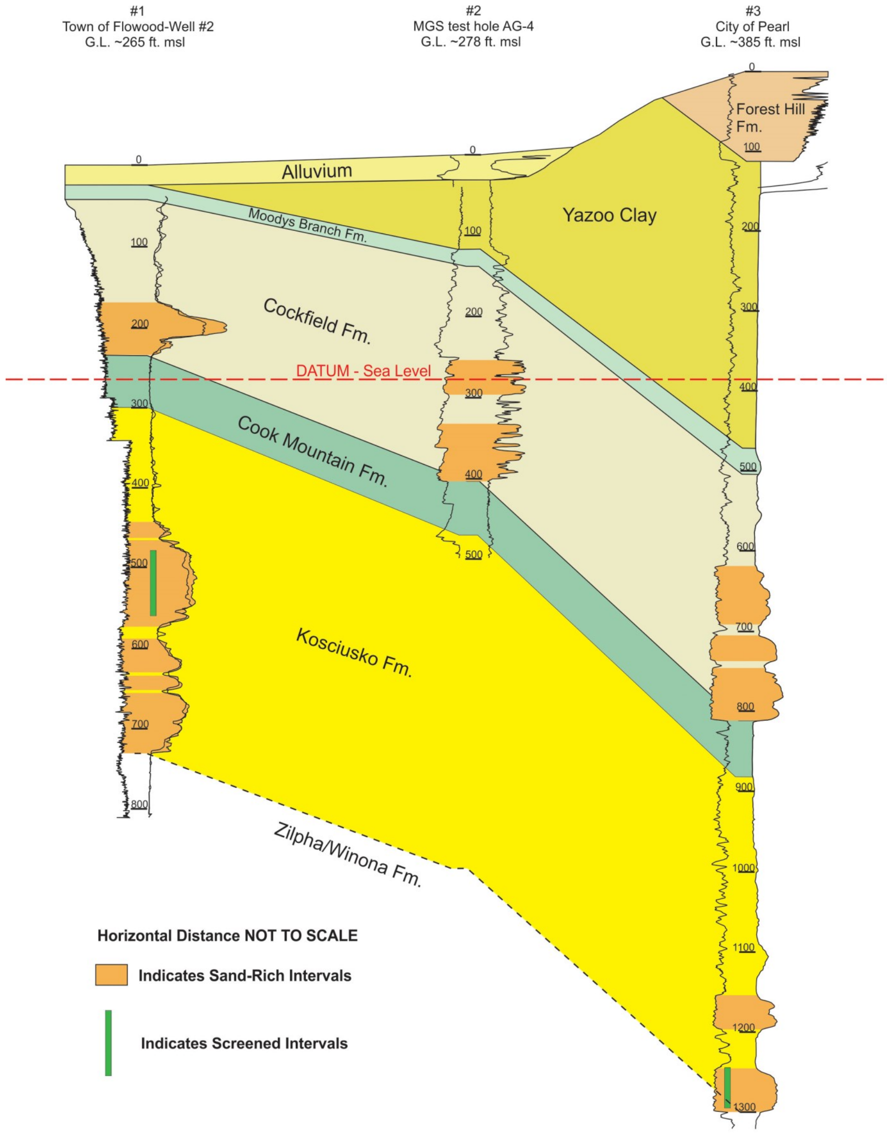


Figure 5. East-west cross section of wells on the eastern flank of the Jackson Dome, showing the westward truncation of the Yazoo Clay and Forest Hill Formation along the outcrop and beneath the Pearl River alluvium. Well #1 is located just northwest of the Sonford Superfund site (located in Figure 4), where the Moodys Branch Formation directly underlies the Pearl River alluvium.

Figure 6. Four-inch-diameter core of the upper Cockfield Formation at the Sonford Superfund site in Flowood, Mississippi. Fossil leaves can be seen in the broken end of the core at left; a close up of the bedding plane with fossil leaves is shown at right. Pictures were taken by Richard Ball on September 10, 2008.

Environmental News, March 2013, volume 10, issue 3, pages 18-23

Cretaceous ammonite for sale at dealer's table at Rock Show.

The 2013 Rock Show and Fossil Road Show

David T. Dockery III

The Mississippi Gem and Mineral Society's 54th Annual Rock Show and the Mississippi Museum of Natural Science's 10th Annual Fossil Road Show were on back to back weekends on February 23 and 24, and March 3, 2013, respectively. The Annual Rock Show is a great way for MDEQ staff to meet those interested in rocks and fossils and to educate the public about the state's geology and groundwater supplies. It is at this event that we see interesting new geological finds and learn about new localities. Figure 1 shows the booths for the Office of Geology and the Office of Land and Water Resources.

The Rock Show is also a family time to bring kids, who have yet to lose their interests in rocks and in finding things in general. I met Mark and Robin Curtis and their son Colton at the Office of Geology booth, where they reminded me of the natural cross in petrified wood that they brought by the office around 1999 when MDEQ was at Southport Center. I remembered photographing the rock. Mark was doing the dirt work at a church site on the Interstate 55 frontage road between Jackson and Byram when, on a Sunday morning at around 9:00 a.m., a shining object in the distance caught his eye. When he walked closer to look, only the crystalline cross was protruding above the surface level. I asked Mark and Robin to bring their cross rock to the Fossil Road Show the following week, which they did.

Figure 1. Left, James Matheny at the Office of Geology booth and Paul Parrish at the Office of Land and Water Resources booth. Pictures were taken on February 23, 2013.

Perhaps the greatest attractions of the Rock Show are the dealers' tables with rocks, gemstones, and fossils from around the world. Figure 2, captioned "Family Affair," shows George and Nicole Phillips and volunteer Ashley Williams at the Mississippi Museum of Natural Science booth and James Starnes roaming the dealers' tables with daughters Abby and Gracie. Mississippi State University, the University of Mississippi, and the University of Southern Mississippi maintain booths at the Rock Show each year to capture their share of budding geology students (Figure 3).

Figure 2. Rock Show, a family affair. Left, George and Nicole Phillips with volunteer Ashley Williams in the middle at the Mississippi Museum of Natural Science booth. Right, James Starnes roams the show with daughters Abby (right) and Gracie. Pictures were taken on February 23 (left) and 24, 2013.

Fossil trilobite with legs at dealer's table at Rock Show.

Figure 3. In alphabetical order from top to bottom are the the geology department booths for Mississippi State University, the University of Mississippi, and the University of Southern Mississippi. Pictures were taken on February 23, 2013.

The Fossil Road Show on Saturday, March 2nd, brought out many families with their prized rocks and fossils to be identified. The high points of this event for me were the return of Mark, Robin, and Colton with their cross rock and Minor and Kim Ferris with fossils from the Byram Formation found at a locality (new to me) on the Mississippi River below their home at Vicksburg, including the large conch *Turbinella wilsoni* (Figure 4). *Turbinella wilsoni* was first illustrated by French naturalist Charles Alexander Lesueur in 1829 after he made a collection of fossils at Vicksburg (then called Walnut Hills) on his way to New Orleans on a flatboat and was later named by New York Geological Survey paleontologist Timothy Conrad in 1848. It was one of the largest conch species in the Vicksburg Group, was prominently featured on our Vicksburg Group gastropod bulletin (#124), and was even used as a defense exhibit in a court case to show the paleontological significance of a certain fossil locality (Figure 5).

Figure 4. Left, Robin, Colton, and Mark Curtis at the Fossil Road Show with their cross in petrified wood. Right, Kim and Minor Ferris holding the fossil conch *Turbinella wilsoni* found in the Byram Formation on the Mississippi River below their home on the bluff at Vicksburg, Mississippi. Pictures were taken on March 2, 2013.

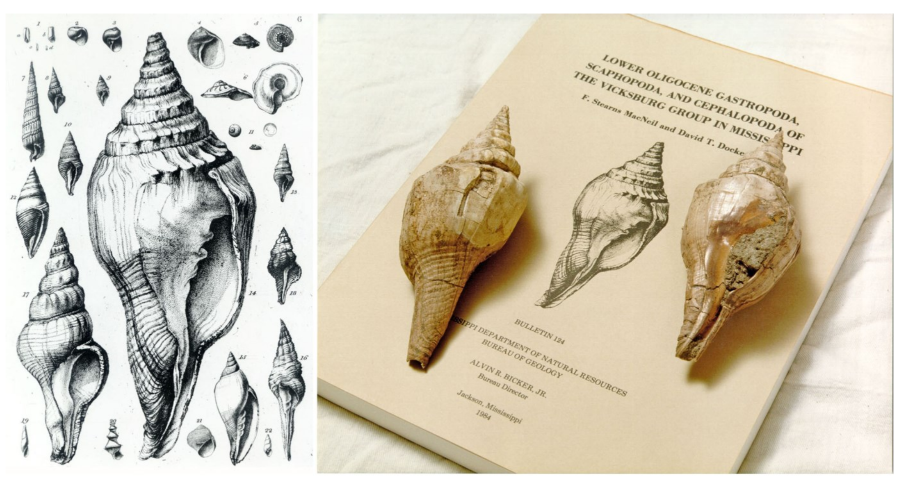


Figure 5. Left, Plate 6 of Lesueur's twelve plates on the fossils of Walnut Hills, now Vicksburg, Mississippi, dated as 1829; *Turbinella wilsoni* is the large central figure. Right, photograph by Gil Ford Photography on October 23, 1999, was exhibit D-86 in a court case tried at Magnolia, Mississippi. The photograph shows two *Turbinella wilsoni* shells from the Byram Formation on the Big Black River at Edwards, Mississippi, beside the cover illustration of Mississippi Office of Geology Bulletin 124

New additions to those at the fossil identification tables include Susan Zachos, who is the wife of Louis Zachos, the latter being a fossil echinoid expert and a visiting assistant professor in the Department of Geology and Geological Engineering at the University of Mississippi. Susan is both an attorney and a Professional Geoscientist licensed by the Texas Board of Professional Geoscientists. Another first time fossil expert at the Fossil Road Show was James Lamb with the University of West Alabama Black Belt Museum. James is a specialist in Cretaceous dinosaur, mosasaur, and turtle fossils from the Gulf Coastal Plain, including those from Mississippi (Figure 6).

Figure 6. Left, Susan and Louis Zachos identifying fossils. Right, James Lamb showing a replica of a Cretaceous turtle shell at the Fossil Road Show. Pictures were taken on March 2, 2013.

Family of nine with one on the way at the Fossil Road Show

John Davis, well-known former science teacher at St. Andrews, is a regular fossil identifier at the Fossil Road Show (Figure 7, left). He was largely responsible for the Office of Geology publishing guidebooks on rocks and fossils found in Mississippi gravel and developed the concept of egg-carton rock collections. John stopped me at the show to tell me in his usual dramatic flair that, if I never did anything else in my professional career, publishing Circular 7 (our color guidebook) was enough to make it worthwhile. Figure 7 at right could be captioned, “Bringing grandchildren to the Fossil Road Show.” This picture had to be PhotoShopped, as camera-shy grandchildren Dylan and Courtney took turns hiding from the camera.

Figure 7. Left, John Davis showing fossils from Mississippi gravel. Right, Pam Milner (in red) with her sister Deb and grandchildren, Dylan (left), Courtney (middle), and Tyler (right). Pictures were taken on March 2, 2013.

Environmental News, April 2013, volume 10, issue 4, pages 21-25

The narrow hole that swallowed up Mark Mihal on the 14th fairway of an Illinois golf course.

SINKHOLES

David T. Dockery III, Office of Geology

Sinkholes, a natural hazard, have been in the news lately after two recent bizarre incidents. First, a man perished when the bed he was sleeping in was swallowed up in a 50- to 60-foot deep sinkhole under his house in Seffner, Florida. As those in the Bush house were going to bed on the Thursday night of February 28, 2013, Jeremy Bush heard a deafening noise and his 37-year-old brother Jeff scream. He ran to his brother's room to find his brother's bed, dresser, and television gone. Jeremy stood in the hole through the collapsed floor and dug through the rubble with a shovel trying to find his brother until the police arrived and pulled him out, saying that the floor was still collapsing. By Saturday March 2, 2013, authorities gave up the search for Jeff Bush, admitting at that point it was not possible to recover the body. Then, on March 12, on the 14th hole at Annbriar Golf Course near Waterloo, Illinois, 43-year-old Mark Mihal disappeared down an 18-foot-deep and 10-foot-wide sinkhole. Mark's golfing buddy Mike Peters turned to say something to Mark, and Mark was gone. He heard Mark moaning and ran to find the small hole that swallowed Mark. In twenty minutes Mark was rescued, suffering only a dislocated shoulder.

Could these things happen in Mississippi? Though not as likely to happen as in the karst terrain of Florida or Illinois, such things could and have happened in Mississippi. Geologic maps produced by the Surface Geology Division are used to determine where sinkholes are most likely to occur. Sinkholes in Mississippi are largely caused by sapping of sediment by groundwater, which leaves a void below the surface. Figure 1, by the Pennsylvania Department of Environmental Protection, shows how soil moving into a void in limestone bedrock can create a sinkhole. In a similar process, sandy soil in the Mississippi Delta can move into desiccation cracks when the water table drops in the Mississippi River Alluvial aquifer. A tractor once broke an axle when it fell into a sinkhole on a farm near Tutwiler in Tallahatchie County. A paper by Tracy Lusk entitled "Problem of Desiccation Sinking at Clarksdale" in Mississippi Geological Survey Bulletin 97 described a sinkhole in 1957 that damaged the foundation of the new Eliza Clark Elementary School.

Drill holes and a test pit indicated the sinking was caused by excess pumping of a well used for the school's air conditioning system, which lowered the water table and allowed sediment from above to move downward into desiccation cracks. Winter rains in 1987-1988, following a drought, produced a "sinkhole" problem in the City of Clarksdale, prompting the city to seek emergency funds to repair foundations and infrastructure. The August 2, 1988, edition of the *Clarion-Ledger* followed up on the city's grant request under the headline "Stop that sinking feeling."

Figure 1. Development of a sinkhole in soil overlying a solution void in limestone bedrock.

Sinkholes also develop in the loess soils of the Loess Hills bordering the east side of the Mississippi River Valley. I have such sinkholes where I live in northwestern Hinds County. I tried to fill one of the larger holes with a dump-truck-load of dirt. The dirt went somewhere, and the hole came back. Since then the sinkhole has taken out a pear tree, while working its way up the hill toward my house. The left side of Figure 2 shows cavernous loess in the highwall of a dirt pit on Old Highway 61 in Vicksburg; the right side shows a "rabbit hole" (like the one in *Alice in Wonderland*) leading downward to a loess cavity with another lateral hole draining the cavity. A person standing above a slightly covered "rabbit hole" could suddenly find himself eighteen feet below ground at the bottom of a loess cavity. The National Park Service regularly deals with sinkholes and erosion while keeping up the grounds on the loess terrain of the Vicksburg National Military Park. The beautifully manicured slopes require periodic maintenance with heavy dirt-moving

Figure 2. Left, cavernous loess uncovered in the highwall of a dirt pit on Old Highway 61 in Vicksburg, Mississippi. Right, red X at top marks the opening of a "rabbit hole" leading downward to a loess cavity; the lower red X marks a lateral drain hole leading from the cavity. Pictures were taken by James Starnes on March 22, 2013.

Figure 3. Left, man standing in a sinkhole up to his shoulders at the Vicksburg National Military Park as National Park Service staff and MDEQ personnel watch. Right, heavy equipment repairing a slope in the Park. Pictures were taken on April 14, 2010.

Sinkholes due to solution cavities in limestone also occur in Mississippi, a state with as many as 50 known caves. Caves, sinkholes, and other karst features occur in: (1) the Tuscumbia Limestone in Tishomingo County, (2) the Pride Mountain Formation in Tishomingo County, (3) the Chiwapa Sandstone (in places a limestone) in Union County, (4) the Clayton Formation in Tippah County, and (5) limestones of the Vicksburg Group along the outcrop belt from Wayne County to Rankin County. Figure 4 shows a sediment-filled sinkhole in the top of the Tuscumbia Limestone in Tishomingo County (at left) and solution channels in a limestone in the Pride Mountain Formation in the same county. Figure 5 shows sinkholes in the Clayton Formation in Tippah County. Figure 6 shows the inside of Muddy Ridge Cave in the Clayton Formation, which is just down hill from the sinkholes in Figure 5. Figure 7 shows a small cave in the highwall of the old Marquette Cement Manufacturing Company quarry at Brandon.

If all of these possible sinkhole sources are not enough, there are always those sinkholes above leaking sewer lines that can cave in a road (Figure 8).

Figure 4. Left, collapsed sediment-filled sinkhole in the top of the Tuscumbia Limestone in the Iuka Quarry. Sediment from the fill has fallen into a pile on the quarry floor. Right, solution channels in the basal limestone of the Green Hill Member of the Pride Mountain Formation below the spillway of Haynes Lake in Tishomingo State Park. Such channels drain the lake of water. Picture at left was taken on May 8, 1989, and on right by Steve Jennings on November 7, 2003.

Figure 5. Wil Howie in a dry sinkhole (left) and Suzie Long at a water-filled sinkhole (right) up slope from Muddy Ridge Cave in Tippah County. Pictures were taken in July of 1975.

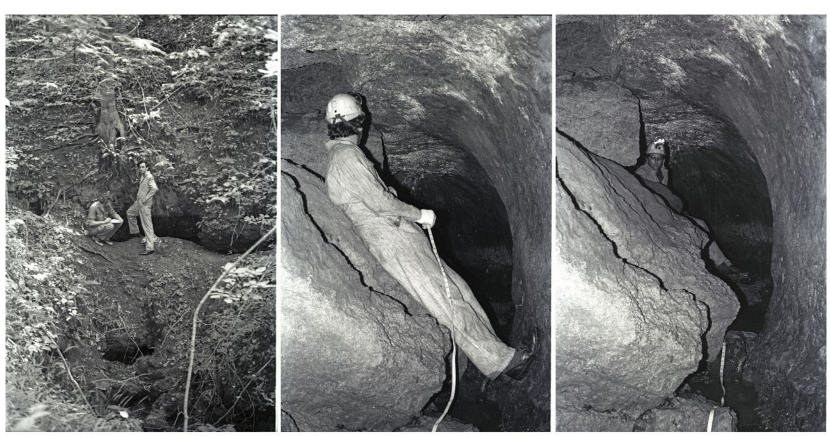


Figure 6. Wil Howie (taking notes) and David Williamson at the entrance of Muddy Ridge Cave in Tippah County (left) and David Williamson surveying the cave passages with a tape and compass (middle and right). Pictures were taken in July of 1975.

Figure 7. Left, Michael Bograd's left hand is at the Glendon Limestone-Byram Formation contact with a cave at the base of the Byram Formation to his right. Right, Michael Bograd looks into the narrow cave passage, which is half filled with Bucatunna clay from above. Pictures were taken around February of 1981.

Figure 8. Tammy Estwick and the WAPT News crew at a road collapse above a leaking sewer line under Longino Street between the railroad tracks and West Fortification Street in Jackson, Mississippi. Picture (digital, Image 2264) was taken on July 6, 2012.

Environmental News, May 2013, volume 10, issue 5, pages 14-18

MISSISSIPPI GEOLOGIC MAPS IN *MAPVIEW, GEOLOGIC MAPS OF THE NATION*

David T. Dockery III and Michael B. E. Bograd, Office of Geology

The May 2012 issue of the MDEQ newsletter contained an article on page 6 entitled, "Geologic 7.5-Minute Quadrangle Maps Go Online," which gave the recent history of the Office of Geology's geologic mapping program and announced that 115 color 7.5-minute geologic quadrangle maps were available online from the MDEQ website. These maps were made available as pdf downloads from the Office of Geology's List of Publications under the section for Open-File Reports. The availability of geologic maps online had been a request of the State Mapping Advisory Committee and more lately a request of the U.S. Geological Survey (USGS). Dan Morse of the Surface Geology Division sent pdf files of published quadrangle maps to the USGS over a period of seven months between August 6, 2012, and March 5, 2013. On March 6, Mississippi geologic maps, including those for 7.5-minute quadrangles, as well as the state geologic map and many of our county geologic maps, were posted on the USGS "MapView, Geologic Maps of the Nation" website.

The purpose of this website is to allow a user to find the best available geologic map, in a range of scales, for any spot in the nation. It helps the user find the publication information and availability of the geologic map for any spot in the nation. One can determine whether a detailed geologic map (such as at a scale of 1:24,000 or greater) has been published for any location, or perhaps a county geologic map, or whether the best available map is the state geologic map.

Mississippi is now one of only three states east of the Mississippi River on the U.S. Geological Survey's "MapView, Geologic Maps of the Nation" website at http://ngmdb.usgs.gov/maps/MapView/, a website that illustrates a significant component of the USGS National Geologic Map Database (NGMDB) as illustrated in Figure 1.

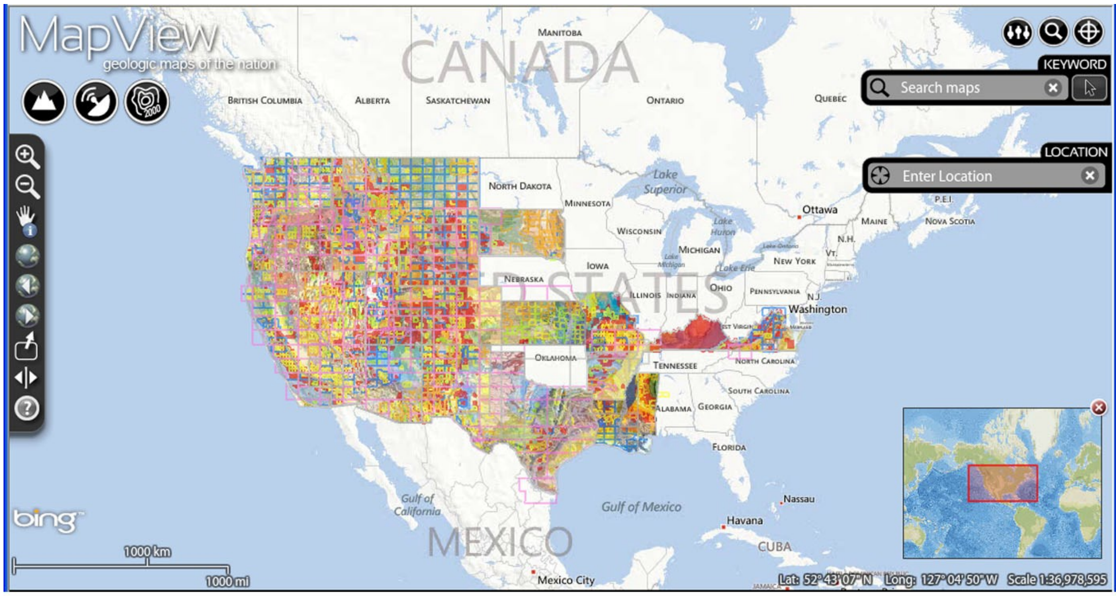


Figure 1. Geologic map coverage of the contiguous 48 United States on the U.S. Geological Survey MapView website. Most states west of the Mississippi River have map coverage available at this site, but only three states east of the Mississippi River, including Mississippi, have map coverage at this time.

A closer view of the entire State of Mississippi shows the Geologic Map of Mississippi, which was published at a scale of 1:500,000 (Figure 2). Red-outlined rectangles show the availability of 7.5-minute geologic quadrangle maps at a scale of 1:24,000, a scale sufficient for most site-specific geologic determinations. County geologic maps in the database are outlined in yellow. Figure 3 is a zoom in on central Mississippi to an enlargement where county geologic maps at a scale of 1:126,720 appear, where available. Again, in this figure, red-outlined rectangles show the availability of 7.5-minute quadrangle maps.

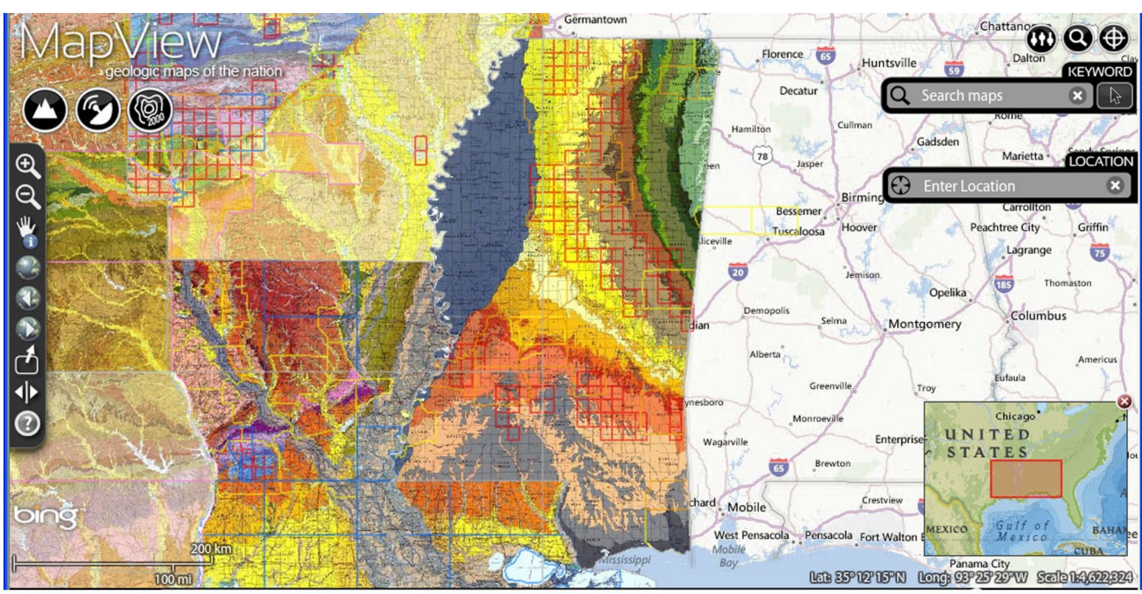


Figure 2. Map view showing the entire State of Mississippi. The red rectangles overlain on the state geologic map (scale 1:500,000) show areas with available 7.5-minute geologic quadrangle maps (scale 1:24,000).

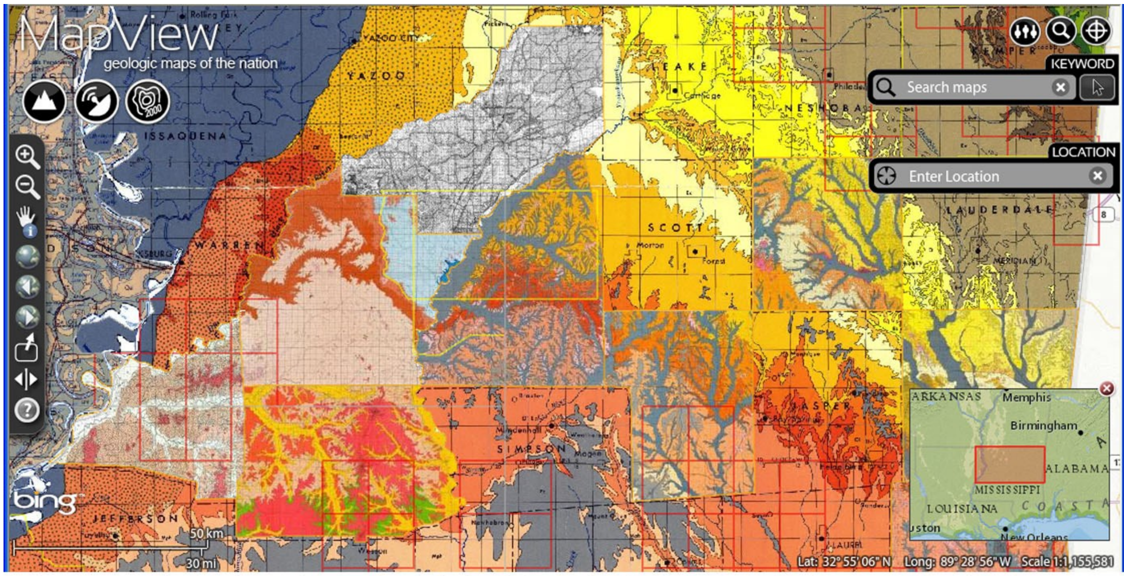


Figure 3. A closer view of central Mississippi shows both the state geologic map at a scale of 1:500,000 and higher resolution county geologic maps at a scale of 1:126,720 where available; the Madison County geologic map is in black and white, while others are in color. Available 7.5-minute geologic quadrangle maps at a scale of 1:24,000 are outlined in red.

Figure 4 shows the Mississippi geologic map in which the Cascilla 7.5-Minute Geologic Map rectangle in Grenada and Tallahatchie counties has been clicked so that its link appears. A click on the link's "Download" gives the window at the top of Figure 5 (Product Description Page), where a click on "Availability" gives the MDEQ window (Figure 5, at bottom). The MDEQ window gives information on where to order a paper copy of the map and offers a "Click image to view" that gives a full-size image of the quadrangle map. Click the symbol for "Preview this image in new window" to view the map in detail. Once opened, you can zoom and pan the map. The goal of the USGS and MDEQ websites is to make geologic maps readily available to professionals and the public.

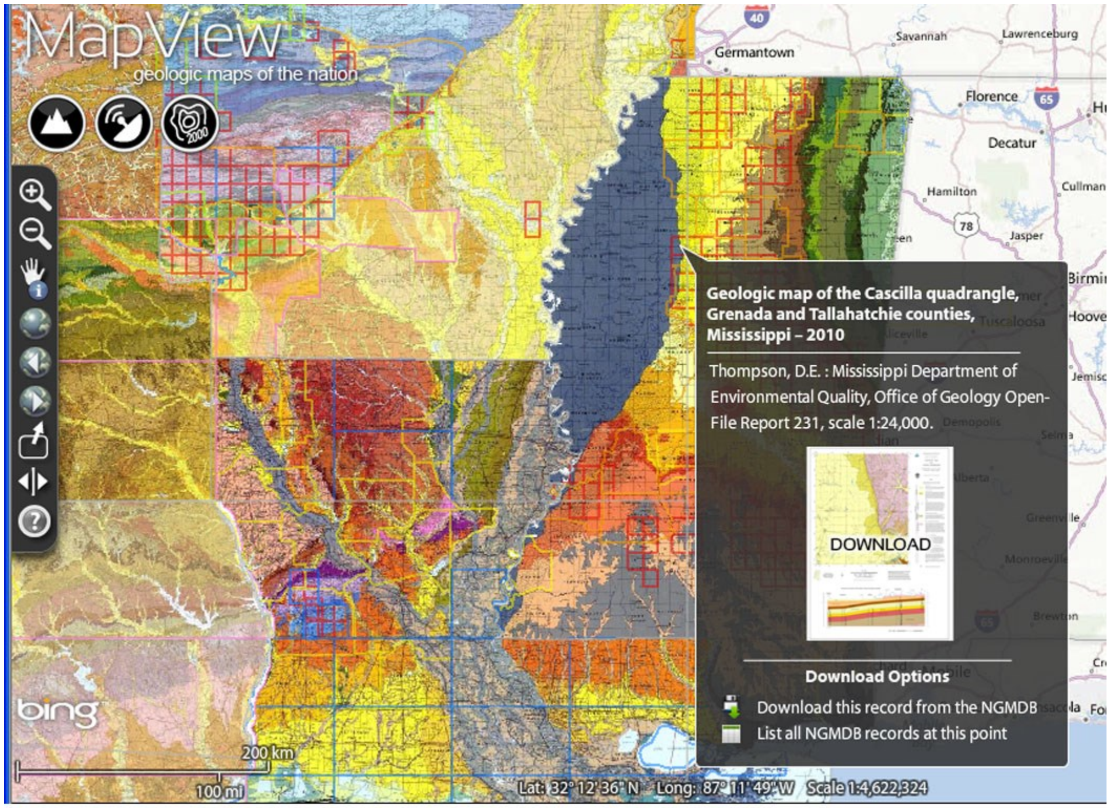
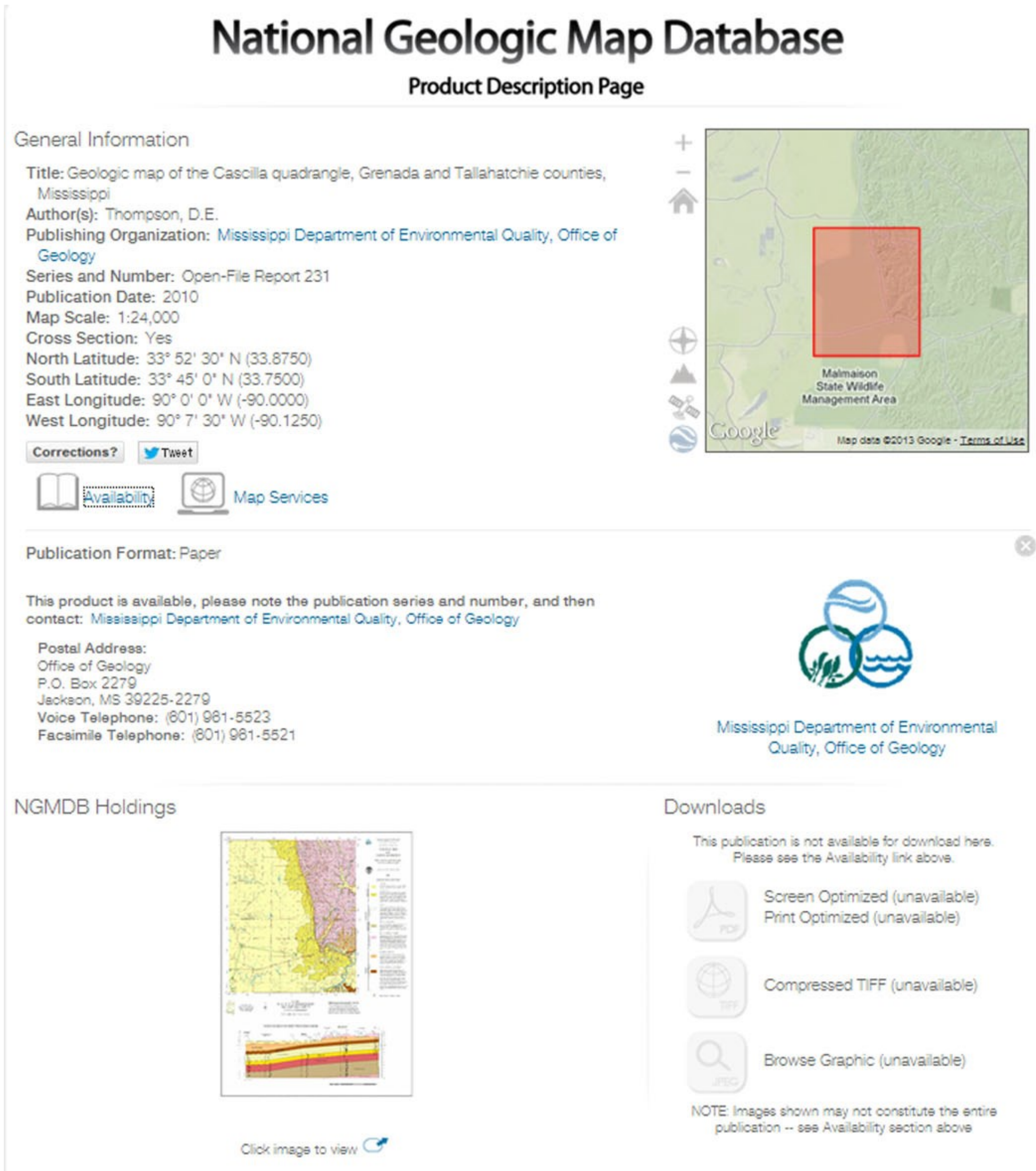


Figure 4. A closer view of the Mississippi geologic map with available 7.5-minute geologic quadrangle maps outlined in red. A click on the Cascilla Quadrangle identifies the publication and gives "Download Options." A click on "Download" gives a "Product Description Page" with an "Availability" link.

USGS staff point out that the MapView website is a work in progress. There are a few corrections to be made and bugs worked out. Geologic maps from many more states need to be added, and the site will need frequent updates as new geologic maps are published. MDEQ's surface geologic mapping staff will continue to send newly published geologic quadrangles to USGS to be added to the site.


National Geologic Map Database

Product Description Page

General Information

Title: Geologic map of the Cascilla quadrangle, Grenada and Tallahatchie counties, Mississippi
Author(s): Thompson, D.E.
Publishing Organization: Mississippi Department of Environmental Quality, Office of Geology
Series and Number: Open-File Report 231
Publication Date: 2010
Map Scale: 1:24,000
Cross Section: Yes
North Latitude: 33° 52' 30" N (33.8750)
South Latitude: 33° 45' 0" N (33.7500)
East Longitude: 90° 0' 0" W (-90.0000)
West Longitude: 90° 7' 30" W (-90.1250)

Corrections? Tweet

Availability Map Services

Publication Format: Paper

This product is available, please note the publication series and number, and then contact: Mississippi Department of Environmental Quality, Office of Geology

Postal Address:
Office of Geology
P.O. Box 2279
Jackson, MS 39225-2279
Voice Telephone: (601) 961-5523
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Figure 5. Product Description Page for the Cascilla 7.5-Minute Quadrangle at top, where a click on “Click image to view” gives a full-size image and a click on “Availability” gives the MDEQ Office of Geology address for ordering a paper copy, as shown at bottom.

Environmental News, May 2013, volume 10, issue 5, pages 19-23

THE MISSISSIPPI PETRIFIED FOREST, A REGISTERED NATIONAL NATURAL LANDMARK, CELEBRATES FIFTY YEARS

David T. Dockery III, Office of Geology

Petrified wood is Mississippi's state stone as designated by Senate Concurrent Resolution No. 601 adopted by the Senate and House of Representatives in April of 1976. The resolution reads:

"WHEREAS, petrified wood can be found all over the State of Mississippi, and

WHEREAS, it is a beautiful rock which has been transfigured into a stony replica of its organic mold by structural impregnation with dissolved minerals; and

WHEREAS, the Mississippi Petrified Forest is recognized across the nation as one of the most significant deposits of this natural phenomenon and has been designated a Registered National Landmark:

NOW, THEREFORE, BE IT RESOLVED BY THE SENATE OF THE STATE OF MISSISSIPPI, THE HOUSE OF REPRESENTATIVES CONCURRING THEREIN, That petrified wood is hereby designated as the official stone of the State of Mississippi."

MDEQ staff use petrified wood in educational talks and outreach activities. Many people enjoy collecting petrified wood.

Shirl Schabilion's book *Out of the Past, Mississippi Petrified Forest, a Scrapbook of Time*, cites the unpublished writings of B. L. C. Wailes around 1852 as the first reference to the Mississippi Petrified Forest, given as "a location 18 miles from Jackson." It would be some 59 years until the Petrified Forest was mentioned again in an article in the November 1913 issue of *Popular Science Monthly Magazine* by Calvin S. Brown, University of Mississippi professor and Mississippi Geological Survey archaeologist, entitled "The Petrified Forest of Mississippi." In the spring of 1918, Dr. J. M. Sullivan took the students of his Millsaps College geology class on a field trip, first by train from Jackson to Flora and then by a hired buggy, to the Petrified Forest. Later Sullivan wrote an article for the November 1932 issue of the *Mississippi Highways Magazine* entitled "Petrified Phenomenon of Flora."

A color photograph of the badlands of the Mississippi Petrified Forest was published in the September 1937 issue of *The National Geographic Magazine* in an article by J. R. Hildebrand with the humbling title "Machines Come to Mississippi." Figure 1 (left) is an illustration from Dr. E. N. Lowe's book *Mississippi, Its Geology, Geography, Soils and Mineral Resources* (Mississippi Geological Survey, Bulletin 12) published in 1915, showing petrified logs in the Mississippi Petrified Forest. To the right in Figure 1 is Bob Schabilion beside similar logs in 1956.

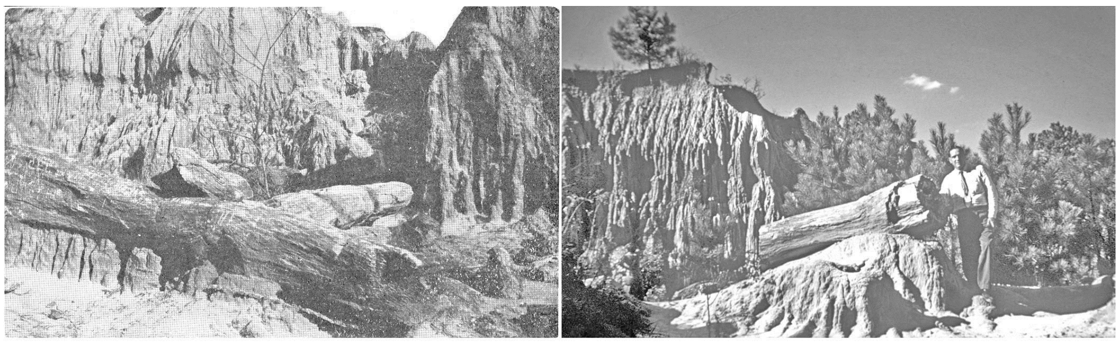


Figure 1. Left, picture of petrified logs in the badlands of the Mississippi Petrified Forest near Flora, Mississippi, from Mississippi Geological Survey Bulletin 12, *Mississippi, Its Geology, Geography, Soils and Mineral Resources*, by E. N. Lowe, 1915, page 81, figure 7. Right, Bob Schabilion beside a petrified log in the same badlands in July of 1956.

Thin sections of petrified wood specimens from the Petrified Forest were identified as *Abies* (fir) and *Acer* (maple) by George Duke in 1958 and 1959. Duke would later (2008) publish a 381-page book on *An Identification Guide to Trees and Other Woody Plants of Mississippi and Southeastern United States*. Samples from the Petrified Forest were sent to the Smithsonian by the Schabilion family in 1962 and were identified as angiosperms that lacked annular rings, indicating uniform growth (such as a tropical rain forest). Additional work reported by Virginia M. Page of Stanford University in July of 1967 identified *Abies* and a species belonging to the spurge family (Euphorbiaceae), an extinct large variety of a family of small trees living today only in Southeast Asia. Later Blackwell et al. (1981) identified a new genus and species of extinct conifer named *Cupressinoxylon florense*, a species belonging either to the Podocarpaceae or Cupreassaceae—conifer families living today in the Southern Hemisphere. In 1960, Dr. Richard R. Priddy, Millsaps geology professor and author of the geology bulletin on Madison County, placed the Petrified Forest as part of the Forest Hill Formation, a formation of river and delta sands and clays with a geologic age of around 30 million years old.

For many years souvenir seekers made off with petrified wood from Mississippi Petrified Forest badlands, some by the truck loads. Property owner Judge J. P. Black was looking for a way to preserve the Petrified Forest as a natural area. It was in the summer of 1955 that the Schabilions, a rock-collecting family, saw the name "Petrified Forest" as a landmark on a Texaco road map, visited the site, and met Judge Black. In 1962, the Schabilion family bought the Mississippi Petrified Forest from the judge's heirs and used their daughters, Lynn at 17 years old, Candace at 15, and Beverly at 10, as publicity models to promote the site. On April 1, 1963, the Mississippi Petrified Forest was opened to the public, complete with museum, gift shop, and nature trail (figures 2-3).

Figure 2. Left, the nature trail in the Mississippi Petrified Forest along the badlands; pictured are Sue and Leslie Pitts, founding members of the Mississippi Gem and Mineral Society, and son Bill. Right, Alan and Beverly Schabilion resting against a petrified log with Pat Pitts (at far right). Pictures were scanned from slides taken by G. Holly in November of 1965.

Figure 3. The Schabilions often used their daughters to model at the park's scenic stops. Here their middle daughter Candace is stationed on the nature trail at the badlands (left) and beside a large petrified log (right). Pictures were scanned from slides taken in the summer of 1963.

A naturalist from the Natchez Trace Parkway visited the Petrified Forest on a spring day in 1965 and asked questions much as did the regular visitors. After this small happening, the National Park Service recommended to the Department of the Interior that the Mississippi Petrified Forest be designated a Registered National Natural Landmark. The National Registry of Natural Landmarks is a program that recognizes and encourages the conservation of sites that "contain geologic values of exceptional quality and significance in illustrating the natural history of the United States." On June 4, 1966, a ceremony was held at the Mississippi Petrified Forest, designating it as a Registered National Natural Landmark (Figure 4).

Figure 4. Top, the Schabilion family at the dedication ceremony when the Mississippi Petrified Forest became a Registered National Natural Landmark. Clockwise from the left are Beverly, Shirl, Bob, Alan, Candace, and Lynn Schabilion. Bottom, from left to right, Candace, Beverly and Lynn at nature trail stop 19, with the loess bluff behind them.

The Mississippi Petrified Forest celebrated its 50th Anniversary (of its opening day in 1963) on April 6 and 7, 2013. Events included live music, geode cracking, flint knapping, and a free fossil dig for children (Figure 5). Tickets for the nature trail (Figure 6) and museum were rolled back to 1963 prices. Schabilion family members present at the celebration included Bob and his daughters Lynn, Candace, and Beverly (Figure 7, left). Leaving the celebration, visitors were greeted by a sign featuring MPF's iconic emblem, the Bent-Beak Rocky-Pecker, giving directions (Figure 7, right).

Figure 5. Mississippi Petrified Forest 50th Anniversary activities included a fossil dig for the children, who used hand trowels and sieves to comb through a mound of sand in search of fossils. Pictures were taken on April 6, 2013.

Figure 6. Left, a cross section of a sequoia log cut in 1960 that is over a thousand years old; the earliest ring was formed in 942 A.D. The highlighted ring marks the discovery of America in 1492. A type of sequoia is one of the species of petrified wood in the Petrified Forest. Right, an even larger petrified log is nicknamed "Frog" and weighs 14,940 pounds. Pictures were taken on April 6, 2013.

Figure 7. Left, seated at left is Bob Schabilion; to Bob's left, from left to right, are daughters Lynn, Candace, and Beverly. Behind Bob are Lynn's daughter, granddaughter, and great granddaughter. Right, a sign giving directions for those leaving the Mississippi Petrified Forest contains the Forest's iconic emblem, a cartoon woodpecker with a contorted beak from pecking on petrified logs. Pictures were taken on April 6, 2013.

Environmental News, June 2013, volume 10, issue 6, pages 17-20

GEOLOGY AT BRIDGE SITES

David T. Dockery III, Office of Geology

Dangerous landslides have occurred periodically in Mississippi's history causing fatalities and also damage to the state's highway systems. Currently, MDEQ's geologic mapping program identifies geologic hazards, such as potential slope failures, that could cause property damage or even loss of life.

In the 1930s, engineers with the Mississippi State Highway Department began to consider the geology of its bridge sites and the potential for landslide damage to bridge abutments. On February 23, 1935, State Geologist Dr. William Clifford Morse accompanied State Highway Department engineers C. W. F. Harper, C. S. Hill, and W. Ellis York to inspect a proposed site for the Yazoo River bridge of U.S. Highway 49 West at Yazoo City (Figure 1). Morse noted that the Yazoo River was undercutting the site and had undercut it to such an extent that the bluff stood abruptly 245 feet above the floodplain of the river. The bluff in ascending order consisted of 131.7 feet of Yazoo Clay, 25.0 feet of pre-loess terrace sand and gravel, and 88.0 feet of loess. Morse found that the old city reservoir had been cracked and abandoned due to a slope failure at the site. The state geologist then documented recent landslides on two spur ridges at the proposed bridge site (figures 2-3) and steered the Highway Department to a better location labeled E-F in Figure 1, which is the location of the bridge today. In Mississippi Geological Survey Bulletin 27 entitled "Geologic Conditions Governing Sites of Bridges and Other Structures," Morse said (Introduction, page 7) that his condemnation of the site saved the state perhaps $100,000 ($250,000 if the cost of the whole bridge project is included), an amount equivalent to the State Geological Survey's appropriation in 15 years.

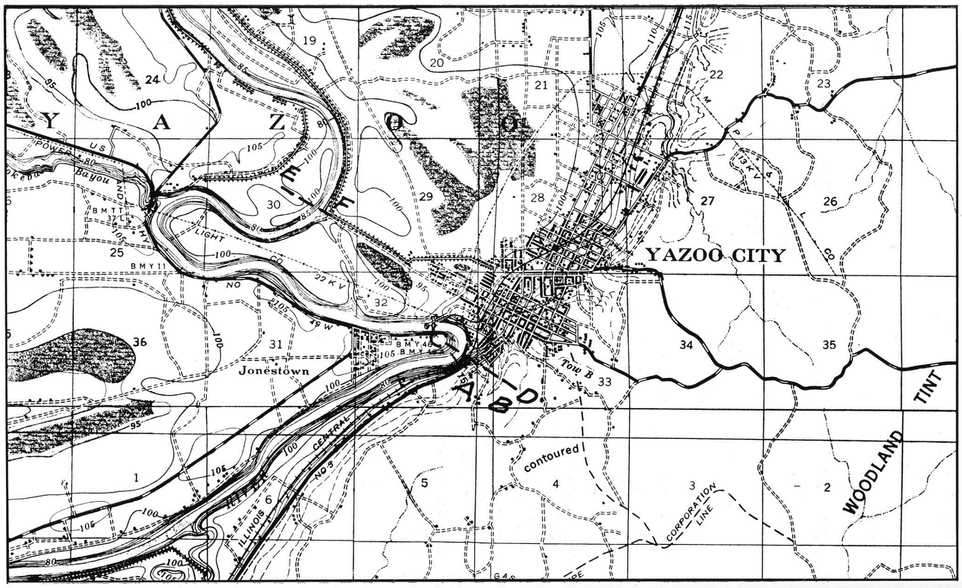


Figure 1. Topographic map of Yazoo City with only a part of the bluff contoured. A and B mark two ridges that parallel the river trending southwest to northeast, both of which have significant landslides. C-D marks the location of the proposed Highway 49 bridge. Dr. Morse steered Highway Department engineers away from the proposed site to a site at E-F where the Highway 49 bridge is today. Map is Plate 1 in Mississippi Geological Survey Bulletin 27 (Morse, 1935).

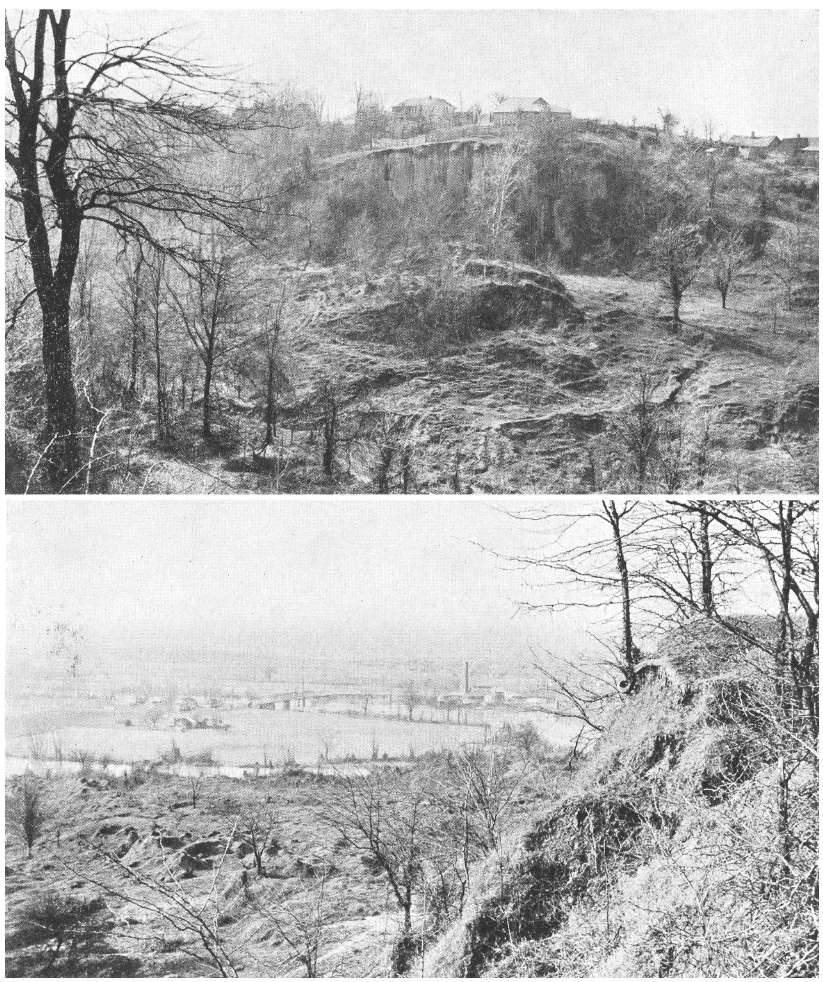


Figure 2. Top, landslide that extended to the top of the first spur ridge (A) east of the Yazoo River. Bottom, the landslide embraced the whole vertical face of the east bluff of the Yazoo Valley on the west side of the first spur ridge (A); the camera is pointed North 22 degrees West toward the proposed bridge site. Pictures are from figures 5 (top) and 7 (bottom) of Mississippi Geological Survey Bulletin 27 (Morse, 1935).

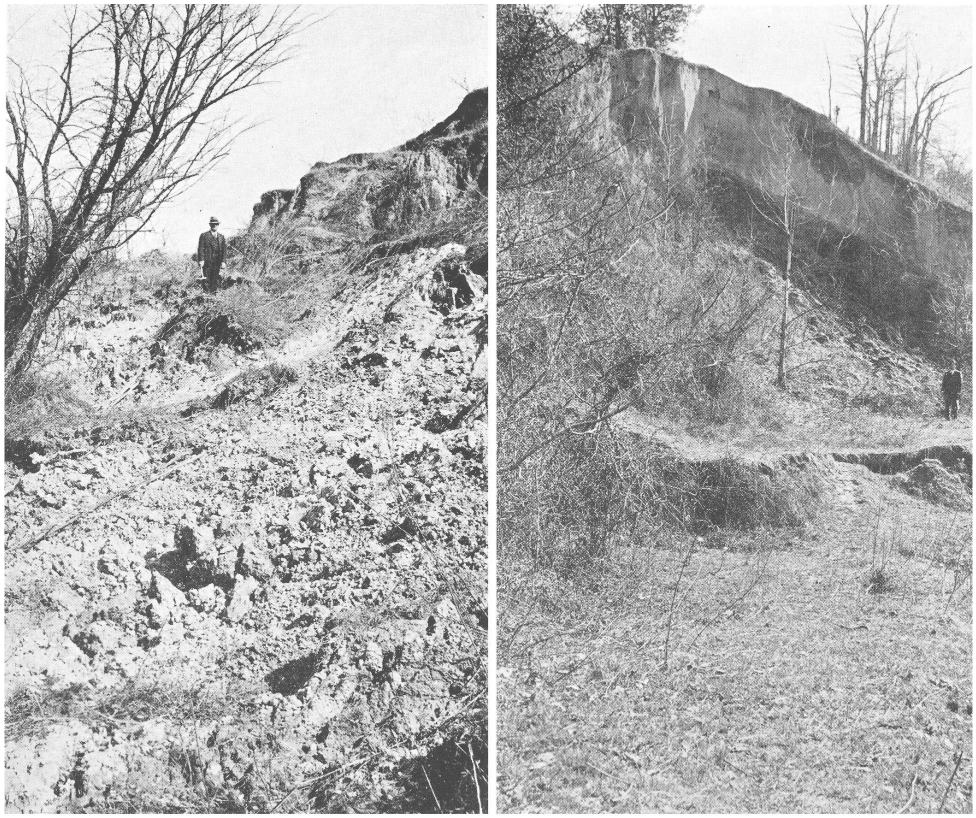


Figure 3. Landslide during the winter of 1934-1935 near the line proposed for Highway 49 at the end of the second spur ridge (B) east of the Yazoo River. Pictures are from figures 2 (left) and 4 (right) of Mississippi Geological Survey Bulletin 27 (Morse, 1935).

Another cooperative effort occurred after landslides in the winter and spring of 1946 destroyed the approach spans of the U.S. Highway 61 bridge over the Yazoo River at Redwood, Mississippi. In March of 1946, concerns over additional landslides led the Mississippi Highway Department to contract with the Army Corps of Engineers drill crew and with Mississippi Geological Survey geologist Fred Mellen to check for faults at a new bridge site. Mellen examined drill cuttings and fossils and drafted a cross section, showing the location of the slide block and the location of solid ground, so that the bridge construction could avoid the failed surface. This story was published from an account given by Highway Department engineer George Lemon (who worked with Mellen on the bridge site) in the January 2004 issue of the Mississippi Geological Society Bulletin. Today MDOT has a registered professional geologist on staff to review all drill tests for bridge pilings. Figure 4 shows tilted beds in the Bucatunna Clay in a landslide/slump block on Old Highway 61 in Vicksburg. Overlying the Bucatunna is another landslide/slump surface overlain by loess; the pre-loess gravel has been faulted out of the section. Figure 5 shows the loess in two down-thrown blocks against pre-loess gravel in a dirt pit in the bluff line along Old Highway 61 in Vicksburg.

Figure 4. Landslide-tilted beds in the Bucatunna Clay on Old Highway 61 in Vicksburg. Overlying the Bucatunna is another landslide scarp overlain by loess; the pre-loess gravel interval is missing. Pictures were taken on August 24, 2011.

Figure 5. En echelon landslide scarps on Old Highway 61 at Vicksburg. At left, the face of the bluff is a landslide of loess against the pre-loess sand and gravel. At right, the landslide scarp pointed out by James Starnes is a second landslide scarp behind the one shown at left. The picture on left was taken by James Starnes on April 8, 2013; the one on right was taken on August 24, 2011.

Left: View looking west of a slope failure on Interstate 20 West at the McRaven Street overpass in Jackson. The crane is driving steel sheet piling to prevent further failure. Picture was taken on March 27, 2013.

Right: View looking east of the Interstate 20 slope failure at McRaven Street in Jackson. The road bed and shoulder have fallen below the level of the bridge.

Environmental News, July 2013, volume 10, issue 7, pages 19-23

The W. M. Browning Cretaceous Fossil Park

David Dockery, Office of Geology

The W. M. Browning Cretaceous Fossil Park is Mississippi's only geological roadside park. This park was created after construction of the Highway 45 Bypass at Frankstown, Prentiss County, in 1990 uncovered the Coffee Sand/Demopolis contact in the south valley wall of Twenty Mile Creek. Here the basal Demopolis contained a foot-thick oyster bed underlain by a foot-thick sand bed containing a basal lag deposit of shark teeth, fish teeth, petrified wood, turtle bones, mosasaur teeth, and rare dinosaur teeth (mostly isolated hadrosaur teeth). So common were the shark teeth (Figure 1) at the construction site that it became famous among fossil collectors. Some of these collectors arrived in vehicles with license tags from distant states.

Figure 1. Shark teeth of the shark *Scapanorhynchus raphiodon texanus* from the Frankstown sand at the Frankstown site at top and site A at bottom; labels are by Earl Manning. Picture (digital; Image 1545) taken on August 19, 2010.

Shark teeth at the construction site also attracted the attention of Booneville High School teachers and students, who made a large collection of fossils and obtained a National Science Foundation SGER (Small Grants for Exploration Research) grant in 1990 to utilize the site as a laboratory for teaching natural history. This was the first such grant ever awarded a high school. Their work at the site was filmed by ABC News and aired nationally by the ABC Sunday evening news in 1991. Booneville High School science teacher, Patsy Johnson, earned the "1992 Outstanding Earth Science Teacher of Mississippi" Award for her work at the site.

MDEQ's Office of Geology was called to help with the geology and fossils at the site. At that time Earl Manning, a vertebrate paleontologist then in Baton Rouge, and I made a student handbook with drawings to help students understand the site and identify the fossils they found at Frankstown. Earl delivered the handbook to Principal Lindley on April 19, 1991, and it was printed and ready for the April 22 to May 1 exercises at the school and at the site. On April 26, 1991, ABC News filmed the students collecting fossils at the site. In a meeting after the ABC film session, Earl and I were awarded the keys to the city by Booneville Mayor Nelwyn Murphy for our help (Figure 2). Earl's handbook was expanded and published on October 12, 1992, as Office of Geology Circular 4, *A Guide to the Frankstown Vertebrate Fossil Locality (Upper Cretaceous), Prentiss County, Mississippi*, 43 pages, 12 plates illustrated by David White. Earl later went on to do his dissertation on the Frankstown site (in which he recognized 53 vertebrate taxa) and received his Ph.D. from Tulane University in 2006.

Figure 2. Key to the City of Booneville; nickel for scale. Picture was taken on November 4, 2011.

On November 10, 1992, I met with Mayor Murphy, Patsy Johnson, and others in Booneville to plan a roadside park at the fossil site on land owned by the W. M. Browning family. There was talk of a granite monument for the site, which would be donated by the family from a quarry in Georgia. After the meeting, with work on the site published and completed, I went on to other things. A few years later, I was asked to speak at the dedication of the W. M. Browning Cretaceous Fossil Park. When I arrived at the dedication on Saturday, May 6, 1995, there were prominent politicians, a tent, a crowd, and a sheet-covered monolith reminiscent of the extraterrestrial monolith in the movie *2001* (Figure 3). I knew that something I said, or gave as a script, was chiseled in stone on that monolith, but I didn't remember what it was, and worried that I might have misspoken. When it came time for me to speak about the park's geological significance, the monolith was ever present, visible just outside the tent. Then there was the unveiling as Browning family members pulled the sheet free (figures 4-5). Fortunately, there were no gaffs in the inscription.

Figure 3. A crowd gathers for the dedication of the W. M. Browning Cretaceous Fossil Park on Highway 45 at Twenty Mile Creek. Picture (scanned Kodachrome slide #283-2) was taken on May 6, 1995.

Figure 4. W. M. Browning's daughter Ann Walker and son William Jr. at the dedication of the W. M. Browning Cretaceous Fossil Park. Picture (scanned Kodachrome slide #283-3) taken on May 6, 1995.

Figure 5. Granddaughter and great grandson of W. M. Browning unveiling the granite monument, a memorial to the Frankstown vertebrate locality. At upper right is the Highway 45 bypass bridge over Twenty Mile Creek. Picture (Kodachrome slide 283-8; Image 281) was taken on May 6, 1995.

Today the roadside park and eight-foot-high granite monument on the east side of the Highway 45 Bypass just north of Twenty Mile Creek commemorate the Frankstown site and excavation (Figure 6). The W. M. Browning Cretaceous Fossil Park serves as a natural area designed to teach students and the traveling public about Mississippi's geology and ancient life.

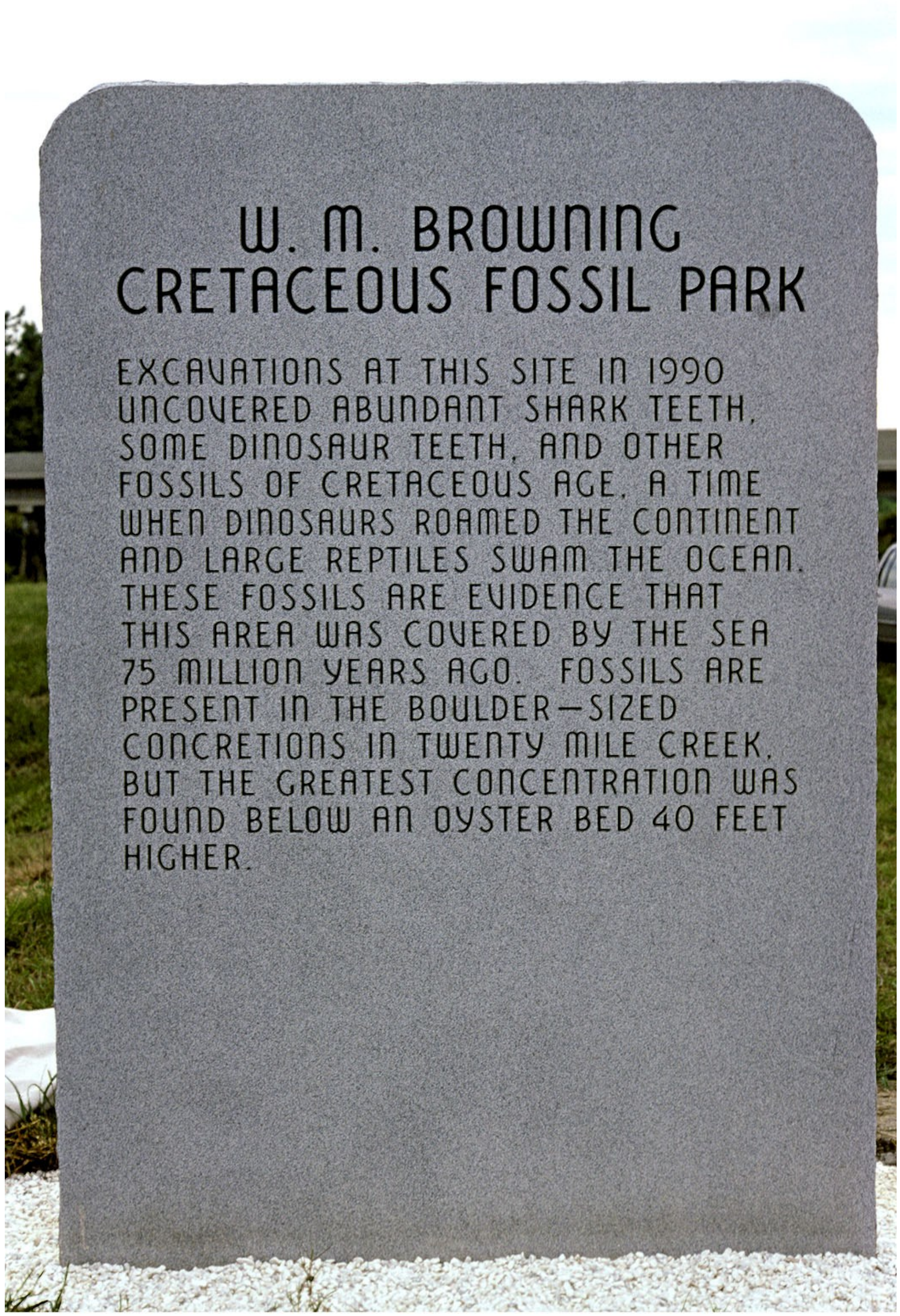


Figure 6. Monument for the Frankstown fossil locality near the Highway 45 bypass bridge over Twenty Mile Creek. Picture (Kodachrome slide 283-12; Image 280) taken on May 6, 1995.

Environmental News, September 2013, volume 10, issue 8, pages 18-20

GULF COAST ENERGY ASSESSMENT

David T. Dockery III and David E. Thompson

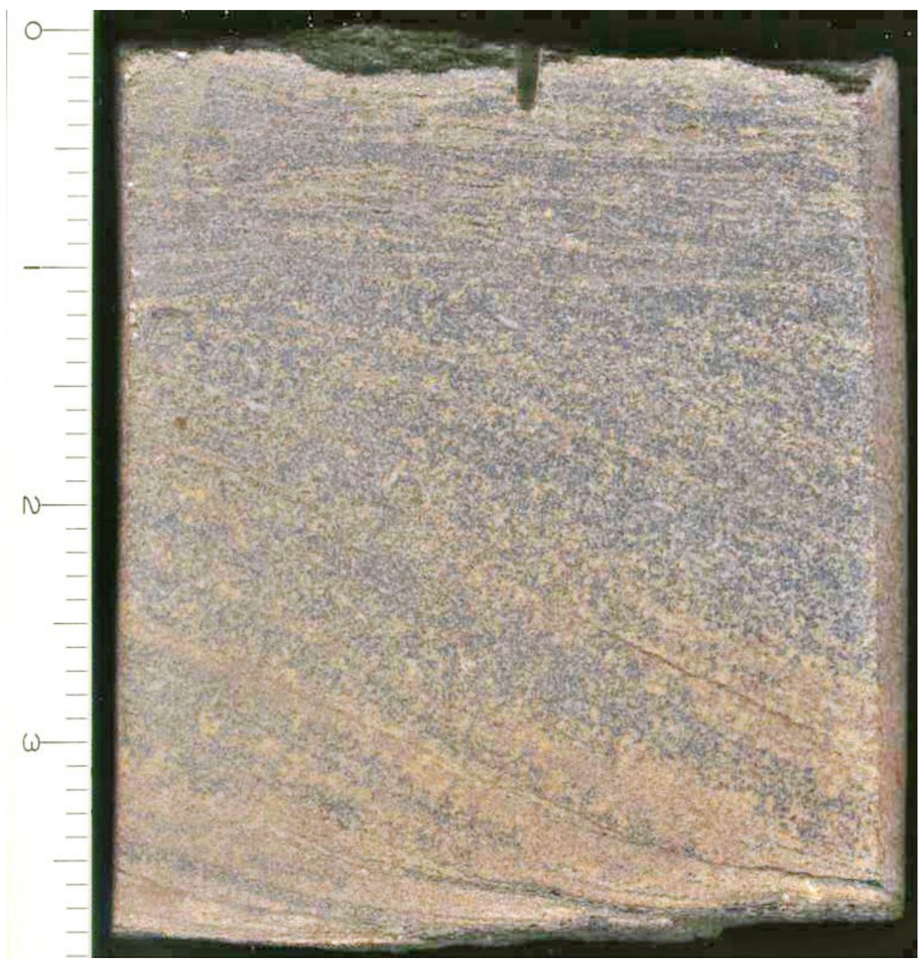
One task of the U.S. Geological Survey is the assessment of the nation's undeveloped energy resources. Recent work in the Mississippi Interior Salt Basin of southern Mississippi included the assessment of the state's Lower Cretaceous and Jurassic hydrocarbon potential. Paul Hackley, Catherine Enomoto, and others at the USGS studied the geophysical logs of 15 wells in the Lower Cretaceous Pearsall Formation (=Pine Island Formation) at depths of 12,000 to 15,000 feet below the surface across southern Mississippi. Enomoto and others then examined actual drill cuttings from these wells at MDEQ's Office of Geology core and sample library on North West Street in Jackson in July and August of 2012 (Figure 1). They also sampled cores of the James Limestone from the Pennzoil No. 1 Piazza at depths of 13,909-13,966 feet below the surface in Jefferson County, Mississippi, at the sample library. The purpose of their work was to characterize the Pine Island section for "shale gas prospectivity." Hackley and others returned this year to continue their work with the overlying Rodessa Formation and also sampled cores of the Jurassic-age Smackover Formation. Figure 2 shows Paul's team at work at the North West Street core and sample facility. Figure 3 shows a core box with thinly bedded sandstone from the Rodessa Formation.

Figure 1. Catherine Enomoto (upper left) and Celeste Lohr (right) examine cuttings at MDEQ's Office of Geology core and sample library at North West Street in Jackosn. Picture was taken on August 1, 2012.

Geology-based assessment methodology used by the USGS in 2010 gave estimated means for oil and gas resources in Jurassic and Cretaceous strata of the Gulf Coast as 147.4 trillion cubic feet of undiscovered natural gas, 2.4 billion barrels of undiscovered oil, and 2.96 billion barrels of undiscovered natural gas liquids. The USGS evaluation of hydrocarbon potential in Mississippi, as well as similar evaluations by the petroleum industry, could not be done without the core and cuttings available at MDEQ's North West Street sample library. The replacement value for the Rodessa core in Figure 3 (as the appraisers of PBS's Antiques Road Show would use for insurance purposes) is estimated around $2,000,000 to $2,500,000, which is today's "dry-hole" cost of drilling to a depth of 13,000 next to the original hole and taking a core. MDEQ's Office of Geology core and sample library contains cuttings from 5,835 wells and cores from 939 wells for a total of collection of samples from 6,774 oil and gas wells. If the Rodessa core is taken as an average, the replacement value of the core and sample library's holdings is 6,774 x $2,000,000 = $13.548 billion.

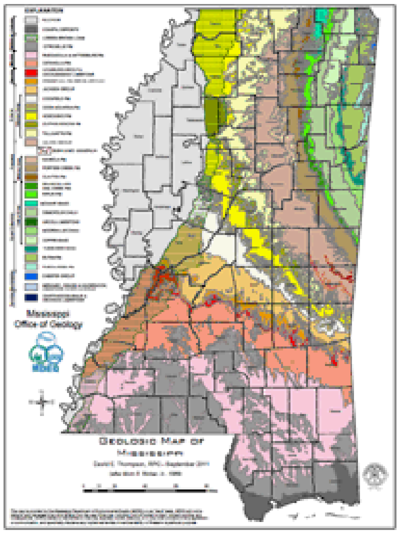
Figure 2. Brett Valentine (left), Paul Hackley (center), and Alana Bove (right) examining core and cuttings at MDEQ's Office of Geology core and sample library on North West Street in Jackson. A portion of their 15-well cross section though southern Mississippi can be seen at the upper right. Picture was taken on July 22, 2013.

Figure 3. Core of the Rodessa Formation at MDEQ's core and sample library on North West Street.



Core of cross-bedded sandstone from the Rodessa Formation at a depth of 13,588 feet in the Triad Oil & Gas Co. #1 Shelby in Smith County, Mississippi.

Environmental News, October 2013, volume 10, issue 9, pages 4-6



GEOLOGIC MAP DAY IN MISSISSIPPI

Michael B. E. Bograd, Office of Geology

What types of rocks are in my neighborhood? Where are mineral resources located? How does geology shape the hills and valleys of Mississippi? What are the oldest and youngest rocks in Mississippi?

The answers to these questions and more can be found on the Mississippi Department of Environmental Quality (MDEQ)'s website at www.deq.state.ms.us.

And, since October 18, 2013, was national Geologic Map Day, MDEQ wants to illustrate some of the geologic maps of Mississippi that are available from this agency. Geologic maps of the State of Mississippi, many of the counties, and 133 individual quadrangles may be viewed online and are available for free download in PDF format.

Here are a couple of sample questions, with answers provided by geologic maps you can view online.

Why is Crystal Springs a major gravel-mining area?

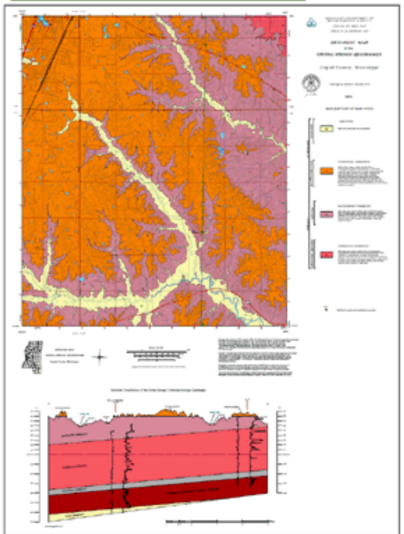
Our website offers a handy state geologic map at

http://www.deq.state.ms.us/MDEQ.nsf/pdf/Geology_MSGeology1969Map/$File/MS_Geology1969.pdf?OpenElement

On this map, in Copiah County where Crystal Springs is located, you can see an area colored gray. Near the top of the Explanation chart, this is identified as the Citronelle Formation. In central Mississippi, the Citronelle is largely gravel and sand and it composes the higher hills of the area. When you consider that Crystal Springs is a short distance down Interstate 55 from the markets of the Jackson metropolitan area, it is clear why so much gravel is mined there.

For a closer look at the geology of Copiah County, click on

http://www.deq.state.ms.us/MDEQ.nsf/pdf/Geology_Bulletin110CopiahCountyGeologyandMineralResources/$File/Bulletin%20110.pdf?OpenElement



This is a book about the geology and mineral resources of Copiah County. If you scroll to the end, you will see the geologic map of the county. Here the Citronelle Formation is colored red on the map. You can see where the formation is located with respect to communities, streams, and highways.

For a more detailed map of a smaller area, link to the Geologic Map of the Crystal Springs Quadrangle.

http://www.deq.state.ms.us/MDEQ.nsf/pdf/Geology_OF262GeologicMapoftheCrystalSpringsQuadrangle/$File/OFR_262_Crystal_Springs_31090H3.pdf?OpenElement

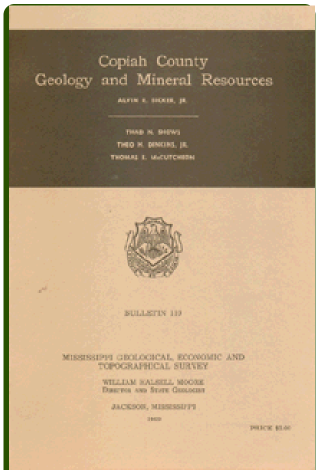
The color of the gravel-bearing Citronelle Formation has changed again on this map, but the formation is identified by a color box in the legend and by the symbol QTc. This map clearly illustrates the location of the Citronelle at higher elevations and along ridges, and this is where you can find the gravel mines that utilize this important industrial mineral.

What are the oldest and youngest rocks in Mississippi?

The answer is found on the state geologic map.

http://www.deq.state.ms.us/MDEQ.nsf/pdf/Geology_MSGeology1969Map/$File/MS_Geology1969.pdf?OpenElement

The oldest rocks at the surface in Mississippi are the Chattanooga Shale and Devonian Limestone. This outcrop is depicted by a small patch of dark purple in northern Tishomingo County. This unit is at the bottom of the explanation, or legend. The rocks of the stratigraphic column get younger as you go up. In the legend, Alluvium, the youngest geologic formation (actually sediments) in the state, is at the top of the list. If you look at the geologic units in the legend one by one, starting at the bottom, and locate the same units on the map, you will see that the oldest rocks are in northeastern Mississippi and the rocks get progressively younger as you move to the west and the south.



A poster size Geologic Map of Mississippi printed at the scale of 1:500,000 is available at the Map and Publication Sales Office at 700 North State Street, Jackson. It measures 35.5 by 46 inches and sells for $7.00. Call 601-961-5523 for information about postage and handling charges if ordering by mail.

Do we have alluvial fans in Mississippi?

An example of an alluvial fan on the Mississippi River alluvial plain at the base of the Bluff Hills is shown on the Geologic Map of the Browning Quadrangle of Carroll and Leflore counties. The geologic map depicts the alluvial fans of Teoc Creek and Big Sand Creek.

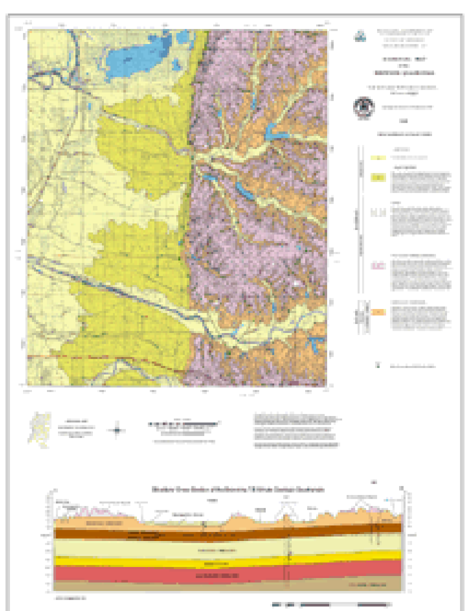
http://www.deq.state.ms.us/MDEQ.nsf/pdf/Geology_OF_223/$File/OFR_223_Browning_33090e1.pdf?OpenElement

What are your questions about geologic maps? To look for answers, go to the Mississippi Department of Environmental Quality website

http://www.deq.state.ms.us/MDEQ.nsf/page/Main_Home?OpenDocument

Scroll down to the Office of Geology link, and start exploring.

The List of Publications provides links to free downloads of many of our publications. The county geologic reports are found in the list of Bulletins, and the geologic quadrangles are found under Open-File Reports.



Environmental News, October 2013, volume 10, issue 9, pages 22-29

VALUE OF A CORE AND SAMPLE LIBRARY

David T. Dockery III, Office of Geology

My earliest summer work with MDEQ's Office of Geology in 1969 (then the Mississippi Geological Survey) was as a driller's helper for work on the Rankin County Geology Bulletin and in cutting cores to be stored in the office's Core and Sample Library. Many of the cores I cut were of the Smackover Limestone, the lower part of which comprises the Brown Dense Play in Arkansas and Louisiana. The organic-rich carbonate rocks of the Brown Dense are believed to be the source of much of the Jurassic and Cretaceous oil reserves in southern Mississippi. Figure 1 shows an upper Smackover Limestone core from the MDEQ Core and Sample Library that is bleeding oil, a sight any petroleum geologist would love to see. The following examples highlight the value of core and sample libraries such as the MDEQ library in Jackson.

Figure 1. Oil-stained cores from the upper Smackover Limestone in Clarke County, Mississippi, at a depth of 10,780 feet. Picture was taken at MDEQ's Core and Sample Library on March 11, 2013.

Canada. Jeff Lewis' article (posted September 29, 2013) entitled "Unlocking oil secrets stored in Alberta's core sample archive" noted that cores of the Grosmont carbonate at the Core Research Centre in Calgary (figures 2-3) indicate the presence of a 400-billion-barrel mother lode of super-viscous crude in the formation.

Figure 2. Views of the sample examination room at the Core Research Centre at the University of Calgary. At left, Conoco Phillips geologists look at cores. Pictures were taken by Todd Korol for the National Post.

Figure 3. Core (left) and drill cutting (right) sample storage at the Core Research Centre at the University of Calgary. Pictures were taken by Todd Korol for the National Post.

As new technology advances oil recovery in Alberta's oil patch, the 193,750-square-foot Calgary core and sample facility (with a $50-billion sample inventory based on replacement cost) is an uncommon asset. An oil-shale play in the Duvernay Shale, based on core sampling done at the Calgary facility, revealed the formation to hold 443 trillion cubic feet of gas, 11.3 billion barrels of natural gas liquids, and 61.7 billion barrels of oil. Companies such as Encana Corp., Chevron Corp., and ExxonMobil Corp. have spent billions in recent years leasing properties over the Duvernay Shale, but no one would have "taken a swing at the Duvernay if they didn't have a bunch of core to look at beforehand."

Texas. Geologist Gregg Roberston (Figure 4) was named Caller-Times 2012 Newsmaker of the Year for his role in the development of the Eagle Ford Shale-Oil Play (Figure 5).

Figure 4. Geologist Gregg Roberston was named Caller-Times 2012 Newsmaker of the Year for his role in the development of the Eagle Ford Shale. Picture was taken by Todd Yates for the Corpus Christi Caller-Times.

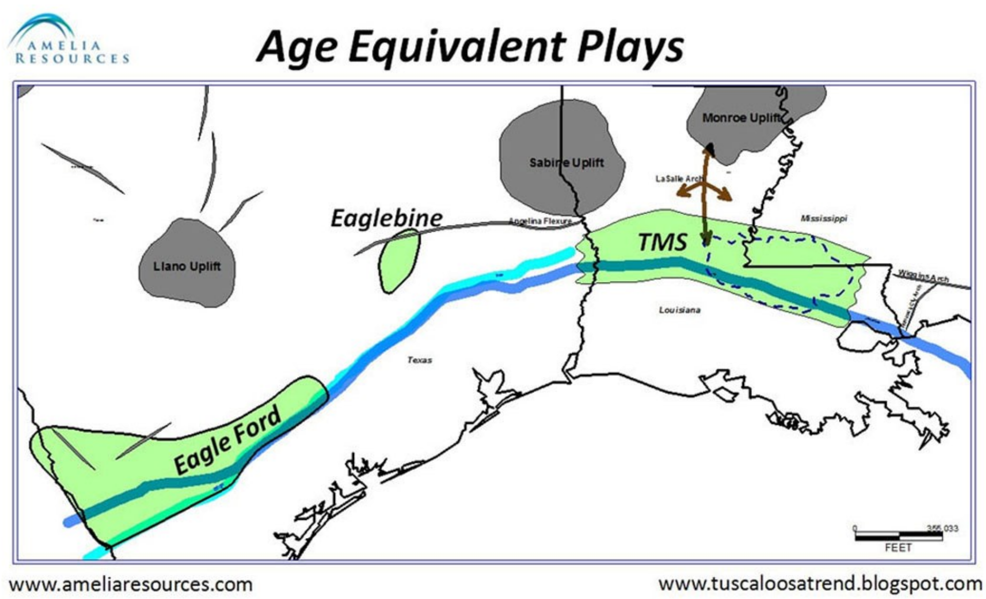


Figure 5. The Eagle Ford Trend of South Texas and the Tuscaloosa Marine Shale Trend of Louisiana and Mississippi; the Tuscaloosa is actually a little older than the Eagle Ford.

Robertson re-examined drill cuttings from a dry hole drilled in the Eagle Ford Shale in 1952. These samples were stored on Row 57, Bay H, Shelf 4, at the Texas core and sample library at Austin. Roberston's fresh look at dry-hole cuttings led to an oil boom in southwestern Texas that can be seen from space (Figure 6). According to Todd Yates of the Corpus Christi Caller-Times (posted December 29, 2012), "the discovery transformed sleepy villages into boomtowns, poured millions of dollars into rural school, city and church coffers, turned struggling ranchers into millionaires and gave thousands of people new careers across South Texas."

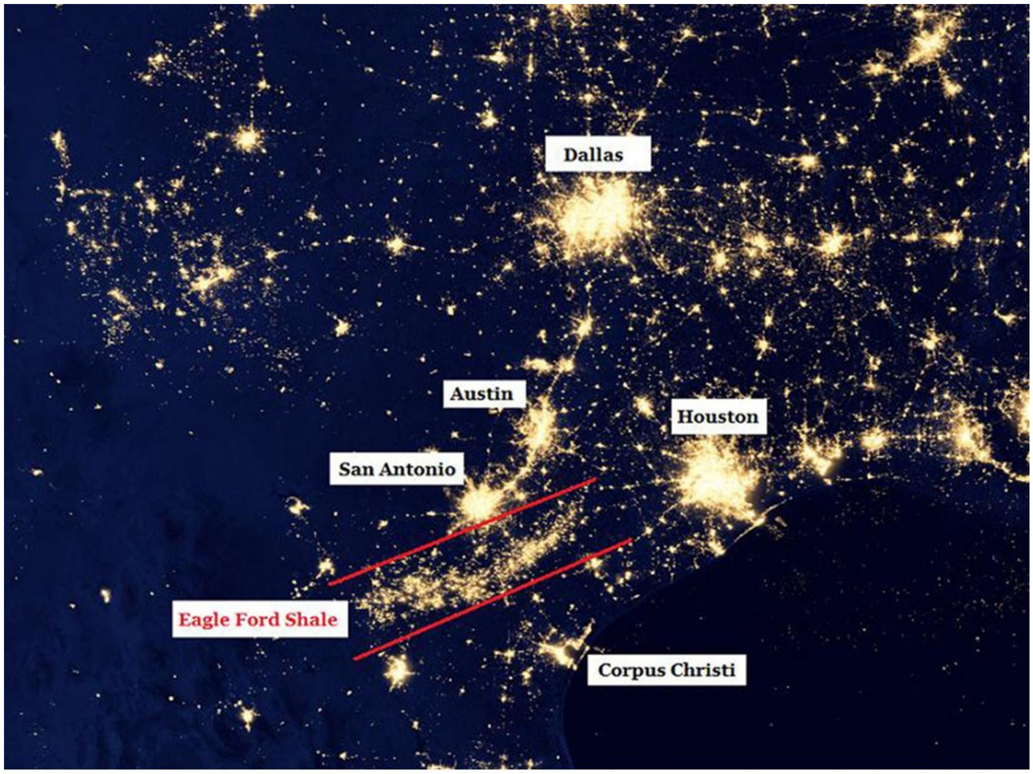


Figure 6. Flares from Eagle Ford oil fields in South Texas can be seen in the night sky from space, rivaling the lights of San Antonio and Austin.

North Dakota. In 1999, U.S. Geological Survey geologist Leigh Price used analyses of cores at the North Dakota Geological Survey Core Repository at Grand Forks, North Dakota, to estimate the total range of oil "in place" in the Bakken Shale at 271 billion to 503 billion barrels with a mean of 413 billion barrels. Price died in 2000 before his paper was published; however, that same year Bakken oil successes began with the discovery of Elm Coulee Oil Field in Richland County, Montana. Reports by the USGS and the state of North Dakota in April 2013 estimated up to 7.4 billion barrels of oil, 6.7 trillion cubic feet of natural gas, and 530 million barrels of natural gas liquids to be "recoverable" in the Dakotas and Montana, using current technology. In July 2013, Bakken wells in North Dakota produced 811,000 barrels of oil per day, raising North Dakota to second behind Texas in oil production. The Bakken oil boom has provided lease bonuses and royalties for mineral rights owners, reduced unemployment, has given the state of North Dakota a billion-dollar budget surplus, and can be seen from space in the night sky (Figure 7).

Figure 7. Left, flares of the Bakken oil fields as seen from space in the night sky; Eagle Ford flares can be seen in South Texas. Right, oil-rich cores of the Bakken Shale.

Michigan. Michigan Geological Survey's Michigan Geological Repository for Research and Education (MGRRE) in conjunction with the Michigan Potash Company announced the "rediscovery" of a mineral deposit in Western Michigan described as "the United States' only shovel-ready potash project" (Yvonne Zipp, posted September 10, 2013). At current market prices, the deposit is estimated to be worth $65 billion based on cores of the potash-rich Borgen Bed at the Michigan Geological Repository. Midwest corn and soybean farmers get their potash from New Mexico or Canada for upward of $400 a ton, of which about $40 to $60 is in the cost of transportation. So, the new deposit will also be an economic boom to the minerals industry and to local famers. The Borgen Bed cores are part of the 500,000 feet of cores housed in the Michigan Geological Repository (Figure 8). According to independent laboratory analyses, the Borgen Bed deposits contain the purest and highest-grade potash being produced in the world—six times higher than that mined in New Mexico. Some layers contain essentially 100 percent potassium chloride.

Figure 8. At left, from left to right, William Harrison, professor emeritus Western Michigan University, Theodore Pagano, general manager of Michigan Potash, and Linda Harrison, administrator of the WMU Michigan Geological Repository. At right, a core of the potash-rich Borgen Bed.

Alabama. Recent initiatives have been made to develop the oil sands of the Hartselle Sandstone in Alabama, which have estimated reserves of 7.5 billion barrels of oil. This reserve estimate was made by Gary Wilson (1987, Geological Survey of Alabama Bulletin 111, pages 30-31) based on analyses of 50 cores. Data from the cores gave: (1) an average reservoir thickness of 14 feet, (2) with 13% porosity, and (3) 30% oil saturation present, (4) within an area of 2,800 square miles or 1.8 million acres, which is equivalent to 7.5 billion barrels of oil. Such analyses could not have been done without the Hartselle cores at the Geological Survey of Alabama, State Oil and Gas Board, State Core Storage Repository (Figure 9). This repository contains samples from more than 10,000 oil and gas wells, more than 400 coal and mineral exploration cores, 200 offshore sediment cores, and 1,000 samples from water wells.

Figure 9, Cores stored in the Geological Survey of Alabama and State Oil and Gas Board State Core Repository.

Mississippi. Following the discovery of the Tinsley Oil Field in 1939 by Mississippi Geological Survey geologist (now MDEQ's Office of Geology) Fred Mellen, Germany invaded Poland and began a march on the Galacian and Romanian oilfields. War quickly spread to North Africa and to the Pacific, including oil-rich British Malaya and Dutch East Indies (Japanese paratroopers seized the Dutch oil fields largely intact). To conserve oil and encourage exploration, the U.S. Government established the Office of Petroleum Coordination and staffed it with 72 leaders from America's oil industry. As the newest of the major oil producers, Mississippi's oil potential seemed unlimited. Drilling in the state reached record levels, and, in the years from 1943-1945, there were large oil finds at Brookhaven, Eucutta, Cranfield, Heidelberg, Mallalieu, and Baxterville. Major gas finds included Gwinville, Soso, and Hub. By the war's end, the state's proven reserve was placed at one billion barrels of oil and 3.5 trillion cubic feet of gas (after Alan Cockrell, 2005, Drilling Ahead; University Press of Mississippi, p. xxii).

Discoveries continued, and, in 1960, state government and the oil industry partnered to build a new facility in Jackson to house the Mississippi Geological Survey and the survey's core and sample repository. By August 1, 1965, the core repository was full of core and samples; space had run out. Fred Mellen, then the State Geologist, circulated a petition to Governor Paul B. Johnson that was signed by politicians, those in the oil industry (including MDEQ's Roy Furrh's father and Dan Morse's father and grandfather), and those in the Mississippi Gem and Mineral Society (signed by my parents and MDEQ's Heather Pitts' grandparents) to build a new and modern core and sample library. The petition succeeded only in fostering a cheaper solution—adding on to the existing facility.

Mississippi's core and sample facility grew as a string of metal buildings, which housed a wealth of new oil and gas well samples (Figure 10). The facility supported Mississippi's oil industry through the boom times. By January 1, 1970, the year of peak oil production for the nation, Mississippi ranked seventh among oil producing states. Following 1970 there was a decline in domestic production and an increased dependence on foreign oil. Today, an upturn in domestic production has come about through advances in drilling technologies, which have unlocked new reservoir possibilities. These new technologies are being used in Mississippi's Black Warrior Basin and the southwestern part of the Mississippi Interior Salt Basin. Our state's next big oil find may be "hiding" in a core or sample box on a shelf in MDEQ's repository.

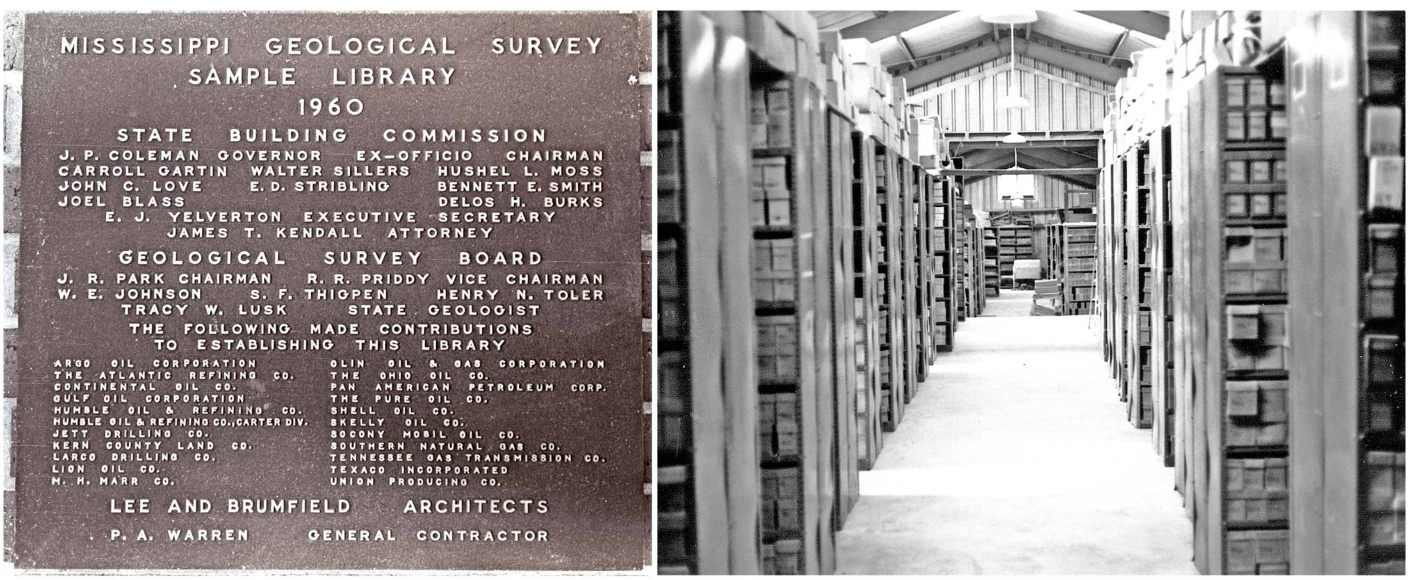


Figure 10. Left, dedication plaque at MDEQ's core and sample library, listing 12 oil industry companies that partnered with the state to build the facility in 1960. Right, a long line of multiple metal buidings house the core and sample collection. Pictures were taken around 1980.

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EFFIGY PIPES MADE OF GLENDON LIMESTONE FROM Mississippi

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Geological Archaeology or Geoarchaeology is a discipline that uses geology to examine topics in the field of archaeology. Archaeologists frequently bring MDEQ geologists stone artifacts and ask the question, “Where did this rock come from?” Usually this question is asked because the bedrock source is from a different area than where the artifact was found. For stone artifacts made of igneous or metamorphic rock, the source is often given as a variety of bedrock/terrain possibilities. However, when the artifact is a sedimentary rock with identifiable fossils, very specific determinations can often be made as to the formation and location.

When Mississippi Geological Survey (now MDEQ Office of Geology) geologist Jim May was working on the geology of Wayne County around 1972, I (Dockery) created a chart of formations in Wayne County that included the Vicksburg Group and overlying Chickasawhay and Paynes Hammock formations and the fossils these formations contained. Of particular importance as guide fossils to these formations were thin wafer-shaped shells (called tests) of the large Foraminifera *Lepidocyclina*. Foraminifera contain perhaps the largest species of the Protista Kingdom of one-celled animals. The Marianna Limestone of the Vicksburg Group contained the quarter to half dollar-size *Lepidocyclina mantelli*. The overlying Glendon Limestone contained the dime-size *Lepidocyclina supera*. Even higher in the section, the Chickasawhay Limestone contained the undulated and even saddle-shaped *Lepidocyclina undosa*. The Marianna and Glendon limestones outcrop across central Mississippi and are exposed on the banks of the Mississippi River at Vicksburg.

Fast forward to January 29, 1996, when Vin Steponaitis (author above) and I met at the Mississippi Department of Archives and History in Jackson where a number of effigy pipes from various locations had been assembled based on the fact that they were composed of a similar-looking limestone. Vin showed me a limestone effigy pipe and asked if I knew the source of the parent rock; I told him it was from the Glendon Limestone of Mississippi. He asked how I could know that, and I showed him the cross section of a *Lepidocyclina supera* in the rock. Some ten of the pipes assembled contained specimens of *L. supera*. That started a research journey in which we have identified Glendon Limestone effigy pipes in the archaeology collections of Harvard University, the Smithsonian Archaeology Museum (Figure 1), and one in the Grand Village of the Natchez Museum in Natchez, Mississippi.

Figure 1. Bird-head effigy pipe in the Smithsonian collections carved by Native Americans from the Glendon Limestone (from the Sycamore Landing site in Morehouse Parish, Louisiana: NMAI #17-2839). The hole in the side is the external mold of the clam *Pitar imitabilis.* Another effigy pipe carved from Glendon Limestone is in the background (from the Moundville site in Tuscaloosa County, Alabama: NMAI #17-0893). Both effigy pipes contain the common Glendon Foraminifera *Lepidocyclina supera*. Picture (color negative 550-17A; Image 337) was taken on October 15, 2004.

The following figures are from: Vincas P. Steponaitis and David T. Dockery III, 2011, Mississippian Effigy Pipes and the Glendon Limestone: American Antiquity, v. 76, no. 2, p. 345-354. Figure 2 is a panther effigy pipe, showing a vertical *Lepidocyclina supera* test across the right corner of the eye. Figure 3 shows Glendon Limestone outcrops at Vicksburg, Mississippi. Figure 4 shows various archaeological sites (solid circles) where Glendon Limestone pipes have been found.

Figure 2. Panther effigy pipe carved from Glendon Limestone (same as in Figure 1). At right, the thin vertical white line cutting the right corner of the eye is the test of *Lepidocyclina supera.*

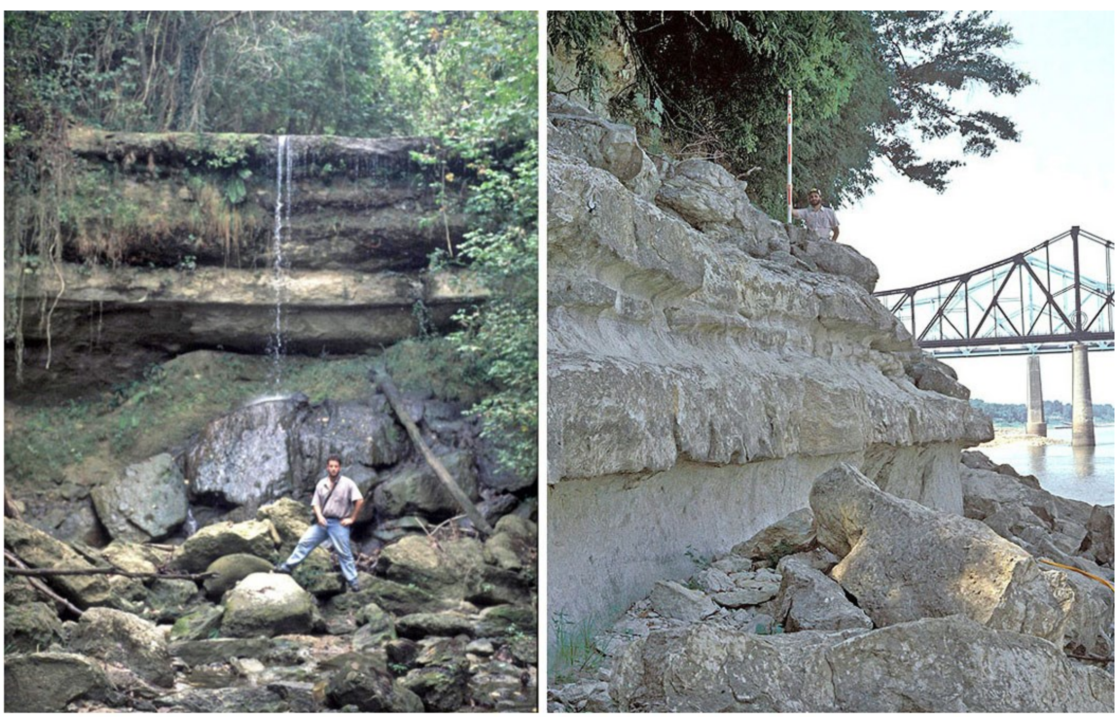

Figure 3. Glendon Limestone outcrops at Mint Spring Bayou in the Vicksburg National Military Park (left) and on the Mississippi River north of the Highway 80 and Interstate 20 bridges.

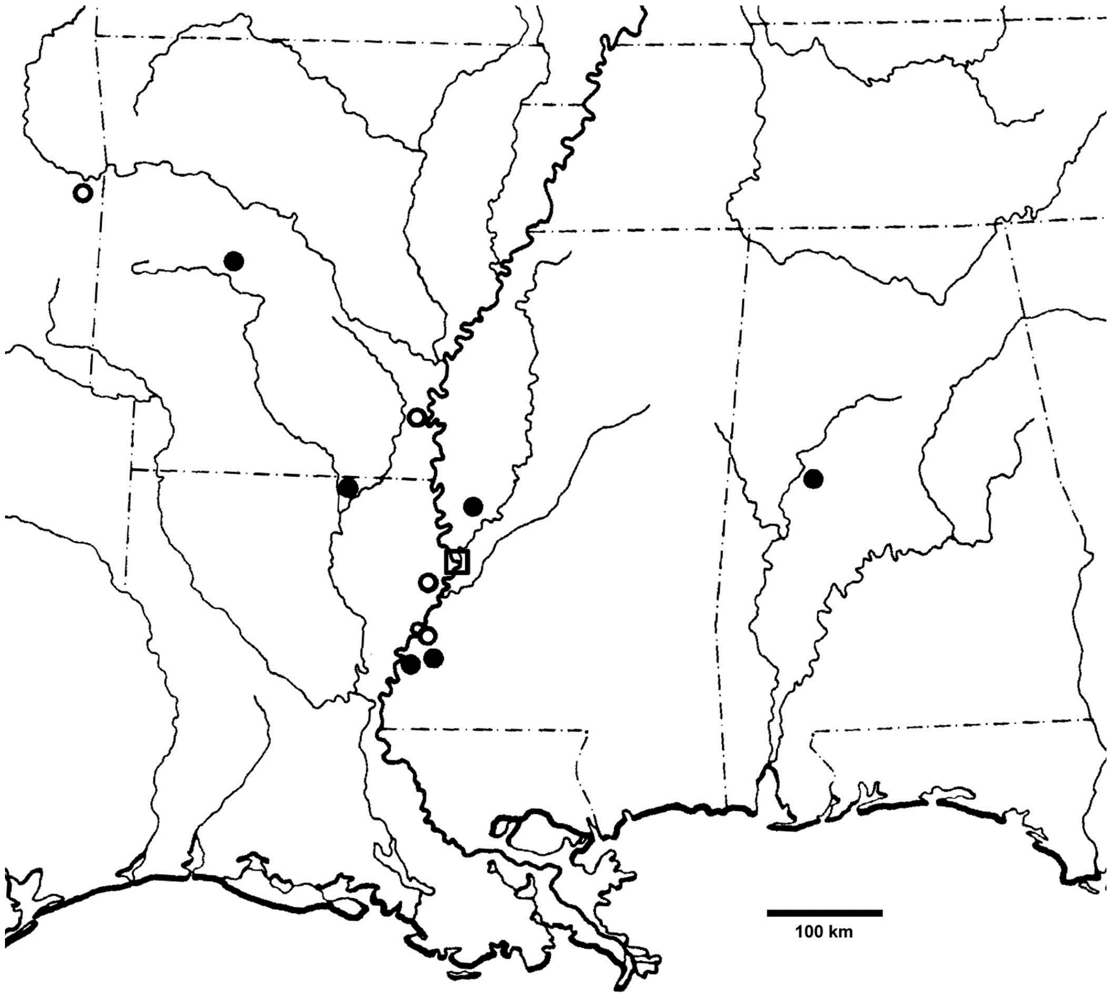

Figure 4. Geographical distribution of limestone effigy pipes of the “Bellaire group.” Solid circles represent pipes made of Glendon Limestone. Open circles are for pipes not examined; open square locates Glendon Limestone outcrops at Vicksburg, Mississippi.

Environmental News, December 2013, volume 10, issue 11, pages 11-15

THE 2013 ENERGY SUMMIT

David T. Dockery III, Office of Geology

The 2013 Governor's Energy Summit was held in the Jackson Convention Center on Thursday, December 5. The opening welcome was given by the President of the Mississippi Energy Institute, Patrick Sullivan. Sid Salter, Chief Communications Office and Director of Public Affairs for Mississippi State University, was the summit moderator. Salter told an audience of more than 800 conferees that the summit was to be informative and entertaining. He later addressed the audience: "Like Gus Malzahn said to Nick Saban, 'I have something I want to run by you'" (a joke on the Auburn-Alabama game). The summit program cover had a map of Mississippi with the location of oil and gas pipelines and the geologic outcrop belts of the Wilcox Group and the Cockfield Formation (from the Office of Geology's state geologic map), units containing important lignite resources.

Governor Phil Bryant (Figure 1) opened the summit with his vision that the state should leverage its energy strengths to grow other areas of its economy, such as manufacturing and technological development. He also discussed his legislation to make new buildings more energy efficient. David Dismukes, Consulting Economist for the Acadian Consulting Group, continued the Governor's discussion on "Leveraging energy for industrial development." Dr. Frank Clemente, Professor Emeritus at Penn State University, discussed "Coal's role in meeting global energy needs." Dan DiMicco, Executive Chairman of Nucor Corporation (Figure 2), spoke on "Energy's role in U.S. Manufacturing." He noted the country's new competitive advantage due to low-cost and abundant energy resources. He recommended these resources be used at home to support manufacturing jobs here rather than be sold abroad to help foreign economies. DiMicco also stated that the widening gap between the "haves and have nots" was due to the loss of high-paying manufacturing jobs during the recent recession.

Figure 1. Governor Phil Bryant addressing the Energy Summit opening session.

Figure 2. Nucor Steel Jackson, Inc., VP/General Manager James A. Sheble (left), Mississippi Governor Phil Bryant (center), and Nucor Corporation Executive Chairman Dan DiMicco (right).

Before lunch, Dr. Hank Bounds, Mississippi Commissioner of Higher Education, moderated a panel discussion with Dr. Rodney Bennett, President of the University of Southern Mississippi, Dr. Dan Jones, Chancellor of the University of Mississippi, and Dr. Mark Keenum, President of Mississippi State University. Each discussed cooperative efforts between their universities and private industries in the energy technology sector. Dr. Mark Keenum recognized the university's energy-efficient competition-winning EcoCAR2 team, many of whom were present at the summit (Figure 3).

Figure 3. Mississippi State University students who worked on the MSU EcoCAR2 competitive hybrid at the Energy Summit (top) and with their EcoCAR2 (bottom). MSU finished #1 in the first year of competition and 5th in the second year. The final competition will be a test of the car in Milford, Michigan, in May of 2014.

Newt Gingrich (Figure 4) mentioned the long gas station lines due to price controls in the 1970s. Federal price controls on gasoline from 1973-1980 created an artificial shortage and long lines at gas stations. Stations could not raise prices to cover increasing labor and operating costs, so they cut their hours or closed down after selling all their gas. This created fewer stations and even longer lines. Price controls were lifted when the situation became unsustainable (during the Iranian oil crisis of 1979), and the gasoline crisis was over.

Figure 4. Crowd stands to welcome Newt Gingrich as keynote speaker.

Interesting energy facts:

1. The United States is #1 in proven coal reserves with about 27% of the total reserves.
2. The United States is #3 in oil production for 2013 behind #2 Saudi Arabia and #1 Russia.
3. Texas pumped 2.7 million barrels of crude oil per day in September of 2013 due to new oil from hydraulic fracturing in the Eagle Ford, putting it in the ranks of heavy-hitting countries such as Venezuela, Kuwait, and Nigeria.
4. Mississippi now pumps 23 million barrels of oil per year.
5. The Fraser Institute, which developed rankings for investments in 157 oil- and gas-producing regions throughout the world, ranked Mississippi as #2 regarding energy policy and first in its tier when energy policy was considered along with proven oil and gas reserves, placing it ahead of Saskatchewan, Kansas, Alabama, Manitoba, and the North Sea region of the Netherlands.

Figure 4. Structure in the Glendon Limestone along the east bank of the Mississippi River at Vicksburg. Pictures were taken on October 15, 2012.