VOLUMES 7-8
2010-2011

JUST GEOLOGY
FROM THE PAGES OF ENVIRONMENTAL NEWS
MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY

VOLUMES 7-8
2010-2011

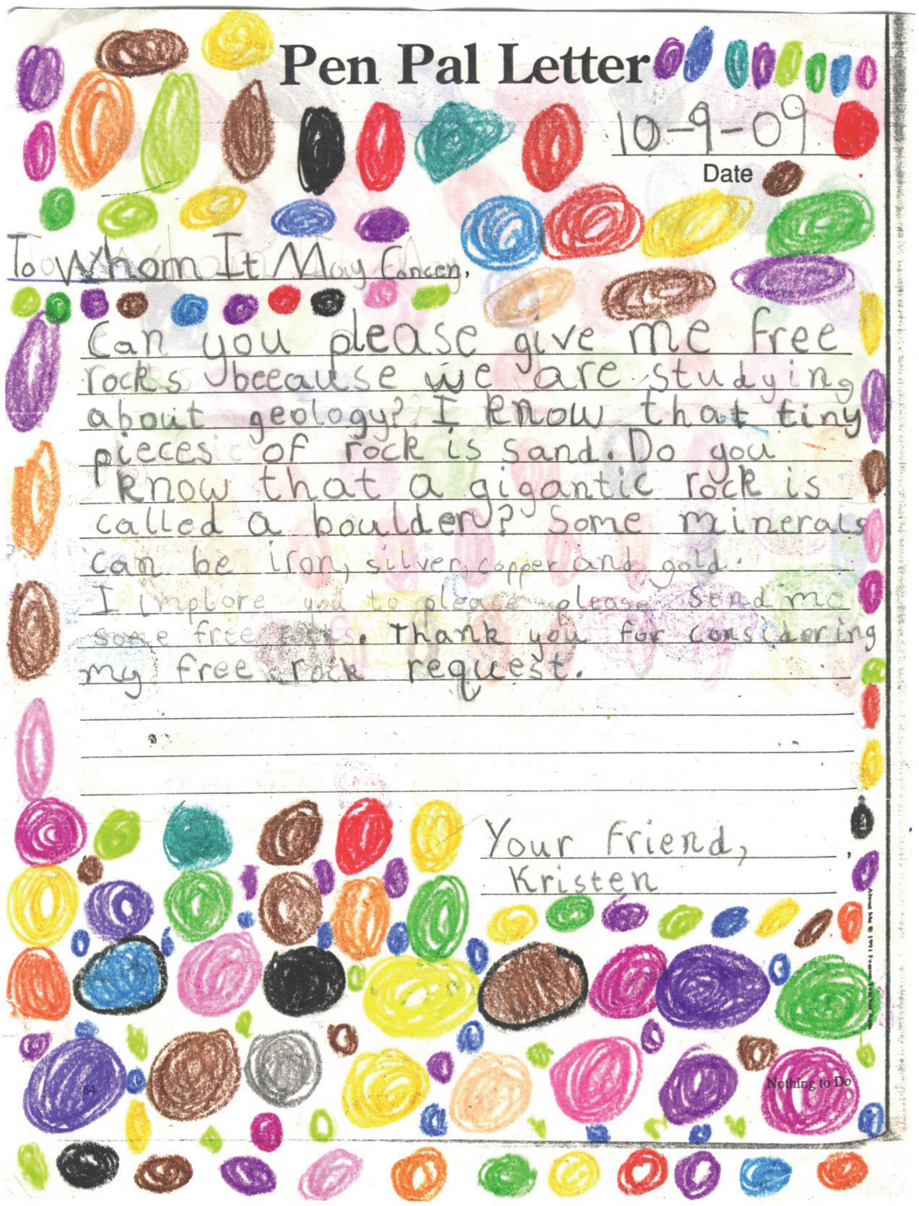
JUST GEOLOGY
FROM THE PAGES OF ENVIRONMENTAL NEWS
MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY

Environmental News, January 2010, volume 7, issue 1, page 6.

OFFICE OF GEOLOGY RESPONDS TO CHILDREN'S REQUESTS FOR ROCKS

The Office of Geology regularly receives requests from students all over the country for rocks from Mississippi. This letter is from a student in Rhode Island. The elementary school students are usually studying science and the geology of the earth. Geology staff respond to every letter and enclose a piece of petrified wood, the official state stone of Mississippi. If requested, staff will also answer questions from students' requests.

Geology staff believe it is important to aid the science education of young students and to provide these students with a good impression of the State of Mississippi.



Pen Pal Letter

10-9-09
Date

To Whom It May Concern,

Can you please give me free rocks because we are studying about geology? I know that tiny pieces of rock is sand. Do you know that a gigantic rock is called a boulder? Some minerals can be iron, silver, copper and gold. I implore you to please please send me some free rocks. Thank you for considering my free rock request.

Your friend,
Kristen

Environmental News, January 2010, volume 7, issue 1, pages 9-11.

MISSISSIPPI, THE GRANITE STATE?

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

“The Granite State” is the nickname of New Hampshire, not Mississippi. In fact, Mississippi’s soft-sediment Gulf Coastal Plain geology makes it the antithesis of “The Granite State.” Of course, if a well is drilled deep enough through the state’s coastal plain sedimentary rocks, there is probably granite down there somewhere. A phone call in April (2009) from Rodger (Tim) Denison, a retired professor from the Department of Geosciences at the University of Texas at Dallas (UTD), taught me (Dockery) a new lesson in Mississippi’s granite geology. I had worked with Tim and his colleague Roy Enrico when they were geologists with Mobil Oil in January of 1990 (see Global Cooling, pages 9-13, in the December 2009 MDEQ newsletter). I was pleasantly surprised when Tim asked if we would like to have his core samples and thin sections of igneous rocks from the Marathon #1 Lay well in Tallahatchie County, Mississippi. I knew nothing about the well but immediately said “yes.”

Figure 1. Sidewall cores of igneous rocks from the Marathon #1 Lay in Section 27, T. 25 N., R. 2 E., Tallahatchie County, Mississippi, at depths of (from upper left to lower right) 4,470, 4,960, 6,485, 7,020, 8,670, 9,530, 9,730, 10,785, 11,500, 11,997, and 12,280 feet. Picture (digital) taken on May 19, 2009.

The Marathon #1 Lay well drilled into basement granite at 3,700 feet below the surface of Tallahatchie County in 1990 and continued drilling through a continuous sequence of igneous and metamorphic rocks to a total depth of 12,550 feet. Some 1.67 miles of basement igneous rocks were penetrated by the well. Sidewall cores (figures 1-2) and thin sections (Figure 3) provided from this well by Denison included: (1) a biotite hornblende granite at 3,790 feet, (2) granite porphyry at 4,470 feet, (3) granodiorite at 4,960 feet, (4) syenite at 5,570 feet, (5) biotite hornblende granite at 6,485 feet, (6-7) quartz-muscovite hornfels at 7,030 feet (2 thin sections), (8) basic hornfels at 7,615 feet, (9) quartz diorite at 7,870 feet, (10) gabbro at 8,670 feet, (11) quartz-sericite-iron oxide rock at 8,850 feet, (12) gabbro at 9,530 feet, (13) quartz gabbro at 9,730 feet, (14) quartz-bearing gabbro at 10,120 feet, (15) quartz-bearing gabbro at 10,785 feet, (16) granite at 11,135 feet, (17) granite at 11,500 feet, (18) quartz-bearing gabbro at 11,800 feet, (19) granite at 11, 997 feet, and (20) gabbro at 12,250 feet. In a separate package, Denison sent a set of 22 thin sections (Figure 3) of various igneous rocks encountered in wells around the state.

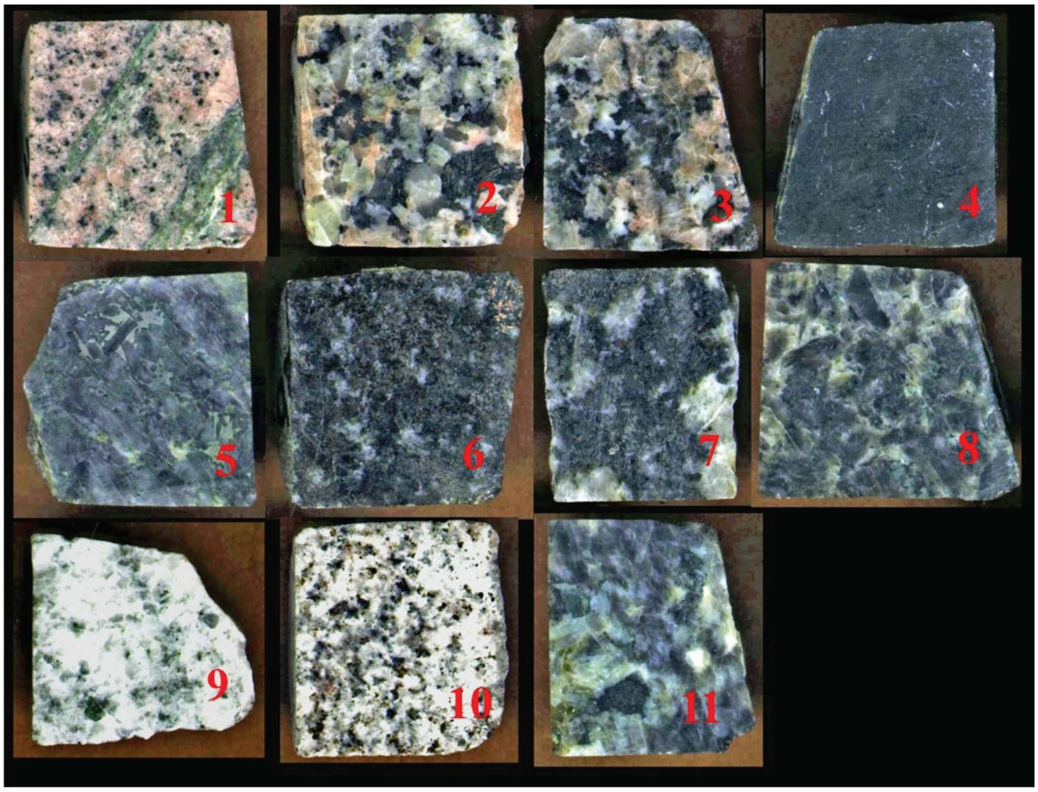


Figure 2. Sidewall cores of igneous rocks from the Marathon #1 Lay in Section 27, T. 25 N., R. 2 E., Tallahatchie County, Mississippi; #1 granite porphyry at 4,470 feet, #2 granodiorite at 4,960 feet, #3 biotite hornblende granite at 6,485 feet, #4 quartz-muscovite hornfels at 7,020 feet, #5 gabbro at 8,670 feet, #6 gabbro at 9,530 feet, #7 quartz gabbro at 9,730 feet, #8 gabbro (quartz-bearing) at 10,785 feet, #9 granite (leucrocratic) at 11,500 feet, #10 granite (fine-grained, leucrocratic) at 11,997 feet, and #11 gabbro at 12,280 feet. Picture (digital) taken on May 19, 2009.

Denison attributed the Marathon igneous sequence to a major granitic pluton (a large mass of once molten rock that crystallized beneath the surface), which underlies parts of Tallahatchie, Yalobusha, and Grenada counties. Radiometric ages determined from well cuttings from 12,620 to 12,640 feet were 198±5 million years old and from 13,090-13,100 feet were 210±5 million years old. Denison noted that these ages were similar to isotopic ages from granites in the Amerada #1 Moore in Yalobusha County and the Texaco #1 Dubard in Grenada County, which dated around 200 million years old, a time near the Triassic-Jurassic boundary. He also noted that the seismic velocity contrast between granite and gabbroic rocks produced a phantom seismic structure, which was seen in association with “a number of other wells that have been drilled on basement seismic anomalies that have a sedimentary structure appearance.” Such seismic anomalies “almost always involved faster [seismic wave travel time] gabbroic dikes and sills in a slower silicic host.” Marathon was exploring the Cambrian-Ordovician Knox Dolomite trend at the time they drilled into granite in Tallahatchie County and continued drilling another 1.67 miles in depth. Information on the well was tightly held for a long time; the Office of Geology didn’t even have a geophysical log of the well. Though we don’t know the complete objective of #1 Lay well, Denison’s comments shed some light on why Marathon drilled so deeply into granitic bedrock in their search for oil and gas.

Figure 4 is a structural features map that shows (in magenta) the well locations and the depth to the top of the granitic pluton in Tallahatchie, Yalobusha, and Grenada counties. The pluton is along the Ouachita Tectonic Belt, a suture that once connected North America with South America and Africa into the supercontinent of Pangea. The initial closure of the intervening ocean that separated these continents occurred in Early Pennsylvanian (Morrowan) time about 320 million years ago. The beginning of Triassic rifting, the breakup of Pangea, and the formation of the Gulf of Mexico began about 225 million years ago. The emplacement of the Tallahatchie-Yalobusha-Grenada granitic pluton, which fueled a volcanic province some 200 million years ago, occurred during the early growth of the Gulf of Mexico seaway—the northern edge of which followed the Pickens-Gilbertown Fault System (southwest part of Figure 4). South of this fault system are Late Jurassic salt deposits that formed in the hypersaline waters of the early Gulf of Mexico. Salt domes are depicted by green circles in the southwestern part of the map.

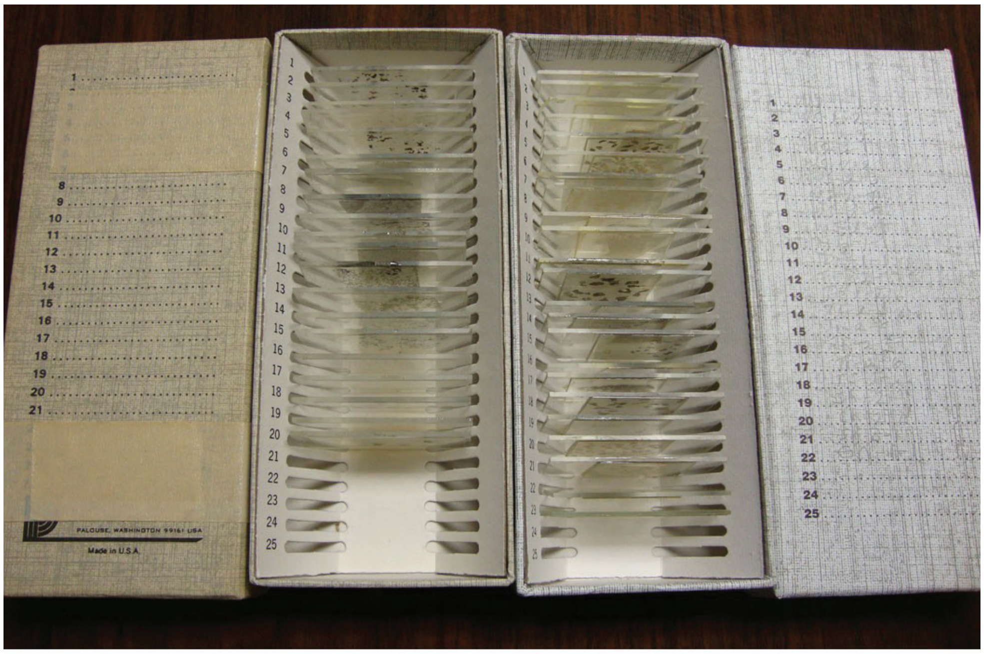


Figure 3. Thin sections of igneous rocks from exploration wells in Mississippi donated to the Mississippi Office of Geology by Tim Denison. The 20 thin sections on the left are from the Marathon #1 Lay in Tallahatchie County; the 22 thin sections on the right are from wells in Washington, Hinds, Tallahatchie, Sharkey, and Grenada counties. Picture (digital) taken on December 28, 2009.

The Tallahatchie-Yalobusha-Grenada pluton was once covered by thousands of feet of Paleozoic sedimentary rocks associated with the Ouachita Tectonic Belt. Penetrating this sediment cover were pipes and dikes fueling volcanic mountain peaks of Late Triassic/ Early Jurassic age. These sediments and mountains were eroded away before Late Cretaceous time, and the top of the pluton was eroded flat. Downwarping of the surface to the southwest occurred in Late Cretaceous time, and the pluton was covered with Late Cretaceous marine sediments. The pluton's downwarped surface is revealed by the increased depth to its top from the northeast to the southwest as indicated for wells in Figure 4: top at 3,000 feet below mean sea level (msl) in the #1 W. B. Moore/Amerada, 3,531 feet below msl in the #1 Lay/Marathon, and 3,878 feet below msl in the #1 D. Y. Dubard/Texaco-Kewanee.

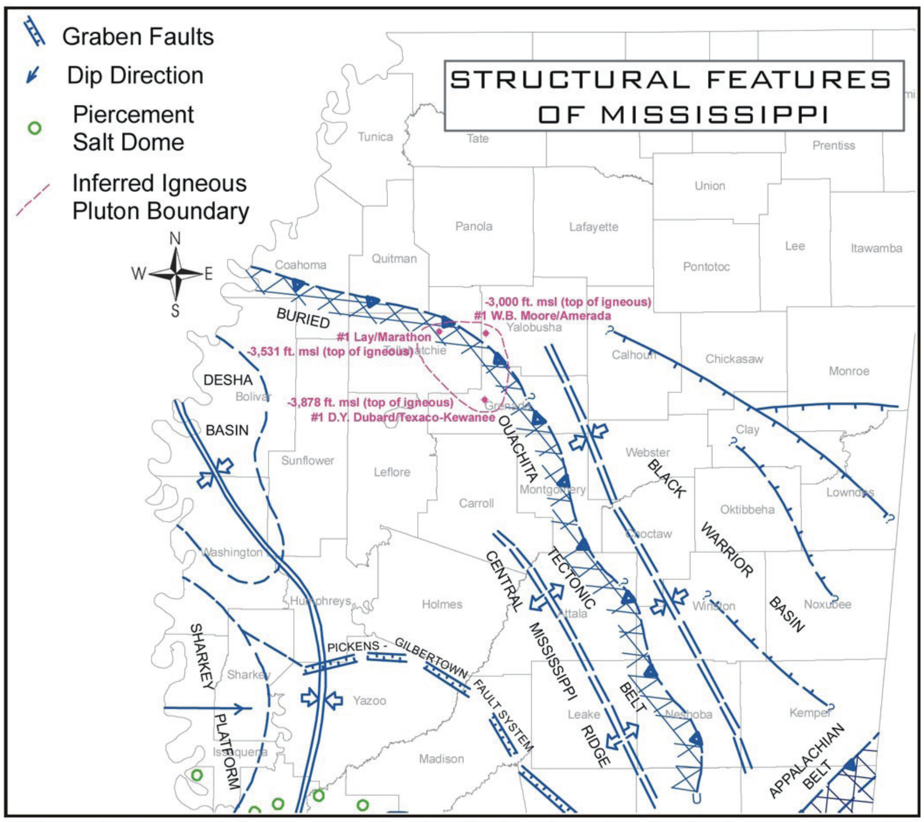
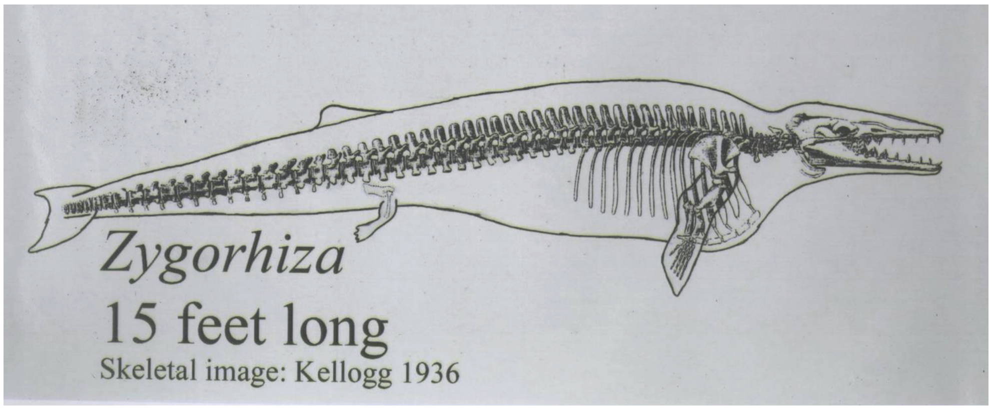


Figure 4. Structural features map showing the location of wells, depth to granite, and the approximate shape of the buried igneous pluton beneath Tallahatchie, Yalobusha, and Grenada counties.

Environmental News, February 2010, volume 7, issue 2, page 6-7

EXCAVATION OF A PARTIAL SKELETON OF A JUVENILE *ZYGORHIZA KOCHII* IN THE LOWER YAZOO CLAY, YAZOO COUNTY, MISSISSIPPI

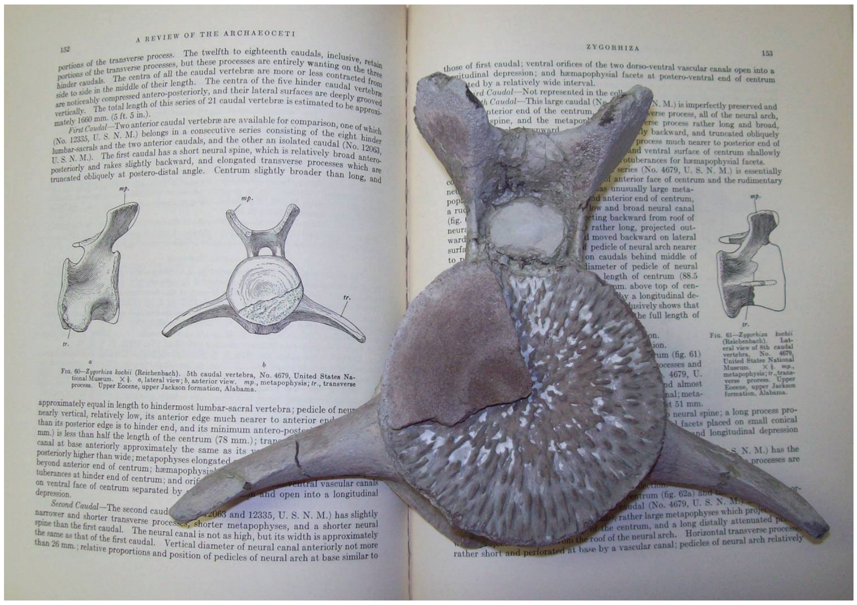
James E. Starnes, Mississippi Office of Geology, Tyler Berry, Millsaps College



During September to October 2008, a partial skeleton of a juvenile *Zygorhiza kochii* was excavated from the Yazoo Clay in an unnamed tributary of Piney Creek, near Benton Mississippi (Southeastern ¼ of Section 18, Township12 North, Range 1 West, Yazoo County). The specimen is fragmentary and largely disarticulated. It is currently represented by: eleven vertebrae including cervical, dorsal, caudal and lumbar elements, along with seven vertebral growth plates with underdeveloped sutures and several rib fragments (mostly posterior). Bone preservation is exquisite, as delicate textured surfaces are preserved where cartilaginous tissues once attached. Vertebrae neural spines and rib fragments show semicircular incisions as evidence of intense scavenging by sharks and other predatory fishes. The fossil bones rested on a well-preserved ancient sea floor surface. This sea floor surface is a bedding plane marked by intermittent invertebrate shell hash containing a concentration of associated fossil vertebrates including: small tiger shark, nurse shark, ray, barracuda, and other fish vertebrae and teeth. This associated fauna is attributed here to a "whale fall" assemblage, such as is found around modern whale remains resting on the sea floor. Whale falls host a complex ecosystem around the whale carcass before burial on an otherwise featureless and barren ocean bottom.

Fossil whale site in the Yazoo Clay of Yazoo County. The Yazoo Clay is at the base of the bluff. The brown soil above, forming the vertical wall, is Pleistocene loess.

Kellogg's (1936) book on fossil archaeocete whales opened to page 152 showing a vertebra of *Zygorhiza kochii* next to a real vertebra from the Yazoo County site



A string of *Zygorhiza* vertebrae with rib fragments from the Yazoo County site

A coffer dam and water pump were used to excavate whale bones below water level on the creek bottom. Working inside the coffer dam are Millsaps geology students Tyler Berry (in red) and Dakota Guillory (in purple).

Environmental News, February 2010, volume 7, issue 2, pages 11-14

THE STATE STONEMASON'S SCANDAL

By David T. Dockery III, Office of Geology

Figure 1. Catahoula sandstone chimney of the Porter House built around 1830 and moved to Raymond, Mississippi, in 2004. Picture (digital) taken on September 20, 2007.

The State Stonemason's scandal was brought to my attention by Cavett Taff, an independent museum exhibit designer, who was concerned that the renovations to the Old Capitol Building match the stone facing of the original building. The stones of the original building had been taken down long ago due to deterioration and were discarded. The State Stonemason awarded the contract by the Board of Commissioners of Public Buildings on March 31, 1836, for the stonework and brickwork on the ground story of the state house had instead high-graded stone from the quarry at Mississippi Springs for use as grave stones and was late in his deliveries of stone to the construction site of the state house. When architect William Nichols visited the stone quarry to investigate, he discovered and later reported that "the ground around the quarry is covered with headstones and footstones…[and] large square tombs." According to Skates' (1990, p. 37) book, *Mississippi's Old Capitol: Biography of a Building*, Nichols charged stonemason Baird "with pilfering the best stone from the state's quarry while sending the inferior stone to be used in the state house." Baird was fired and his ex-partner Robb was assigned the job to finish the work. Baird must have taken his high-graded gravestones with him, as the action by the Board of Commissioners of Public Buildings to accept Robb as the new stonemason happened in September of 1836, while gravestones in the old Raymond cemetery (not far from the stone quarry) have dates of 1837 and 1838.

Figure 2. Catahoula sandstone steps and facing/foundation stones in a building on the Raymond town square. Picture (digital) taken on September 20, 2007.

Figure 3. James Starnes behind box-grave monuments in the old Raymond cemetery made of Catahoula sandstone quarried at Mississippi Springs. Picture (color negative 601-24A) taken on December 19, 2006.

One event in the 1830s which may have facilitated the stonemason's scandal was the great loss of life due to yellow fever and malaria epidemics along the Mississippi River and inland. A yellow fever outbreak in Natchez, Mississippi, from September 8 to November 25, 1837, claimed 280 lives. Demand was high for gravestones and monuments in communities where families lost loved ones, especially wives and children. Cavett Taff located some of the gravestones described by Nichols as headstones, footstones, and large square tombs in the old Raymond cemetery. He asked the Mississippi Office of Geology to confirm that the stones came from the Mississippi Springs quarry. Upon examination, the cemetery stones were found to be sandstone with opal cement typical of sandstones in the Catahoula Formation, such as those at Mississippi Springs. Some eight months later, an absentee landowner living in a distant state asked us to look at rock on her property east of Raymond, Mississippi. Her property was on a proposed right-of-way for the Norrell Road extension (Byram-Clinton Norrell Corridor Project) from Interstate 20 to Siwell Road at Davis. The landowner wanted to develop the property and thought the stone might be a valuable resource. When we examined the property, we found the old Mississippi Springs stone quarry. Though it was our first time to visit the quarry, the location had been published by others. Watson Monroe gave the location in his 1954 publication on the "Geology of the Jackson Area, Mississippi" (U. S. Geological Survey Bulletin 986), in which he reported the quarry to have been in operation from 1833-1839 in the construction of the state house and to have been a working quarry in the early 1950s for building stone and riprap.

Figure 4. James Starnes standing behind the ruins of a box-grave monument in the old Raymond cemetery made from Catahoula sandstone quarried at Mississippi Springs. Picture (color negative 603-21) taken on December 19, 2006.

Figure 5. Alston family monuments in the old Raymond cemetery with death dates of 1838 (bench in foreground) and 1837 (tall monument in background). Monument stones are slabs of Catahoula sandstone from a quarry at Mississippi Springs. Picture (color negative 603-23) taken on December 19, 2006.

Stone from the state quarry at Mississippi Springs had also been used as building stones for private structures in the Raymond area. The Porter House, built around 1830, had a large fireplace and foundation stones from the quarry. In 2004, this house was moved from its original site to the Robert A. Brigg family lot at the corner of Oak and Court Streets in Raymond. Today it serves as a bed and breakfast and has been renamed Cedarwood. Figure 1 shows Cedarwood's reconstructed chimney made of sandstone from the Catahoula Formation. Figure 2 shows Catahoula sandstone steps and lower facing stones in a building on the Raymond town square. A stone tomb or box grave made of Catahoula sandstone is shown in Figure 3; the ruins of another are shown in Figure 4. Figure 5 shows the monument for two sons of P. M. and A. Alston--John M. Alston (died September 5, 1837, at an age of 5 years, 9 months, and 15 days) and 8-year-old Absalom H. Alston (died September 7, 1837, at an age of 8 years, one month, and 9 days). Figure 6 shows the inscription for Absalom Alston, which is remarkably clear after withstanding the weather for some 170 years—something that can't be said for the cemetery's old limestone monuments. Figure 7 is a grave-size slab of Catahoula sandstone, which marks the grave of Sarah Ann Alston, who died on June 5, 1838, at the age of one year, 8 months, and 18 days. Figure 8 shows Cavett Taff and his son Philip examining a sandstone exposure in the old Mississippi Springs stone quarry (Guy Cavett Taff passed away at age 60 on September 26, 2009, after a two year battle with cancer).

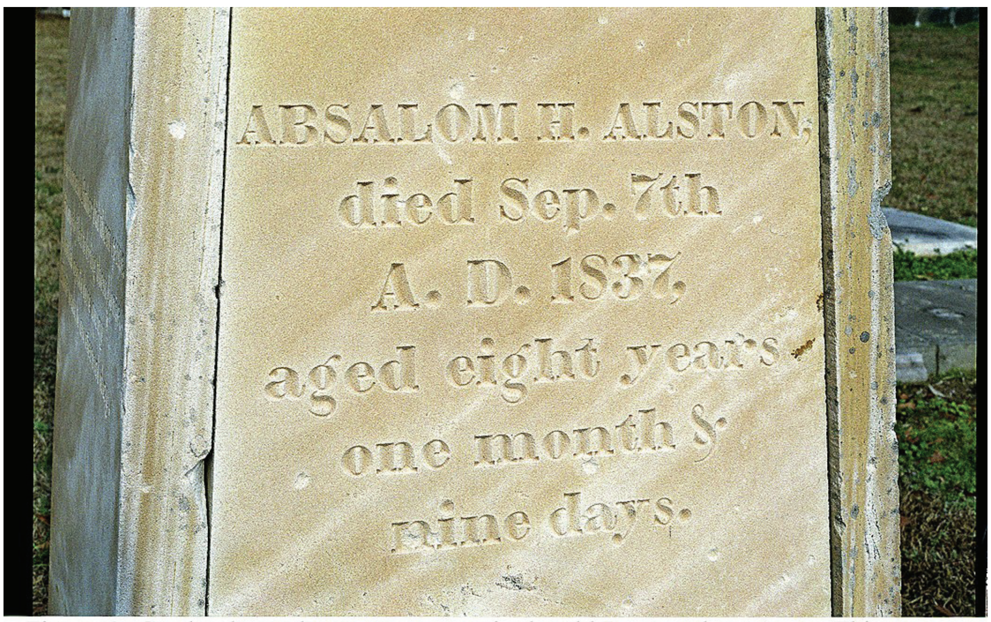


Figure 6. Catahoula sandstone monument in the old Raymond cemetery. This stone came from the quarry at Mississippi Springs, where stone was quarried for the Old Capitol Building in Jackson, Mississippi. Picture (color negative 603-5) taken on December 19, 2006.

Figure 7. Catahoula sandstone slab marking the grave of Sarah Ann Alston, who died on June 5, 1838, at the age of one year, 8 months, and 18 days. Picture (digital) taken on September 18, 2007.

Figure 8. Cavett Taff (right) and his son Philip examining a Catahoula sandstone ledge at the old state stone quarry at Mississippi Springs east of Raymond, Mississippi. Picture (digital) taken on September 20, 2007.

THREE WEATHER EMERGENCIES, JANUARY AND FEBRUARY 2010

By David T. Dockery III, Office of Geology

Figure 1. Early snow of December 5, 2009, at Mossy Grove in northwestern Hinds County. Picture (digital) taken on the morning of December 5, 2009.

After a string of mild winters, fall of 2009 gave hits that the winter of 2010 would be a cold one. In October through early December, some of these hints included: (1) a bumper apple crop in Michigan, (2) record breaking cold temperatures and snowfall records in the American Upper Midwest on October 12, 2009, (3) the Upper Midwestern blizzard of December 8-9, 2009, with wind gusts up to 50 mph and snow that snarled traffic and closed hundreds of schools from the Upper Midwest to New England; the storm left more that a foot of snow in parts of Illinois, Wisconsin, and Iowa, and (4) the more modest December 4, 2009, snowfall across Arkansas, Louisiana, and Mississippi, the third earliest measurable snow officially at Jackson, Mississippi (Figure 1). In late December there was: (1) snow at the Copenhagen climate summit, (2) the December 21, 2009, East Coast blizzard with 18 inches of snow in the Washington D.C. area, breaking snowfall records at the National, Dulles, and Baltimore airports, and (3) the December 24, 2009, first-ever-recorded blizzard on the rolling plains of West Texas, west and northwest of the Dallas-Fort Worth area, with up to 8 inches of snow, wind gusts up to 65 mph, and snow drifts as deep as 5 feet; this storm gave Dallas its first white Christmas in 80 years. December of 2009, for the contiguous United States, was 3.2°F cooler than the 1901-2000 (20^{th} century) average and was the 14^{th} coldest December in 115 years.

First State of Emergency Declaration of 2010. The first weather-related state of emergency declaration came to our office by email at 1:42 p.m. on January 6, 2010, (I opened the email with chapped, cracked, sore hands from the cold weather): “GOVERNOR BARBOUR DECLARES STATE OF EMERGENCY IN ANTICIPATION OF SEVERE WINTER WEATHER.” At the time of this declaration, we were not alone in the winter emergency. On January 4, 2010: (1) Seoul, South Korea, received 11 inches of snow, the heaviest snowfall in 70 years; the snow cancelled flights and paralyzed traffic; (2) at 8:00 a.m. on January 4, a New Jersey nuclear power plant was shut down because of ice on the Delaware River, which was clogging its cooling mechanism. On January 6, 2010: (1) more than a foot of snow caused chaos on the roads and rails in the United Kingdom, which had only 8 days of gas left (of its 15-day, 4.3 billion-cubic-meter supply) after a 30% rise in demand, and (2) cities across eastern and central China were rationing power for industry and urging residents to limit gas use due to cold weather and big snowfalls on Beijing.

To place the cold spell of January 2010 in perspective, the following are low temperatures of 10° F or less (Jackson, Mississippi) from the last 30 years (going backwards):

Early morning of February 5, 1996: **10.0° F** (see Figure 2A).

Night of December 23-24, 1989: **3.9° F** (see Figure 2B).

Early morning of December 22, 1989: **8.1° F**.

Night of January 21-22, 1985: **1.9° F**.

Early morning of January 20, 1985: **7.0° F**.

Night of December 31, 1983-January 1, 1984: **10.0° F**.

December 26, 1983: **9.0° F**.

December 25, 1983: **8.1° F**.

The night of January 11-12, 1982: **3.0° F**.

The 2010 first-week-of-January cold spell, with predicted lows in the teens and lower twenties, was not as severe as one that occurred 14 years ago in February of 1996 [the first event listed above], when both of my lakes froze over (Figure 2A). The second and third low temperatures listed above occurred during the Christmas cold spell of 1989, when the lower Ross Barnett Reservoir froze over, and a strong north wind and frigid surf created fantastic ice sculptures along the dam and Spillway Road. State workers were told to stay home on December 27, 1989, due to frozen water lines in Jackson (more frozen lake pictures--Figure 2B). John Marble (Office of Geology) was newly married in 1989 and spent the Christmas cold spell of that year without electricity and sleeping on an electrically-warmed water bed that turned cold. He said it was like sleeping on a cold wet sponge. The cold weather of Christmas 1989 killed off the tall stately palm trees in the median of St. Charles Street and elsewhere in New Orleans (Figure 3), permanently changing the look of the city; these were later replaced with smaller, more cold-tolerant palm species. My desk diary entry for January 21, 1985, reads: "My car didn't start." David Thompson (Office of Geology) remembers the Christmas cold spell of December 1983 because the engine block of his 1969 Cutlass Supreme froze up.

The first state of emergency ended with warmer weather on Sunday afternoon on January 10, after 67 continuous hours below freezing. Cloud cover had moderated night-time lows, but a low record was broken for the day-time high of 27° F in Jackson, Mississippi, on Friday, January 8, 2010. The following morning both my lakes were frozen over (Figure 2C) for the first time in 14 years (On February 17, 2010, the National Weather Service in Cleveland reported that Lake Erie was completely frozen over for the first time in 14 years). This early January cold air mass moved southeast on January 8-9, endangering Florida's $9 billion citrus industry. There were snow flurries across parts of central Florida, including Jacksonville, Orlando, and Tampa, and, on January 11, record-breaking temperatures of 14°F at Tallahassee (breaking the previous record of 15° F set in 1982) and 36° F at the Miami Airport (beating an 82-year-old record of 37°F). This was the first year since the mid 1950s that Florida has had more than one snow accumulation in a single year.

Figure 2A. Frozen over upper lake (left) and lower lake (right) at Mossy Grove after a low of 10 degrees F the night before. Picture (color negative, #429-10&17) taken on February 5, 1996.

Figure 2B. Frozen over upper lake (left) and lower lake (right) at Mossy Grove after a cold spell with a low of 4 degrees F on the night of December 23-24, 1989. Picture (color negative, #518-6&18) taken on December 27, 1989.

Figure 2C. Frozen over upper lake (left) and lower lake (right) at Mossy Grove after record low day-time high of only 27 degrees F on the previous day; this is the first time these lakes have been frozen over in 14 years. Picture (digital) taken at 3:30 PM on Jauuary 9, 2010.

Figure 3. The tall palm tree in the median of St. Charles Street in New Orleans, to the left of the trolley, is dwarfed by the one behind it, which towers over the live oak trees. These, and other palm trees in New Orleans, were killed by record cold weather in 1989. Picture (slide) taken in the winter of 1976.

Second State of Emergency Declaration. The second state of emergency declaration was given at noon on Monday January 11 when Governor Barbour declared a state of emergency in the City of Jackson due to numerous water line breaks and the lack of water service in the city. State offices were closed, and "non-essential" state workers in Jackson were sent home (as happened 20 years ago on December 27, 1989). When we returned to work, we were greeted with GOTTA GO portable toilets in the parking lot (Figure 4). Governor Barbour re-opened state offices in Jackson on Tuesday January 19, after repairs were made to some 154 water main breaks with help from additional work crews from other cities.

February brought still more impressive weather across the lower 48 states. By late afternoon of February 7 a total of 32.4 inches of snow was recorded at Dulles International Airport outside of Washington, D. C. This two-day total topped the previous record made during the blizzard of January 1996. Even President Obama, a hardy Chicagoan accustomed to bad weather, was impressed by the snow event, calling it "Snowmaggedon." The storm effectively shut down the Federal Government in Washington. A second snow storm added to the total so that by early afternoon of February 10 a total of 54.9 inches of snow had fallen on the capital, again grinding government to a halt and breaking all snowfall records since the time record-keeping began in 1888. Baltimore, Maryland, also broke all records with a total of 65.6 inches just before noon on February 10.

Figure 4. Gotta Go portable toilets (his and hers) at the 700 North State Street office, where water pressure is low. The Gotta Go motto is "We're #1 in the #2 business." Picture (digital) taken about 1:00 PM on January 13, 2010.

Third State of Emergency Declaration. The February snow came to the Deep South when a snow storm on February 11-12 dumped 12.5 inches of snow in Dallas, Texas, an all time 24-hour record for the city, and then dumped 5.4 inches of snow in Shreveport and 5 inches in Monroe, Louisiana. By about 7:00 p.m. on February 11 it was snowing in Jackson, Mississippi, and continued snowing till about noon on February 12, covering central Mississippi in 3 to 6 inches of snow and with 7 to 8 inches reported in some areas. The official snowfall total at the National Weather Service in Jackson was 4.7 inches, of which 4.1 inches fell on February 12, beating the old daily record for February of 4 inches set on February 23, 1901. The two-day snow event was the second largest February snowfall on record behind a 9.1-inch snowfall in February 1960 (see the June 2009 issue of *Environmental News*, page 5). On Thursday February 11, Governor Barbour issued his third State of Emergency declaration for the year due to the approaching winter storm and, the following Friday, closed state offices south of U.S. Highway 82 due to snowy and icy conditions. Figures 5 and 6 show the snow cover in northwestern Hinds County.

Figure 5. Snowy greeting in northwestern Hinds County on a Friday morning. Picture (digital) taken at 9:15 a.m. on February 12, 2010, while snow was still falling.

Figure 6. Snow in northwestern Hinds County, making a solid cover over grassy fields and tree limbs. Picture (digital) taken at 11:49 a.m. on February 12, 2010.

THE ANNUAL GEM AND MINERAL SHOW AND THE FOSSIL ROAD SHOW 2010

By David T. Dockery III, Office of Geology

Figure 1. A father poses his rock-collecting daughters in front of the Office of Geology booth at the Gem and Mineral Show in Jackson. Sitting in the booth is John Marble, standing is David Thompson. Picture (digital) taken on February 27, 2010.

The Mississippi Office of Geology participated in back-to-back weekend rock and fossil events, beginning with the Mississippi Gem and Mineral Society's annual Gem and Mineral Show at the Trademart Building on February 27-28 and then the Fossil Road Show at the Mississippi Museum of Natural Science on March 6. The Office of Geology staffed a booth at the Gem and Mineral Show with a selection of our publications and to answer questions from the public. The show is often a time that someone will bring by an unusual rock or fossil to be identified. It is also a time we see geologists and rock enthusiasts drawn to Jackson by the event. Near our booth were those of the geology departments of the University of Mississippi, Mississippi State University, and the University of Southern Mississippi. Figure 1 shows the Office of Geology booth, and Figure 2 shows the Mississippi State booth, a booth featured here for its lively banners.

Figure 2. Mississippi State University's Geoscience Department's booth at the Gem and Mineral Show in Jackson. The banners effectively wall the MSU booth from the adjacent University of Mississippi booth. Picture (digital) taken on February 27, 2010.

Figure 3. Prize Cretaceous fossils at the Fossil Road Show at the Mississippi Museum of Natural Science. At front left are a fossil lobster and crab, at middle is a large, toothy, fish skull (facing up), and in back is a large nautiloid. Picture (digital) taken on March 6, 2010.

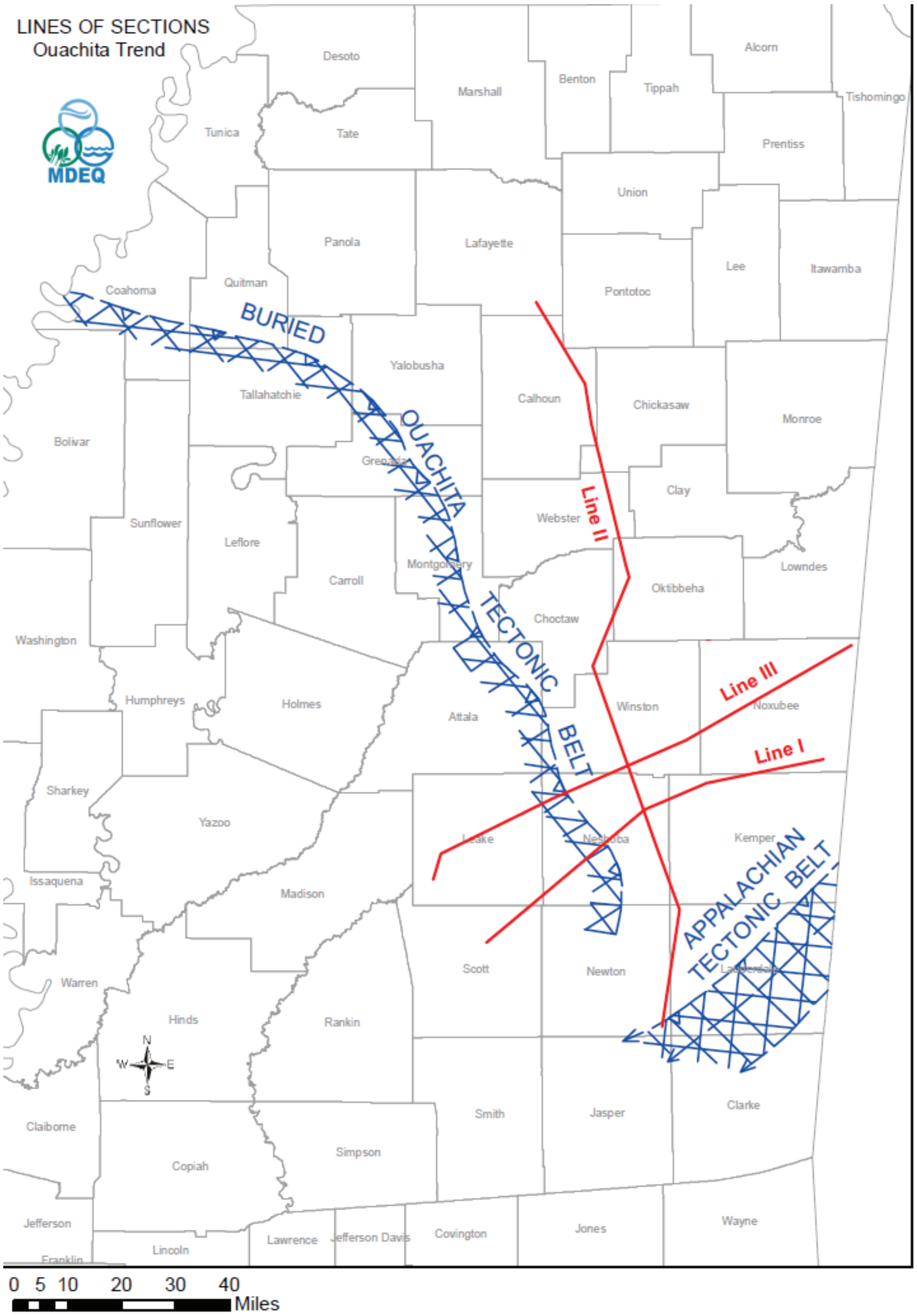
David Dockery and James Starnes of the Office of Geology and Robert Seyfarth of the Office of Pollution Control participated in the Mississippi Museum of Natural Science's Fossil Road Show on March 6 along with many fossil specialists from Mississippi and other states. We saw many interesting rocks and fossils collected from the state's chert gravels. The prize specimens exhibited at the show are shown in Figure 3. They were a fossil lobster (*Linuparus canadensis*) and crab (*Dakoticancer australis*) and a fossil nautiloid (*Eutrephoceras*) from the Ripley Formation at Blue Springs, Mississippi, and a large toothy fish skull of an unidentified species from the upper Demopolis Chalk found during recent construction on Highway 9 just southwest of Tupelo, Mississippi. According to George Phillips, the vertebrate paleontologist for the Museum of Natural Science, the fish skull is related to *Saurodon leanus* from the Niobrara Formation of Kansas. Figure 4 shows Robert Seyfarth showing off his fossil mastodon tooth from Natchez. Figure 5 shows James Starnes identifying fossils collected from Mississippi gravel.

Figure 4. Robert Seyfarth shows off a mastodon tooth and other mastodon bones collected at Natchez, Mississippi. Picture (digital) taken on March 6, 2010.

Figure 5. James Starnes identifies fossils at the Fossil Road Show at the Mississippi Museum of Natural Science. Picture (digital) taken on March 6, 2010.

MOUNTAINS BENEATH OUR FEET

By David E. Thompson, Office of Geology



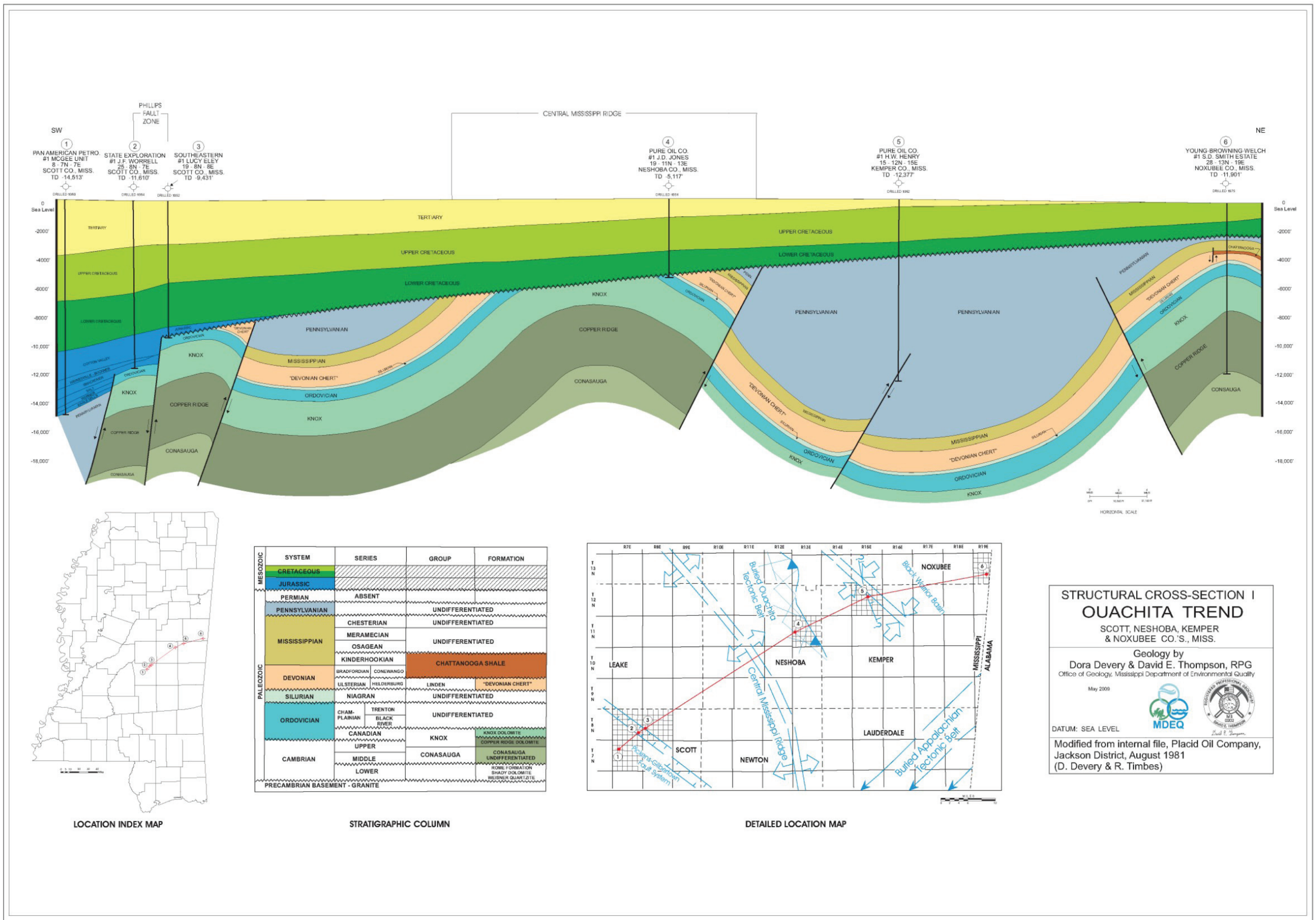
The Office of Geology possesses a number of files, reports, and maps which have never been officially published. About 10 years ago, David Dockery showed me a set of unpublished crosssections created by Dora Devery, a staff geologist back in 1981. She moved on to the private sector before they could be made available, and her work was filed away, perhaps never to see the light of day. Her work consisted of three crosssections: blueline copies with colored pencil shading. The focus of the cross sections was the deep Ouachita Trend architecture. The cross sections were very appealing, and I imagined how a digital sprucing up might enhance their quality.

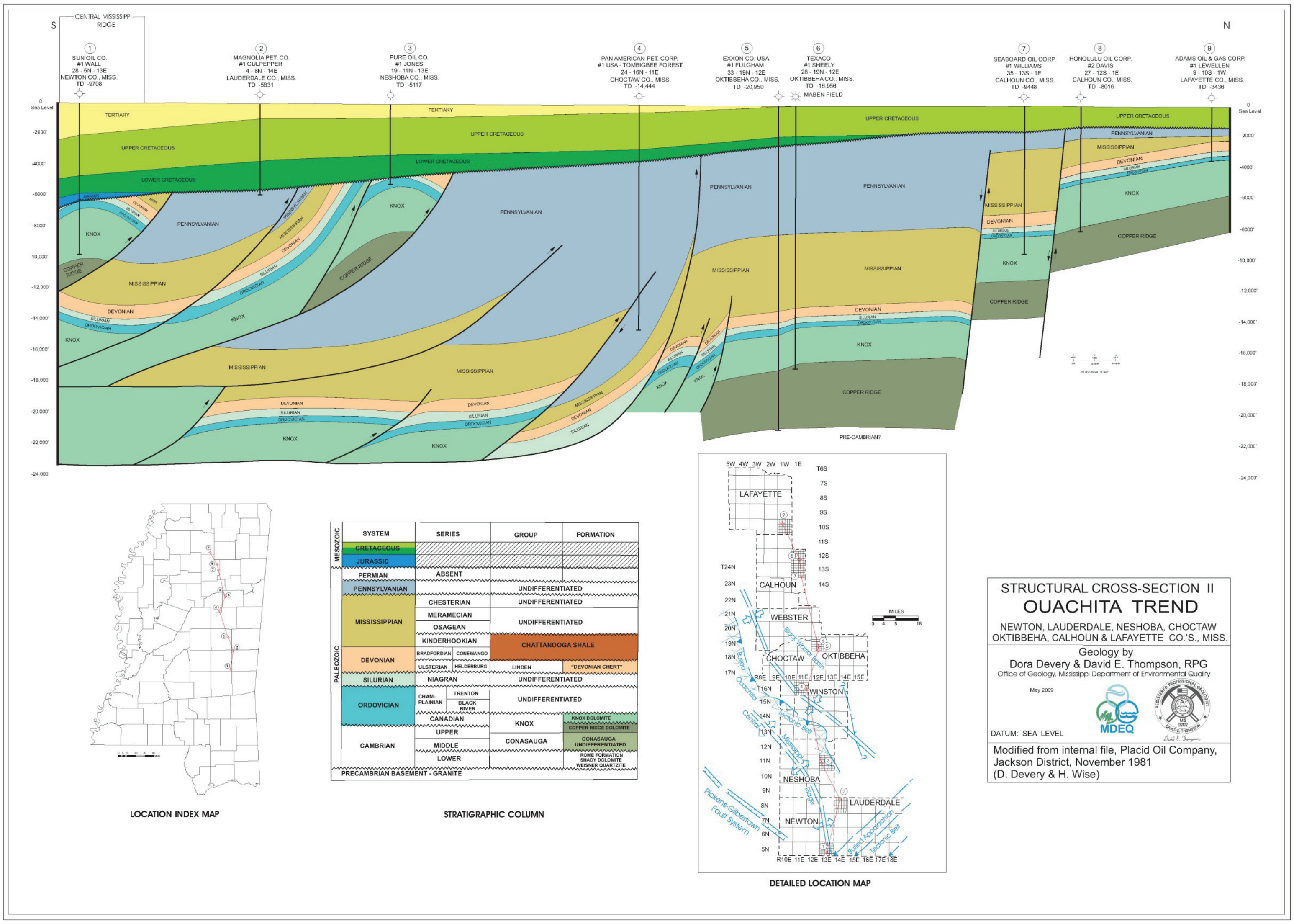
I contacted Dora back in the summer of 2009 and inquired if she might be open to co-authoring her long dormant work with me. She was happy to see her work valued and brought to life. One possible snag in the refurbishment was that Placid Oil Company was listed in each legend as the original source via an internal file. Placid Oil is now part of Occidental Oil & Gas, so we got in touch with Kirk Sparkman, Senior Geological Advisor at Occidental, to gauge possible concerns and seek their approval. Occidental was pleased as well, and granted their permission in late June 2009. The resulting restoration was accomplished utilizing CorelDraw, and care was taken to remain true to the original design, with one exception. We thought it would be useful and illustrative to include a detailed location map with structural features delineated.

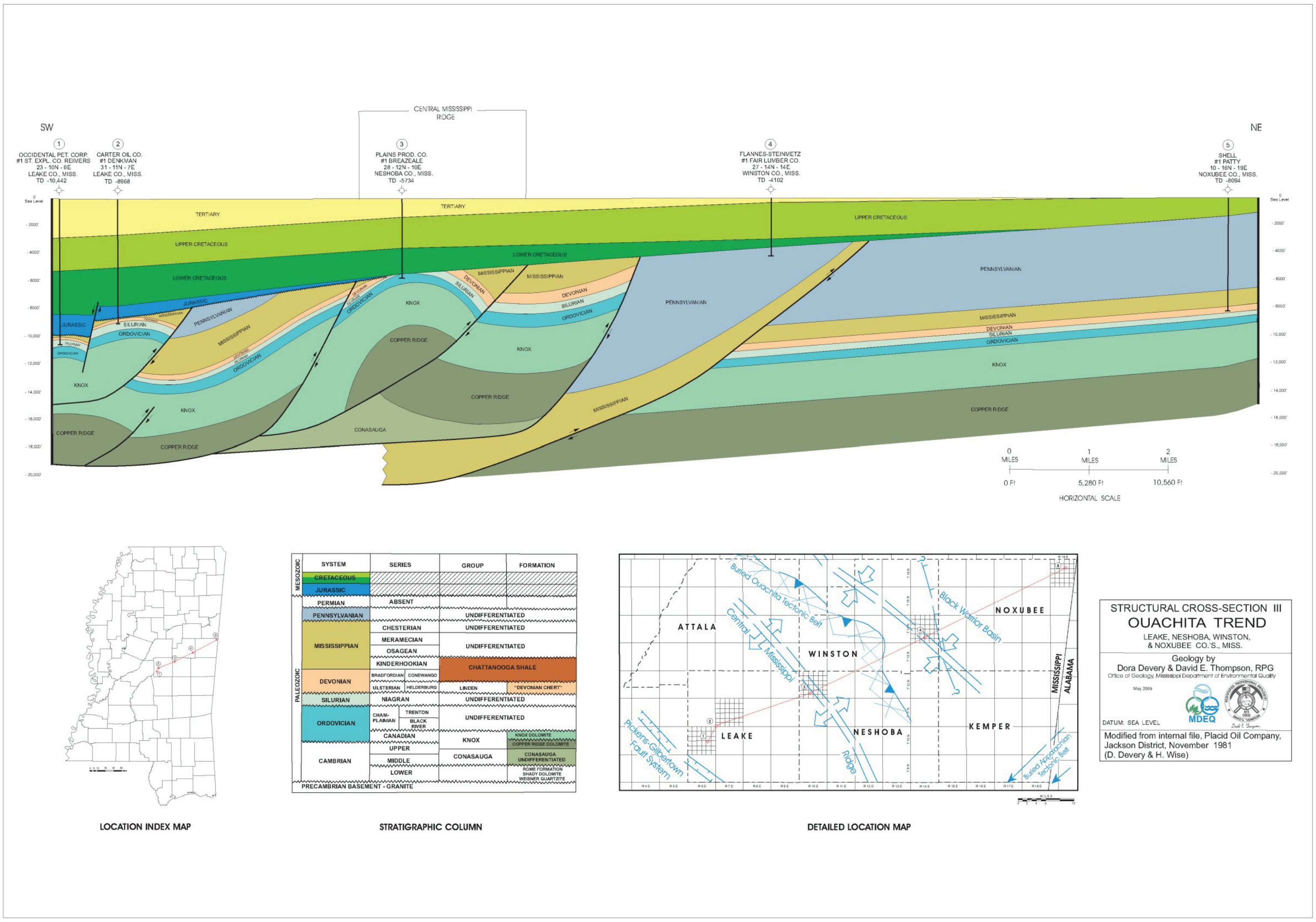
The ancient Ouachita Mountains lie in western Arkansas and formed about 300 million years ago. Yet, subsurface data indicate that the Ouachita fold belt continues southeastward into eastern Mississippi, where it is overlain unconformably by thick sequences of Cretaceous and Tertiary coastal plain sediments. Interestingly, the Appalachian Trend and fold belt plunges into Mississippi from the opposite direction, and the exact nature of the juncture with the Ouachita Trend remains largely obscured. The Ouachita Trend has been interpreted as a suture along a subduction zone where the South American plate was forced beneath the North American continental crust. In their prime, the Ouachita Mountains were similar in size to the Rocky Mountains, but over millions of years the mountain tops eroded away, leaving behind the folded heart of the mountains.

The Ouachita Trend crosssections may be viewed at the MDEQ website:

http://www.deq.state.ms.us/Mdeq.nsf/pdf/Geology_OuachitaTrendCross-Sections(3pages)/$File/Ouachita_Trend_Devery_Thompson.pdf?OpenElement




S
N
CENTRAL MISSISSIPPI RIDGE
1 SUN OIL CO. #1 WALL 28 - 5N - 13E NEWTON CO., MISS. TD 9708
2 MAGNOLIA PET. CO. #1 CULPEPPER 4 - 8N - 14E LAUDERDALE CO., MISS. TD 5831
3 PURE OIL CO. #1 JONES 19 - 11N - 13E NESHOBA CO., MISS. TD 5117
4 PAN AMERICAN PET. CORP. #1 USA - TOMBIGBEE FOREST 24 - 16N - 11E CHOCTAW CO., MISS. TD 14,444
5 EXXON CO. USA #1 FULGHAM 33 - 19N - 12E OKTIBBEHA CO., MISS. TD 20,950
6 TEXACO #1 SHEELY 28 - 19N - 12E OKTIBBEHA CO., MISS. TD 16,956
MABEN FIELD
7 SEABOARD OIL CORP. #1 WILLIAMS 35 - 13S - 1E CALHOUN CO., MISS. TD 9448
8 HONOLULU OIL CORP. #2 DAVIS 27 - 12S - 1E CALHOUN CO., MISS. TD 8016
9 ADAMS OIL & GAS CORP. #1 LEWELLEN 9 - 10S - 1W LAFAYETTE CO., MISS. TD 3436
TERTIARY
UPPER CRETACEOUS
LOWER CRETACEOUS
PENNSYLVANIAN
MISSISSIPPIAN
DEVONIAN
SILURIAN
ORDOVICIAN
KNOX
COPPER RIDGE
PRE-CAMBRIAN?
LOCATION INDEX MAP
STRATIGRAPHIC COLUMN
SYSTEM
SERIES
GROUP
FORMATION
MESOZOIC
PALEOZOIC
CRETACEOUS
JURASSIC
PERMIAN
ABSENT
PENNSYLVANIAN
UNDIFFERENTIATED
CHESTERIAN
MERAMECIAN
OSAGEAN
KINDERHOOKIAN
CHATTANOOGA SHALE
BRADFORDIAN
CONEWANGO
ULSTERIAN
HELDERBURG
LINDEN
"DEVONIAN CHERT"
NIAGRAN
CHAMPLAINIAN
TRENTON
BLACK RIVER
CANADIAN
KNOX
KNOX DOLOMITE
COPPER RIDGE DOLOMITE
CAMBRIAN
UPPER
MIDDLE
LOWER
CONASAUGA
CONASAUGA UNDIFFERENTIATED
ROME FORMATION
SHADY DOLOMITE
WEISNER QUARTZITE
PRECAMBRIAN BASEMENT - GRANITE
DETAILED LOCATION MAP
LAFAYETTE
CALHOUN
WEBSTER
CHOCTAW
OKTIBBEHA
WINSTON
NESHOBA
LAUDERDALE
NEWTON
Pickens-Gilbertown Fault System
MILES
STRUCTURAL CROSS-SECTION II
OUACHITA TREND
NEWTON, LAUDERDALE, NESHOBA, CHOCTAW
OKTIBBEHA, CALHOUN & LAFAYETTE CO.'S., MISS.
Geology by
Dora Devery & David E. Thompson, RPG
Office of Geology, Mississippi Department of Environmental Quality
May 2009
MDEQ
DATUM: SEA LEVEL
Modified from internal file, Placid Oil Company,
Jackson District, November 1981
(D. Devery & H. Wise)


CENTRAL MISSISSIPPI RIDGE
SW
NE
1 OCCIDENTAL PET. CORP. #1 ST. EXPL. CO. REIMERS 23 - 10N - 6E LEAKE CO., MISS. TD -10,442
2 CARTER OIL CO. #1 DENKMAN 31 - 11N - 7E LEAKE CO., MISS. TD -8968
3 PLAINS PROD. CO. #1 BREAZEALE 28 - 12N - 10E NESHOBA CO., MISS. TD -5734
4 FLANNES-STEINMETZ #1 FAIR LUMBER CO. 27 - 14N - 14E WINSTON CO., MISS. TD -4102
5 SHELL #1 PATTY 10 - 16N - 19E NOXUBEE CO., MISS. TD -8094
0 Sea Level
- 2000'
- 4000'
- 6000'
TERTIARY
UPPER CRETACEOUS
LOWER CRETACEOUS
JURASSIC
PENNSYLVANIAN
MISSISSIPPIAN
DEVONIAN
SILURIAN
ORDOVICIAN
KNOX
COPPER RIDGE
CONASAUGA
0 MILES 0 Ft
1 MILES 5,280 Ft
2 MILES 10,560 Ft
HORIZONTAL SCALE
SYSTEM
SERIES
GROUP
FORMATION
MESOZOIC
PALEOZOIC
CRETACEOUS
JURASSIC
PERMIAN
ABSENT
PENNSYLVANIAN
UNDIFFERENTIATED
MISSISSIPPIAN
CHESTERIAN
MERAMECIAN
OSAGEAN
KINDERHOOKIAN
CHATTANOOGA SHALE
DEVONIAN
BRADFORDIAN
CONEWANGO
ULSTERIAN
HELDERBURG
LINDEN
"DEVONIAN CHERT"
SILURIAN
NIAGRAN
ORDOVICIAN
CHAMPLAINIAN
TRENTON
BLACK RIVER
CANADIAN
KNOX
KNOX DOLOMITE
COPPER RIDGE DOLOMITE
CAMBRIAN
UPPER
MIDDLE
LOWER
CONASAUGA
CONASAUGA UNDIFFERENTIATED
ROME FORMATION
SHADY DOLOMITE
WEISNER QUARTZITE
PRECAMBRIAN BASEMENT - GRANITE
ATTALA
WINSTON
NOXUBEE
LEAKE
NESHOBA
KEMPER
MISSISSIPPI
ALABAMA
Buried Ouachita Tectonic Belt
Central Mississippi Ridge
Black Warrior Basin
Pickens-Gilbertown Fault System
Buried Appalachian Tectonic Belt
STRUCTURAL CROSS-SECTION III
OUACHITA TREND
LEAKE, NESHOBA, WINSTON, & NOXUBEE CO.'S., MISS.
Geology by
Dora Devery & David E. Thompson, RPG
Office of Geology, Mississippi Department of Environmental Quality
May 2009
MDEQ
DATUM: SEA LEVEL
Modified from internal file, Placid Oil Company, Jackson District, November 1981
(D. Devery & H. Wise)
LOCATION INDEX MAP
STRATIGRAPHIC COLUMN
DETAILED LOCATION MAP

A SLOPE TOO STEEP: SLUMPS IN THE YAZOO CLAY IN CENTRAL MISSISSIPPI

By David T. Dockery III, Office of Geology

The Yazoo Clay forms a physiographic region across central Mississippi known as the Jackson Prairie. This region consists of low rolling hills, mostly wooded with a mix of hardwoods and some pines, and some natural prairie land. The largest remaining natural prairie of the Jackson Prairie is the Harrell Prairie in Bienville National Forest in Scott County, a location selected for the September picture of Jerry Litton's *Narrative of Nature* calendar for 2010. When streams cut into the rolling hills of the Jackson Prairie, the Yazoo Clay of the cut bank fails in a series of en-echelon slumps until the slope reaches its natural grade. Such large slumps occur at Red Bluff on the east bank of the Chickasawhay River in Wayne County, just south of Shubuta.

So, what is the natural grade of a Yazoo Clay slope? I asked this question to Britt Maxwell of Maxwell Engineering in Jackson. Britt was also a classmate of mine (and of Michael Bograd) in geology at Mississippi State University and is one who has fixed many a failed structure on the Yazoo Clay. Britt said that he puts a slope no greater than 3:1 on the Yazoo Clay, but added that even this slope could fail though he hasn't seen it happen. Britt's 3:1 rule should apply: (1) whether a cut is made into a natural slope on Yazoo Clay, (2) whether a natural slope on Yazoo Clay is steepened with fill material, or (3) whether Yazoo Clay is used as construction fill.

Figure 1. Slump in Yazoo Clay on the north side of Interstate 20 west of Gallatin Street. Picture (digital) taken on February 10, 2010.

To see the “slopes too steep” on the Yazoo Clay in central Mississippi, one only has to ride the Interstate 20/Interstate 220 loop at Jackson, where rains and cold weather have taken their toll. There is: (1) a slump on the north side of I 20 West just west of Gallatin Street, where the slope failure may be in Yazoo Clay used as fill, (2) one on the northwest corner of the intersection of I 20 and Terry Road, and (3) one on the east side of I 220 North just north of the intersection with I 20, where the Yazoo Clay may have been used as fill. The fourth slump of note is behind the new Farmer’s Market; this slump threatens to undercut Jefferson Street.

The I 20/Gallatin Street slump is a small one and is a “frequent flier.” This slump is sometimes patched up, and sometimes tolerated, but never fixed (Figure 1). The buff brown soil in the slump’s toe and seen in the mound of dirt drilled from the foundation of the light pole is weathered Yazoo Clay, which was perhaps used as fill in the construction of I 20.

Figure 2. Work crew excavates slump toe from Terry Road at Interstate 20 and erects concrete barriers to keep the toe off the road. Picture (digital) taken on the afternoon of February 9, 2010.

The I 20/Terry Road slump is new and moved into the southbound lanes of Terry Road. Road crews excavated the toe of the slump from the road on February 9, 2010, and placed concrete barriers to prevent further movement onto the road (Figure 2). The slump fragmented the concrete apron of the I 20 bridge abutment as seen in Figure 3. Bridge abutments along I 20's right-of-way across the Yazoo Clay outcrop belt have had similar problems, as is evidenced by the rip-rap buttresses at bridge abutments beginning at Lake in Newton County to the east and continuing westward to just west of the I 20/I 220 interchange. One slope repair on the north side of I 20 near Forest, Mississippi, has a large rip-rap buttress and a system of underground and above-ground drains (Figure 4). The cost of this repair was such that one state worker claimed that for less money he could hire a bulldozer operator to work 24-7 to keep the slope in place.

The I 220/I 20 slump is new (Figure 5), but rip-rap to the south of it tells of a nearby slump that MDOT recently repaired with buttressing fill material (and the rip-rap toe). Together these slopes show that the interstate east slope is too steep. The Yazoo Clay involved in this slope failure may have been used as fill in the construction of this section of I 220; if so, it is Yazoo Clay fill on Yazoo Clay "bedrock."

The Farmer's Market slump is a new failure at a spot where a slump was repaired just last year (Figure 6). The repair was an economical one that was not billed as a permanent fix. This slump continues to grow and contains water in the sag ponds on top of the tilted slump blocks. The clarity of this water indicates that a broken city water main likely contributed to weakening of the soil and the resulting slope failure. At present, the slump scarp endangers a water line and fire plug and is a threat to Jefferson Street. I was taking pictures of the slump just as Dr. Zach Musselman of Millsaps College brought his geomorphology class to the slump on a field trip (Figure 7). Geomorphology is a field in geology that studies the earth's surface features and natural landscapes, a perfect class to be taught in Jackson's slumping and changing terrain.

Figure 3. Slump in Yazoo Clay on Terry Road at Interstate 20 in Jackson. Concrete barriers keep the slump toe off the road; the slump has fractured the concrete apron under the 1-20 bridge. Picture (digital) taken on February 10, 2010.

Figure 4. Rip-rap and concrete drain installed to prevent slumping in the Yazoo Clay on a roadcut north of the Interstate 20 west-bound lane near Forest, Mississippi. Picture (color negative 568-0A) taken on March 1, 2006.

Figure 5. Slump in the Yazoo Clay on the east side of Interstate 220 South near the I-20 interchange. Picture (digital) taken on February 10, 2010.

Figure 6. Slump in Yazoo Clay behind the new Farmer's Market. The slump scarp at top threatens a water main and Jefferson Street. Picture (digital) taken on February 18, 2010.

Figure 7. Dr. Zach Musselman (far left) and his geomorphology class from Millsaps College examine the Farmer's Market slump. Picture (digital) taken on February 18, 2010. I knew these students looked familiar when they showed up; they are also in my Invertebrate Paleontology class at Millsaps, and Alex Aguilar at the far right was in my Physical Geology class at Hinds Community College's Rankin County Campus.

JACKSON'S WATER CRISIS, JANUARY 2010

By David T. Dockery III, Office of Geology

The following is a verse from *The Rime of the Ancient Mariner* by Samuel Taylor Coleridge that has been changed by just a word (in bold) to explain Jackson's water crisis of January 2010.

Water, water, everywhere

And all the **pipes** did shrink;

Water, water, everywhere

Nor any drop to drink.

When Jessica Larche of Jackson's FOX40 News asked me for an interview concerning Jackson's broken water mains and the shifting Yazoo Clay, I was prepared to blame a combination of cold weather and the Yazoo Clay as the problem. After all, the clay does plenty of structural damage when it gets wet and swells; how much more damage could it do if the wet clay froze, and the water expanded another 9%. In preparation for the interview, I studied up on the damage done by cold-weather geologic processes such as frost heaving and ad-freezing. Ad-freezing requires a clay-rich soil such as the Yazoo Clay. When the upper clay layer freezes, water is drawn by capillary action from the clay below, adding to the ice at the top and increasing the soil thickness by as much as 30%. Such winter-time freezing in more northern climates can lift foundations. For this reason building inspectors require that foundations be built below the frost line, the average depth of winter freezing in that area. Even with deep foundations, frozen soil can freeze to unheated basement walls and lift the walls above their foundations.

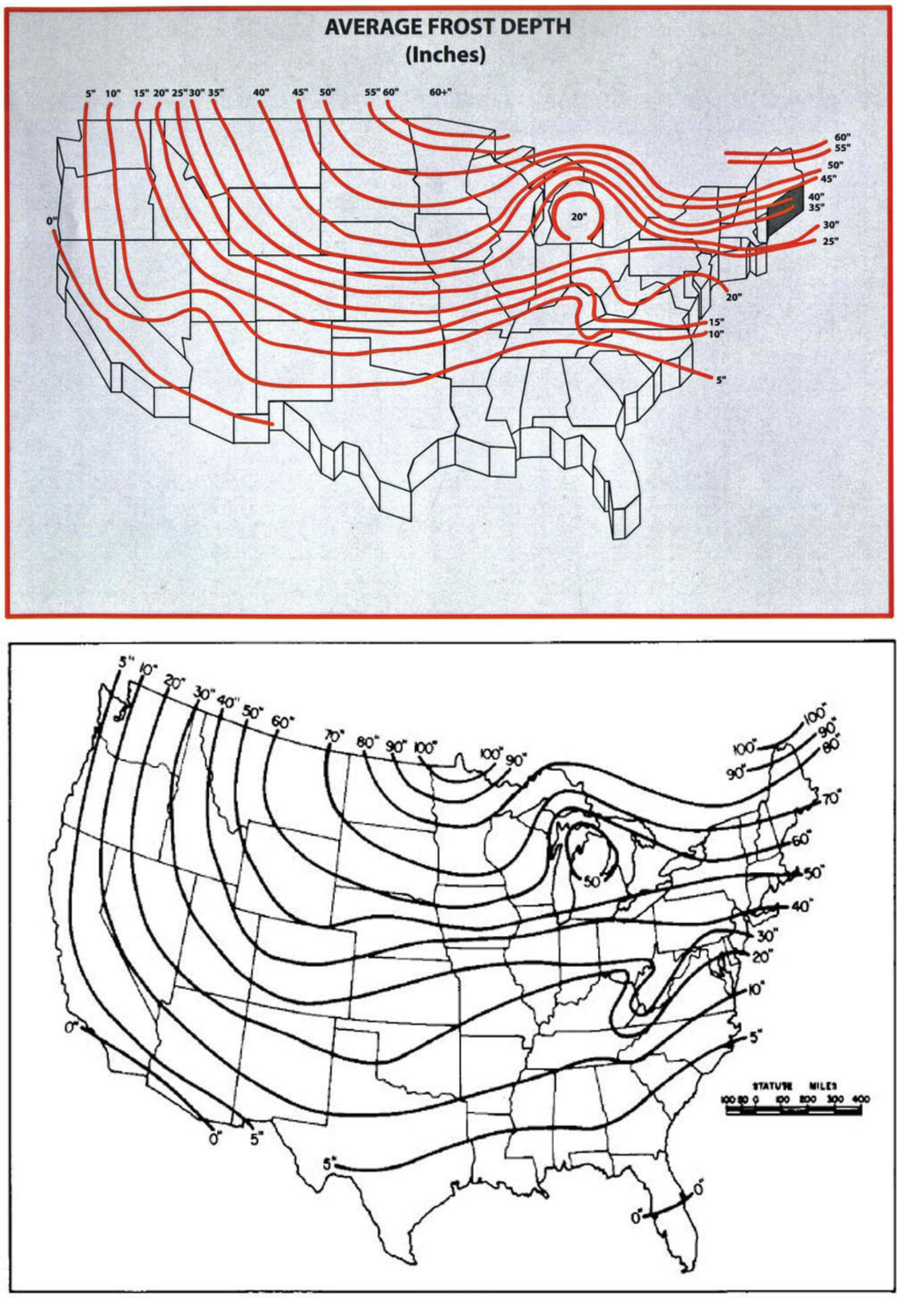


Figure 1, Top, average frost depth in inches; bottom, extreme frost penetration in inches based upon state average.

I ran some of my ideas about frozen clay and broken pipes by Eddie Templeton with Burns Cooley Dennis, Inc., Geotechnical and Materials Engineering Consultants. Eddie cautioned me that the Yazoo Clay was only part of the problem; the main problem was cold surface water running through the pipes. In my thinking, the cold water could only be 32° F; while frozen ground could be much colder. I tried in several email exchanges to bring Eddie over to my side. One reason I believed frozen Yazoo Clay was the problem was that I had heard and read so many times that the cold weather caused the clay to shift and the pipes to break. Checking online, I found the same thing said in other cities plagued with water main breaks. The maps shown in Figure 1 are the reasons I conceded. The frost line in Mississippi in a normal winter is much less that 5 inches deep (Figure 1, top), and in a severe winter is at best 5 inches deep (Figure 1, bottom). Even in especially severe cold spells, the depth of frozen ground increases at a rate of only one inch per day. I had no good explanation of how five inches of frozen ground could break a water main buried four feet below the surface. Then I found that other engineers I talked with agreed with Templeton that the especially cold surface water running through Jackson's water mains caused the old, brittle, cast iron pipes to shrink and break. One of those who agreed with this explanation was Rob Ritchey; Rob worked for Jackson's Public Works Department for 18 years before working for the City of Clinton's Public Works the last 9 years.

Figure 2. Meg Myers and Ken McCarley inspecting a supposed spring with 82 degree F water on a hilltop in Rankin County. The "spring" proved to be a broken 2-inch water line. Picture (slide #348-7) taken on February 13, 2002.

One question Jessica asked in the interview (on February 19, 2010) was why were the Jackson water mains breaking and not those of the surrounding cities? The answer I gave, which was not aired, was that surrounding cities use groundwater for their water supply. Deep water wells produce water with temperatures ranging between 80° F and 90° F and sometimes higher; so these cities had warm water running though their water mains. Though well water is pumped into water tanks exposed to cold air, it doesn't stay there long enough to cool down much. One example of this was a supposed spring I (and others) inspected in Rankin County on a cold day on February 13, 2002. The problems with this spring were that it was on a hilltop rather than at the base of a hill, and the water was warm (Figure 2).

Figure 3. Cell phone picture taken by a duck hunter of frozen water at Pine Islands on the Rankin County side of the Ross Barnett Reservoir. Picture taken by James Starnes at about 8:00 a.m. on Tuesday, January 12, 2010, after state employees were sent home on Monday at noon.

We were told that the spring had been there some 20 years; it had carved a nice ravine down the hill side. Spring water in central Mississippi has a temperature of about 65° F, the ambient temperature of shallow aquifers in the region. The "spring" water we measured with a laboratory-grade mercury thermometer was 82° F. When we reported this to Wilbur Baughman, a water-well contractor who once worked for the Mississippi Geological Survey and wrote the Rankin County Geology Bulletin, he said "That's Sparta water," Sparta being the name of a deep aquifer. We notified the Greenfield Water Association of our findings; they later found the "spring" to be a break in one of their 2-inch pipes.

Unlike groundwater, the surface-water temperature of Jackson's water supply from the Ross Barnett Reservoir is highly variable. The reservoir is a very large lake, but with an average depth of only ten feet. When I told Jessica that cold reservoir water was the reason that Jackson water mains shrunk and broke, she was surprised and said she hadn't heard that explanation before (nor had I before I prepared for the interview).

The Ross Barnett Reservoir was partially frozen over (Figure 3) during a 67-hour period below freezing from January 7 through January 10, 2010. To find the actual water temperature at the intake of Jackson's water system, I used information from Jackson State University's Ross Barnett Reservoir Flux Station operated by Dr. Heping Liu and his team of the Department of Physics, Atmospheric Sciences, & Geoscience.

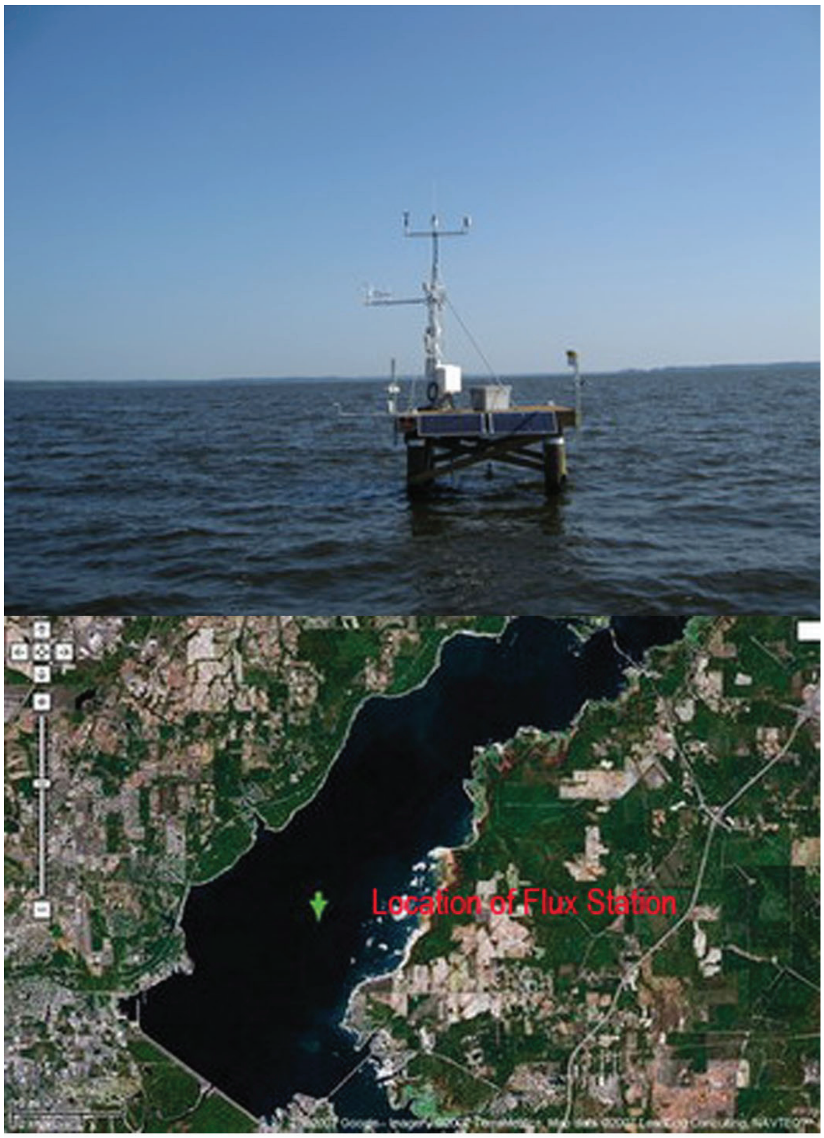


Figure 4. Top, the Ross Barnett Reservoir Flux Station operated by the Micrometeorology Laboratory at Jackson State University in collaboration with the Pearl River Valley Water Supply District; Bottom, location of the station within the reservoir.

With support from the Pearl River Valley Water Supply District, the JSU station was established in August of 2007 by the university's Micrometeorology Laboratory and is located in the middle of the reservoir. It measures air temperature, wind speed and direction, and water temperature at three depths (Figure 4). Figure 5 is a chart of air and water (at three depths) temperatures for the Ross Barnett Reservoir from January 1, 2010, to February 20, 2010. Each tick along the horizontal bottom line marks a five-day period. The chart shows about a three-day lag between the coldest air temperatures and the coldest water temperatures. After air temperatures fell below -5° C on January 7, the reservoir water temperature fell to about 3° C on January 10. Governor Barbour issued a State of Emergency declaration at noon on Monday January 11, due to broken water mains and the loss of water pressure in the City of Jackson, and sent state employees home.

Addendum: Since the writing of this article in late February, Baptist Hospital (Figure 6) and the Mississippi Department of Transportation (Figure 7) have contracted with the Donald Smith Company to drill their own water wells in downtown Jackson to provide a dependable water supply should there be a repeat of the February water crisis. These wells will be drilled to a depth of 800 feet to tap the Sparta aquifer.

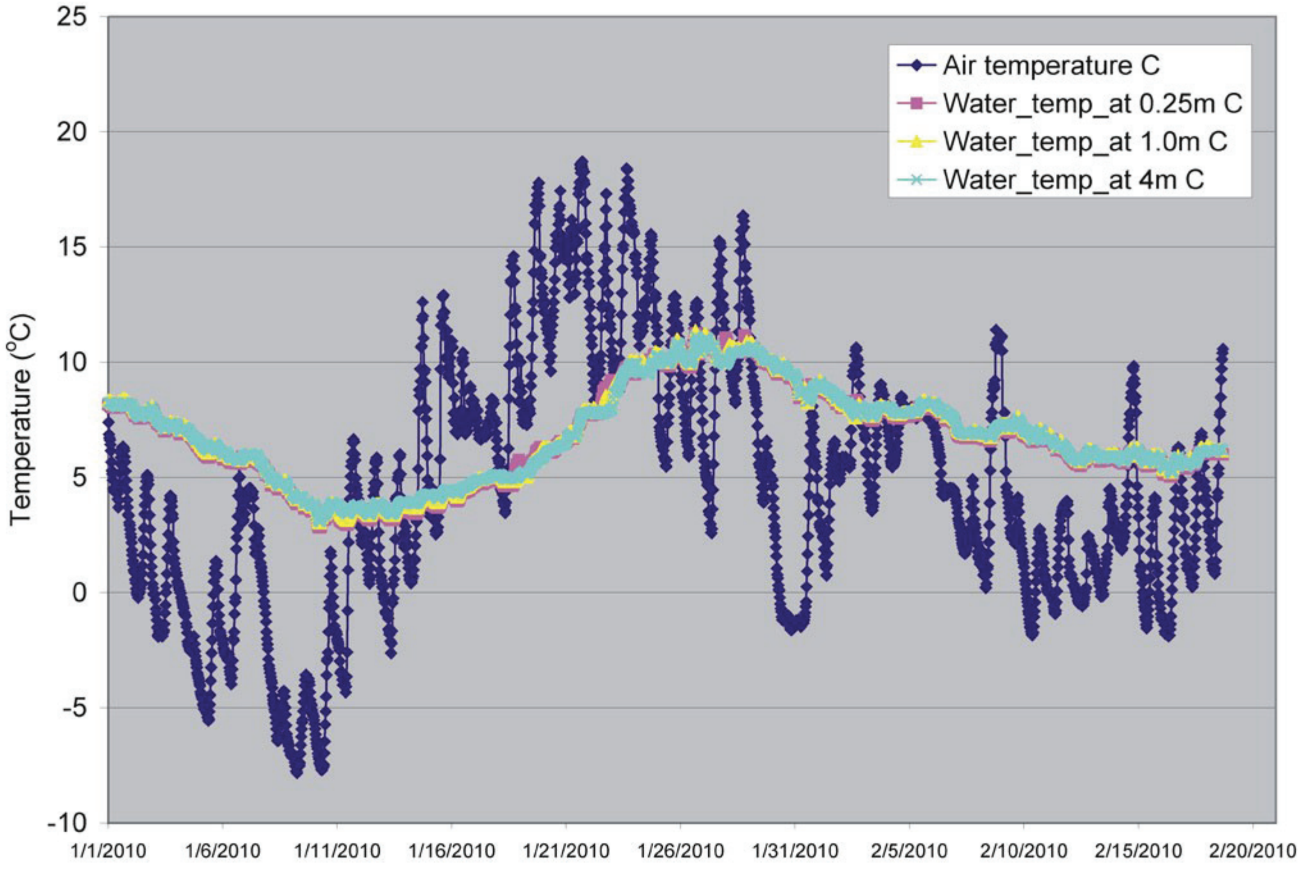


Figure 5. Air temperature in dark blue and water temperature in light blue (at 4 meters depth), yellow (at 1 meter depth) and purple (at 0.25 meter depth) in degrees centigrade (C). Record from the Ross Barnett Reservoir Flux Station from January 1 to February 20, 2010.

Figure 6. Drilling of an eight-hundred-foot-deep well in the Sparta aquifer by Donal Smith Company for the Baptist Hospital. Picture (digital) taken on June 22, 2010.

Figure 7. Drilling of an eight-hundred-foot-deep well in the Sparta aquifer by the Donald Smith Company for the Mississippi Department of Transportation. Picture (digital) taken on July 22, 2010.

THE NEW ORLEANS BARRIER SAND TREND AND KATRINA

David T. Dockery III, Mississippi Office of Geology

Stephen A. Nelson, Department of Earth and Environmental Sciences, Tulane University

August 29, 2010, marked the fifth anniversary of the landfall of Hurricane Katrina on the Mississippi Gulf Coast and the destruction of much of the Mississippi coastal area and the destruction of large sections of a major American city, New Orleans. Though initial news reports suggested that New Orleans had dodged another bullet, the city was doomed to flood from two directions, one from a storm surge on the Intracoastal Waterway to the east and a second from a storm surge from Lake Pontchartrain to the north. The following is a geological explanation as to why the London Avenue Canal leading to Lake Pontchartrain failed. This explanation begins with the New Orleans area as it was 5,000 years ago.

A rise in sea level after the Wisconsin Ice Age brought the retreating Gulf Coast shoreline to the New Orleans area about 5,000 years ago. At this time an east-west spit, extending from the mouth of the Pearl River, grew westward to form a barrier island at present-day New Orleans. This barrier island sand body is variously named the "Pine Island Barrier Spit" or the "New Orleans Barrier Trend" and is now buried beneath the City of New Orleans. Covering the barrier sands are more recent fluvial and deltaic sediments. As shown in Figure 1, the spit underlies the southern shore of Lake Pontchartrain, where it is encountered on occasion during construction work and excavations

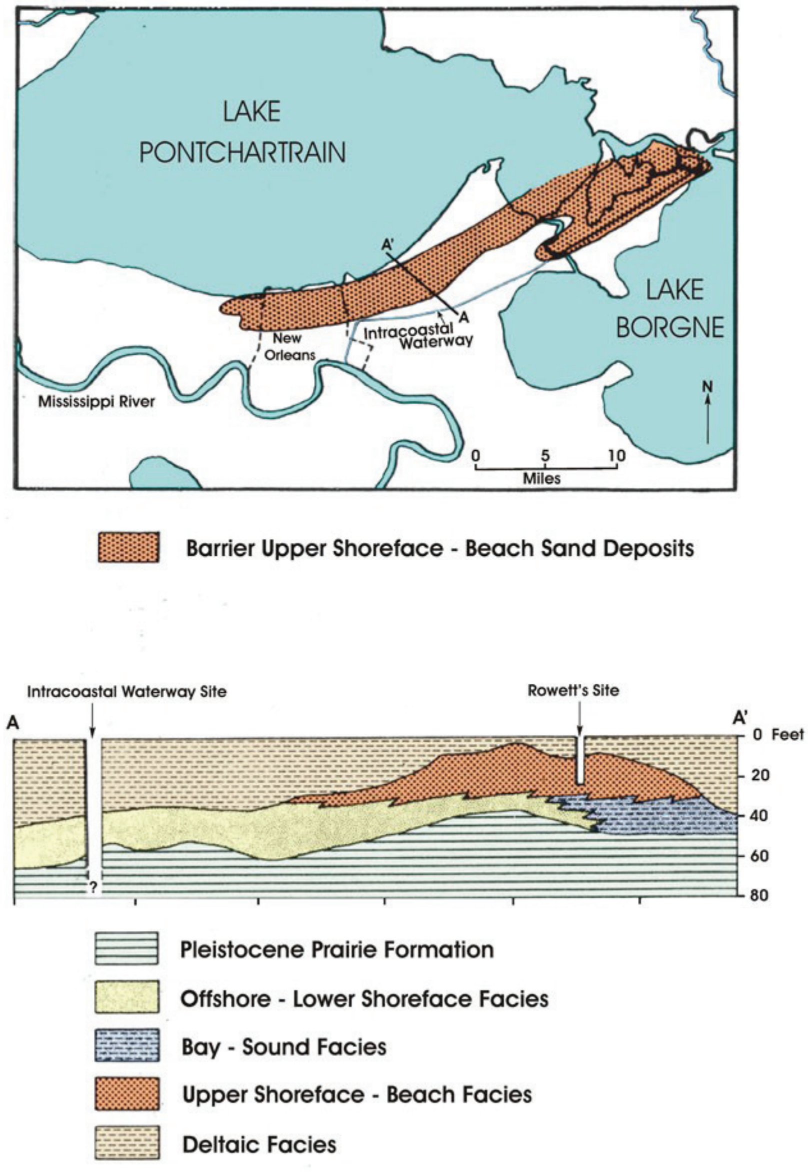


Figure 1. Distribution of upper shoreface-beach sands in the New Orleans Barrier Trend and cross section of the barrier facies with two locations where seashells were found (figure from the publication of Hollander and Dockery, 1977).

Figure 2. Invertebrate Paleontology students at Tulane University preparing for a field trip to collect seashells from the Intracoastal Waterway dredge piles. Picture (slide #10-13) taken in April of 1976.

Evidence that the New Orleans Barrier Trend was a barrier island much like those off the coast of Mississippi today came from the dredging of the Intracoastal Waterway on the east side of the city in September of 1975. Here dredge work cut through sands seaward of the island and brought up an abundance of seashells similar to those presently living in the northern Gulf of Mexico. At the time, I (Dockery) was a graduate student at Tulane University and was teaching the lab for an Invertebrate Paleontology class. The students were assigned a class project to salvage fossil shells dredged from the Intracoastal Waterway (figures 2-4). Another Tulane graduate student and biology major, Eileen Hollander, worked with me to publish and illustrate some 95 molluscan species from the site. One particularly large shell that survived the passage through the dredge pump was a large whelk of the species *Busycon contrarium* (Figure 5). The species was named *contrarium* because of the shell's left-handed coil rather than a right-handed one as is common for most gastropod (snail) shells.

Figure 3. Tulane students collecting shells dredged from the Intracoastal Waterway east of New Orleans. Eileen Hollander is at far left. Picture (slide #10-15) taken in April of 1976.

Figure 4. Seashells in dredge piles along the Intracoastal Waterway east of New Orleans. Picture (slide #10-10) taken in April of 1976.

The New Orleans Barrier Trend proved to be one factor that contributed to levee failures during Hurricane Katrina's storm surge. When Hurricane Katrina struck the Gulf Coast on Monday August 29, 2005, NOAA's buoy about 50 miles off the mouth of the Mississippi River recorded 40-foot waves at 3:00 AM; two hours later these waves reached a height of 46 feet. Katrina's storm surge of some 18 feet, two feet higher than the levee tops in eastern New Orleans, arrived in the city from the Gulf of Mexico by way of the Intracoastal Waterway (Figure 6), overtopping the waterway's levees along the way. Levees along the New Orleans Industrial Canal connecting the Mississippi River and Lake Pontchartrain were overtopped and breached by 7:00 AM, flooding areas north of the French Quarter. A catastrophic failure of the canal's eastern floodwall and levee devastated the city's Lower Ninth Ward.

Figure 5. Shell of the large whelk *Busycon contrarium* (Conrad, 1840) dredged from the Intracoastal Waterway east of New Orleans. Picture (digital) taken on January 27, 2010.

Figure 6. Katrina storm surge with high waves topping the levee on the north side of the Intracoastal Waterway right under the Paris Road/Highway 47 bridge. Picture taken by someone at the Entergy Power Plant in the early morning of August 29, 2005.

When Hurricane Katrina made landfall on the Mississippi Gulf coast, many New Orleans residents awoke that morning thinking that the city had dodged another hurricane "bullet." However, by 8:00 AM, New Orleans Mayor Nagin told the audience of NBC's *Today Show* that the city's levees had been breached and that the city was flooding. Soon after this announcement and as the hurricane moved inland, the storm surge from Lake Pontchartrain entered canals designed to drain the city's rainwater, resulting in the catastrophic failure of levees at two sites on the London Avenue Canal. These sites were not overtopped but failed as high water piped through sands of the New Orleans Barrier Trend and undermined the levee's foundations. Figure 7 shows the presence of the barrier sand, labeled the "Pine Island/Beach Sands," under the flood wall along the southern shore of Lake Pontchartrain. Figure 8 shows how the storm surge seeped through the barrier sands to undermine the floodwall at the south breach on the London Avenue Canal. Homes near the breach were extensively damaged and filled with sand in a type of flood deposit called a crevasse splay. The London Avenue Canal crevasse splay buried cars and yards under some 26,380 cubic meters of sand and gravel-size clay balls (Nelson and Leclair, Katrina's unique splay deposits in a New Orleans neighborhood: *GSA Today*, September 2006, p. 4-10). These deposits also contained seashells, like those collected by Tulane students from the Intracoastal Waterway dredge piles. Among the splay-deposit shells was the large clam *Dinocardium robustum*, a clam common in the forementioned dredge piles and common today along the seaward side of Mississippi's barrier islands, especially the southern shore of Ship Island.

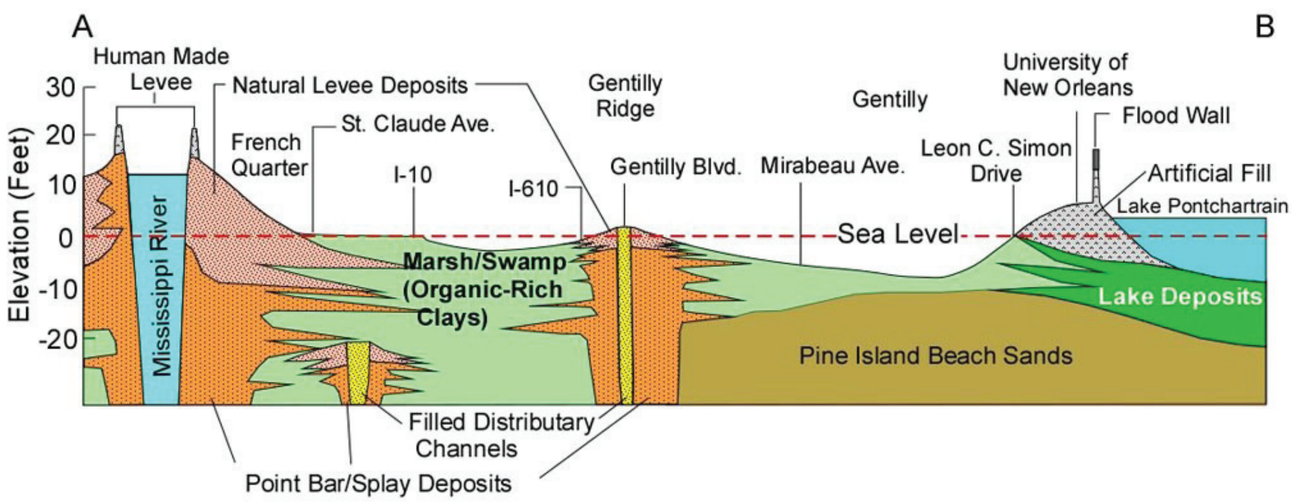


Figure 7. Geologic and topographic profile across New Orleans, showing Gentilly Ridge.

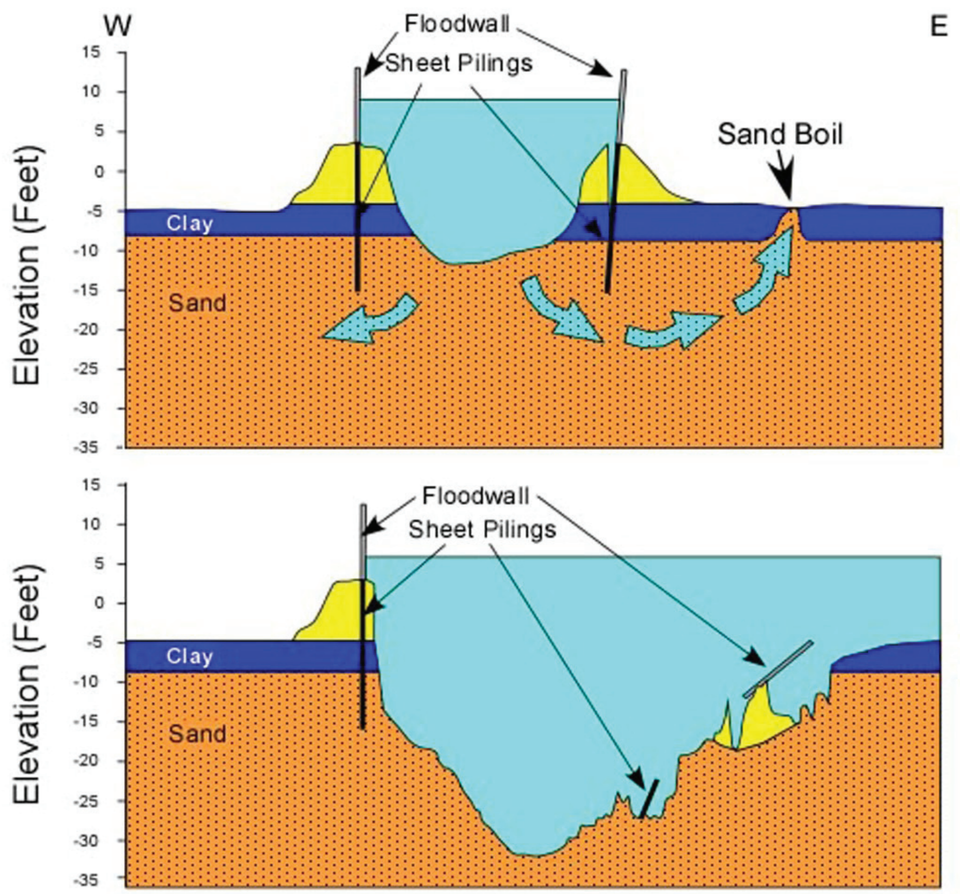
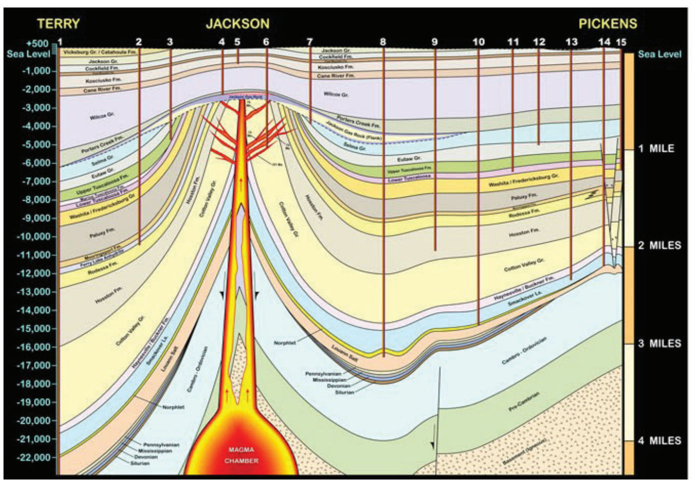


Figure 8. Seepage and piping through the New Orleans barrier sand at the London Avenue Canal south breach.

Just Geology 2008-2009



Just Geology 2008-2009

Just Geology 2008-2009 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:

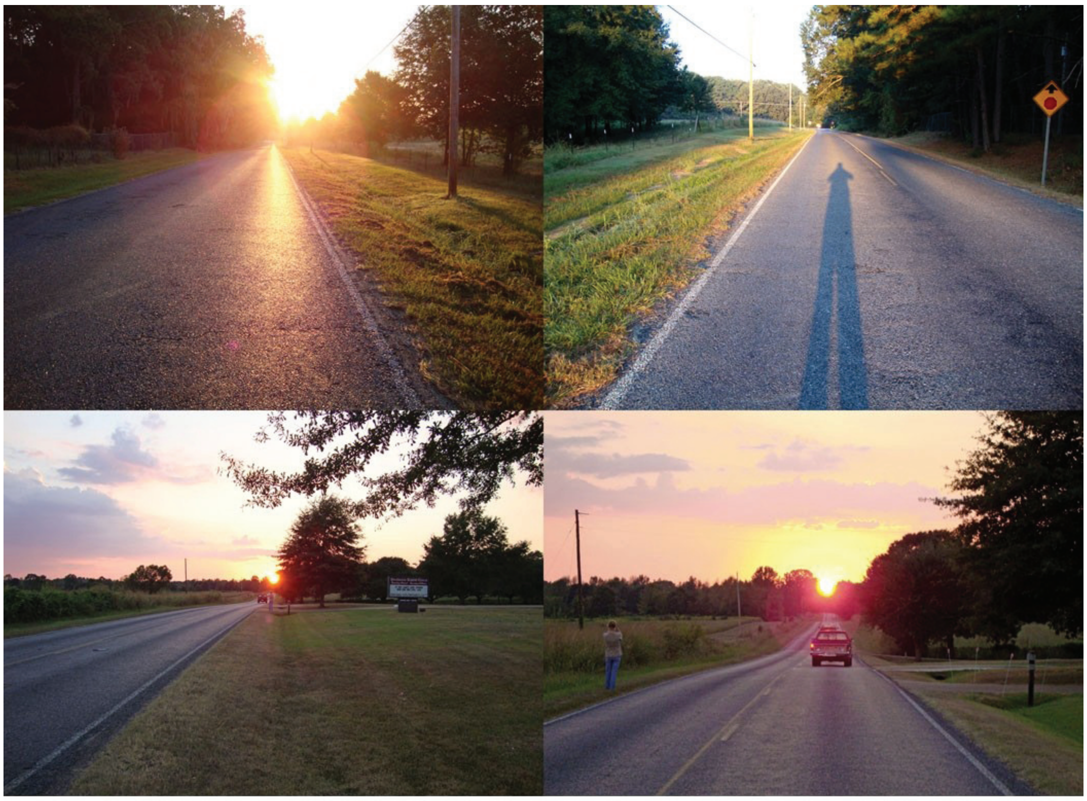
http://www.deq.state.ms.us/MDEQ.nsf/pdf/Geology_JustGeology20082009/$File/89850%20Just%20Geology%20Book%20Final.pdf?OpenElement.

THE 2010 AUTUMNAL EQUINOX

David T. Dockery III, MDEQ Office of Geology

On the last day of summer (the autumnal equinox) and the last day of winter (the vernal equinox), the sun rises due east and sets due west. This can be difficult for those who live on an east-west-running road and have to drive to work in the face of a blinding sunrise as can be seen in the upper-left picture. The 2010 autumnal equinox was special as it coincided with a full harvest moon, an event which Brian Williams reported on the September 22nd NBC nightly news, as well as reporting the visible presence of both Jupiter and Uranus in the night sky. But there was even more on the following day, the first day of fall. Toward the end of summer, Venus and Jupiter were brilliant in the evening sky after sunset, Venus above the western horizon and Jupiter above the eastern horizon. Venus is the third brightest object in the sky and was in its brightest phase on the opposite side of the sun from Earth; when it is closest to Earth, we see, or don't see, its dark side. For the opposite reason, Jupiter was in its brightest appearance because it was in its closest approach to Earth. Venus set just after the sunset on September 23, as the full moon rose with Jupiter, the fourth brightest object in the sky, rising level with the moon on the moon's right side. So what did all this mean?

The following were a series of coinciding astronomical events that occurred in the evening sky on September 23. Every 14 years Jupiter, which orbits the sun about every 12 Earth years, catches up with Uranus, which orbits the sun every 84 years, and comes between it and the sun, thus heliocentrically Jupiter conjoins Uranus as happened on September 23. Curiously, on this same day, Earth caught up with Jupiter and Uranus, and the three planets were conjoined in alignment. At this time of alignment, the harvest full moon was opposite the sun and was also conjoined with the Earth, Jupiter, and Uranus. Venus was nearly opposite the sun from the Earth. Thus on the evening of September 23, 2010, Venus, the sun, Earth, the moon, Jupiter, and Uranus were roughly aligned.



Top: Sunrise on the last day of summer, rising due east as viewed from the west end of east-west-running Kickapoo Road (left), making my shadow cast due west (right). **Bottom**: Sunset on the last day of summer, setting due west on the autumnal equinox as viewed from the east end of Kickapoo Road in front of Pocahontas Baptist Church. Pictures taken at 7:10 a.m. and about 7:00 p.m. Daylight Saving Time on September 22, 2010.

Environmental News, November 2010, volume 7, issue 9, pages 9-11.

THE MISSISSIPPI GEOLOGICAL SURVEY 150, 100, AND 50 YEARS AGO

Michael B. E. Bograd, MDEQ Office of Geology

The Mississippi Geological Survey, now named the Office of Geology of the Mississippi Department of Environmental Quality (MDEQ), has a long history mapping the state's geology, mineral resources, soils, agricultural resources, forest resources, and topography. In its early years, it served as a geological and natural history survey, and started work that later was carried on by state agricultural, forestry, and water management agencies. Today it is focused on mapping surface geology and economic mineral resources, collecting information on subsurface geology, compiling digital map data, and regulating mine reclamation. It is instructive to study how the Geological Survey evolved with changing societal needs to provide information vital to the economy of the state.

1860

In 1860 the Mississippi Geological Survey was located at the University of Mississippi, where the State Geologist served also as a professor. The office was in a front room of the Lyceum, and collections of rocks, soils, minerals, and fossils were displayed in the University Museum. The Survey maintained an office also in Jackson in the state Capitol building, which we know today as the Old Capitol. That year Dr. Eugene W. Hilgard published the "Report on the Geology and Agriculture of the State of Mississippi," which served as the key reference on those topics for over half a century. This was the third report on the geology of Mississippi since the establishment of the Mississippi Geological Survey in 1850. Dr. Hilgard was the fourth State Geologist of Mississippi, serving from 1858 to 1866; he served later as the sixth State Geologist, 1870 to 1872. These were difficult times for the State of Mississippi, but the appropriations for the Survey were maintained by the state in 1861 and throughout the Civil War, and Dr. Hilgard remained on duty.

The State Geologist in 1860 was Dr. Eugene W. Hilgard. His bust and field kit are at the University of California, Berkeley.

The first half of Hilgard's "Report" described the geology of the state. It started with the Orange Sand, a widespread unit of uncertain age. Then the geologic units were described from oldest to youngest. The lithology and terrain underlying each unit were described, including characteristic fossils and occurrence of economic mineral resources. Hilgard described a structural anomaly at Jackson that 70 years later was drilled and produced natural gas from a carbonate reef overlying a buried extinct volcano. The agriculture section of the report encompassed pages 202-388. It started with a section on Principles of Rational Agriculture, including a scientific definition of soils and a primer on agricultural chemistry. Then the several regions of the state were described in turn, including soils, vegetation, lay of the land, erosion problems, sources of water, and other agricultural considerations. Mississippi was an agricultural state at this time, and Hilgard directed his inquiries toward serving the needs of the farmers. His studies of soils during his years in Mississippi served him later as a founder of soil science; he later went to the University of California and developed the concept of an agricultural experiment station.

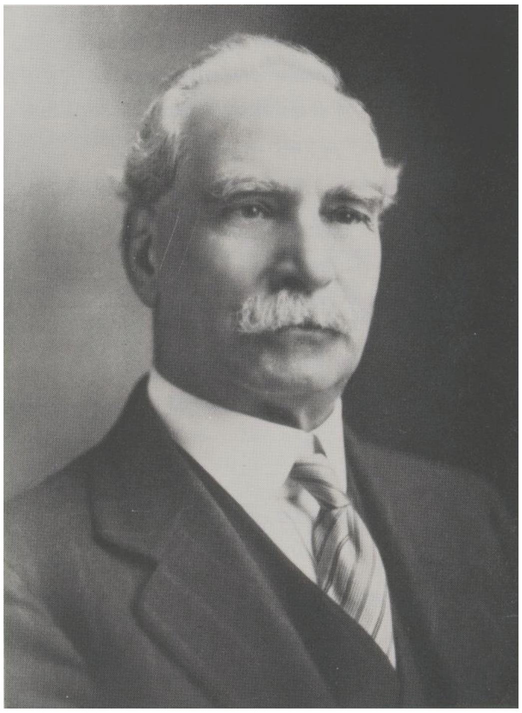
Dr. Eugene W. Hilgard's field kit

The state geologic map in Hilgard's "Report" was printed in color at the scale of one inch equals approximately 25 miles, or 1:1,584,000. It showed one Carboniferous unit, four Cretaceous units, seven Tertiary units, and the Bluff Formation and Mississippi Bottom as "Post Tertiary."

1910

In 1910 the Survey recently had relocated to Jackson (from Biloxi; it's a long story) and was housed in the New Capitol for a time and then back to the Old Capitol. The State Geologist was Ephraim Noble Lowe, MD. Dr. Lowe was among the last of the professional men who trained as medical doctors and pursued careers in geology and other sciences. He served as the eighth State Geologist, 1909-1933. In 1910 the Survey was working on county soil surveys in cooperation with the U.S. Bureau of Soils (while mapping topography with plane table and alidade), was working on stratigraphy and groundwater resources of the state (including groundwater chemical analyses) in cooperation with the U.S. Geological Survey, published a bulletin on the forest resources of Mississippi (Bulletin 7, 1910), and was completing bulletins on soils and on structural (road-making) materials. A new state geologic map had been published in 1907, but geologic mapping at this time was on a statewide reconnaissance scale.

This year the Survey assembled an exhibit in seven display cases in the front corridor of the Capitol illustrating the state's geology and mineral resources. One case had a display of the native woods of the state. The other six cases held specimens of pottery, "brick and tile clays, building stones, cut and polished, cement materials, bituminous rock, lignite, road-making materials, iron ores, a large collection of soils," and plant and animal fossils (from the Third Biennial Report of the Mississippi Geological Survey Commission).



The State Geologist in 1910 was

Dr. Ephraim Noble Lowe.

1960

The State Geologist in 1960 was Tracy Wallace Lusk.

The Mississippi Geological Survey had returned to the Ole Miss campus in 1924, and in 1960 was housed in Ventress Hall, also called the Old Library Building. Though still based on campus, after 1958 the State Geologist no longer served as a professor of geology at the university. Tracy Wallace Lusk was the tenth State Geologist of Mississippi, serving from 1958 to 1962.

By 1960 the Survey was publishing annually one or more county geologic bulletins with county geologic maps at a scale of one inch equals two miles. In 1960 and 1961, the Survey published three county geologic bulletins, a report on water supplies in northern Mississippi, and two bulletins on the geomorphology, stratigraphy, and structure along highways 16 and 80. The highway bulletins were done in cooperation with the Mississippi State Highway Department. The water resources studies and the groundwater resources sections of the county geologic bulletins were cooperative efforts of the U.S. Geological Survey, the Mississippi Geological Survey, and the Mississippi Board of Water Commissioners (now the MDEQ Office of Land and Water Resources). The Sample Library in Jackson (at the 2525 North West Street building) was first occupied in June 1960.

In the mid twentieth century, the Survey's surface geologic mapping focused on identification of industrial minerals (e.g., sand and gravel for road building, lime for cement manufacture, clay for making bricks and ceramics) and on locating structures indicative of potential oil and gas traps. The Sample Library was built in Jackson, with contributions from oil and gas companies, to serve the petroleum industry based in central Mississippi. A severe drought in 1952-1953 spurred mapping in support of water resources investigations.

Office of Geology drilling rig

HOLDING BACK THE YAZOO CLAY AT THE FARMERS' MARKET

David T. Dockery III, Office of Geology

You've probably seen a wall built from bottom to top, but have you ever seen a wall built from top to bottom? It was a top-to-bottom wall that Burns Cooley Dennis, Inc., designed and Hayward Baker Geotechnical Construction built to hold back the Yazoo Clay at the Farmers' Market on the Fairgrounds at Jackson. This is the same team that worked together to build the hundred-foot-high retaining wall along the bluff line at Natchez and the retaining wall on the bluff side of the Ameristar parking lot at Vicksburg.

Figure 1. Left: Adding and compacting fill material to the upper slope behind the Farmer's Market on July 19, 2010. Right: New failure in the Yazoo Clay of the upper slope the following day on July 20, 2010. (Image 1681).

On April 8, 2009, I went to see the newly repaired slope below Jefferson Street and behind the Farmer's Market parking lot. Yazoo Clay had been removed from the failed slope and replaced with non-expansive fill dirt, which was freshly landscaped at the time. Less than a year later on February 10, 2010, I returned to see a complete failure of that same slope (see the May 2010 issue of *Environmental News*, page 20). At risk were the Farmers' Market parking lot, Jefferson Street, and water mains beside and under Jefferson Street. The repair design to fix the failed slope was a shotcrete wall anchored by soil nails. The term "soil nail" is not the most reader-friendly term to explain the structures that secured the wall. Soil pilings better describe the 35 to 45-foot-long grouted-rebar structures that are drilled, inserted, and grouted at a 10-20 degree angle to the horizon. Some 160 soil nails were placed to hold the shotcrete wall, a welded-wire-mesh-reinforced wall that would be only about 6 inches thick. A photographic record of the wall's construction was kept from July 19 to August 16, 2010, as shown in the accompanying figures.

The upper tier of the wall was constructed first with soil nails at a 20-degree slope below the horizon and on centers spaced four to five feet apart. The middle and bottom tiers of the wall had soil nails with a 10-degree slope and with a similar spacing. Soil nails had a vertical spacing of about five to six feet. The finished wall had a 1 to 2 slope, one foot horizontal for two feet vertical, and the grassed slope at the base of the wall was 6 to 1, six feet horizontal for each foot vertical. Figure 1 shows the dirt work in preparation for the wall construction. Figures 2-4 show the construction of the wall's upper tier. After this construction, an afternoon storm complicated work as water poured out from behind the wall at the contact of the Yazoo Clay and adjacent fill material. When the rain stopped, the water flow continued, leading to the discovery of a leak in a 6-inch city water main behind the wall. This leak was repaired by the city, and the leaky south end of the middle tier was sealed with shotcrete.

Figure 2. Left: The yellow cross marks the spot for drilling the hole for the second soil nail in the upper tier of the Farmer's Market retaining wall. Right: Rebar protrudes from five holes, while a sixth hole is being reamed out. The white hose is for pumping grout. Pictures taken on July 28, 2010. (Image 1682)

Figure 3. Left: Rebar and spacers for soil nails. Right: Forms, grouted rebar (soil nails), and welded wire mesh of the upper tier of the Farmer's Market retaining wall. Pictures taken on July 28 (left) and July 31, 2010. (Image 1683)

Figure 4. Left and right: Spraying shotcrete onto the welded wire mesh of the upper tier of the Farmer's Market retaining wall. Pictures taken on August 2, 2010. (Image 1684)

Figures 5 and 6 show the construction of the middle and lower tiers of the retaining wall, including the effort to insert rebar into drill holes after a rainstorm. Figure 7 shows the wall's finishing touches as it is sprayed over with a buff-brown grout to make it look natural, like dirt. When you shop at the Farmers' Market, be sure to see the newly landscaped wall.

Figure 5. Left: Workers hurry to insert rebar into drill holes in the south end of the middle tier after an afternoon storm sends water pouring in from behind the wall at the contact of brown Yazoo Clay and red fill dirt just to the right of the man at far left. A leak in a 6-inch city water main was discovered, which contributed to the flow; the leak was repaired by the city that evening. Right: Cement truck pours shotcrete into hopper where it is pumped through a hose and sprayed onto the soil nails and welded wire mesh on the troubled south end of the middle tier to seal the leak site behind the Farmer's Market retaining wall. Pictures taken on August 4 (left) and August 6, 2010 (right). (Image 1685)

Figure 6. Left: Welded wire mesh is checked before shotcrete is sprayed on the north end of the wall's middle tier. The black vertical strips are drains to prevent the accumulation of water behind the wall. Right: Holes are drilled for the soil nails of the lower tier of the Farmer's Market retaining wall. Drain pipes are visible at the base of the wall. Pictures taken on August 9 (left) and August 11, 2010 (right). (Image 1686)

Figure 7. Left: Shotcrete is sprayed onto the welded wire mesh of the lower tier of the Farmer's Market retaining wall. Right: A brown dirt-colored grout is sprayed over the entire retaining wall to give it a natural appearance (like dirt). Water drains can be seen protruding from the base of the wall. Pictures taken on August 12 (left) and August 16, 2010 (right). (Image 1687)

Environmental News, January 2011, volume 8, issue 1, pages 12-14.

OPENING OF THE MISSISSIPPI CHILDREN'S MUSEUM

David T. Dockery III, Office of Geology

The Mississippi Department of Environmental Quality and the Office of Geology have worked with the Mississippi Children's Museum Partners, the Junior League of Jackson, and others in two statewide educational fairs (see the April 2009 and the July 2010 issues of *Environmental News*) and the design of the Mississippi Children's Museum's geological exhibits. Geological exhibits at the museum include oil-well drilling, a fossil whale dig, a seismic station, and fossil whale bones. One of the museum's main displays is a raised model of the State of Mississippi, which contains a volcano room under the City of Jackson and connecting tunnels with fossil shells embedded in the walls. The fossil shells for the tunnel walls were collected for that purpose by the Millsaps College spring 2010 Invertebrate Paleontology class, during a field trip to the Cretaceous of northeastern Mississippi. On that trip, about a hundred pounds of fossil oyster shells were collected from the Birmingham Ridge Lime Quarry northwest of Tupelo. Fossil shells not used by the Children's Museum were offered free to visitors at the Office of Geology's fossil exhibit at the museum's public opening on Saturday, December 4, 2010.

Figure 1. The Fossil Tent (left) sponsored by the Office of Geology with fossil oysters of the species *Exogyra cancellata* and *Pycnodonta mutabilis* of Cretaceous age from Lee County, Mississippi, to be given away to those visiting the exhibit. At right are a Choctaw mother and son; the son has found a use for his fossil oyster shells as saucers to hold his acorn collection. Picture (digital) taken on December 4, 2010.

Children's Museum cont.

The Office of Geology fossil exhibit for the public opening of the Mississippi Children's Museum was situated in a 20 by 20-foot tent in front of the neighboring Mississippi Museum of Natural Science and with a front-row seat of the opening parade. Gusty winds from an approaching cold front dismantled the fossil exhibit's standing backdrops and displays, leaving the fossil tent with only rocks and fossils exhibited on the tent's five tables (Figure 1). Passing in review beside the tent were a band and a number of celebrities, including Elvis, the cast of the *Wizard of Oz*, and the Grinch (Figure 2). Other celebrities included the lion cast of *Between the Lions*, Sammy Soil, and the Mad Scientists (Figure 3). Performing beside the fossil tent were a high school group, that gave a *Reject All Tobacco* message in dance, and the Choctaw dancers (Figure 4).

Figure 2. Celebrities at the opening of the Children's Museum included Elvis (at left) and the cast from the *Wizard of Oz*--plus the Grinch (at right). Picture (digital) taken on December 4, 2010.

Figure 3. Additional celebrities at the opening of the Children's Museum included the lions of *Between the Lions* at left, Sammy Soil at center (front and back), and the Mad Scientists at right. Picture (digital) taken on December 4, 2010.

Figure 4. Performances at the opening of the Children's Museum included the *Reject all Tobacco* performers--the Rat Pack--at left; Derrick Amos of the Rat Pack does a flip at center; and the Choctaw dancers, plus two Choctaw-adopted Rat Pack members, perform at right. Picture (digital) taken on December 4, 2010.

Environmental News, February 2011, volume 8, issue 2, pages 6-9

Environmental Geologic Map, Jackson County, Mississippi

David T. Dockery III, Office of Geology

The title, *Environmental Geologic Map, Jackson County, Mississippi*, is not about a new map publication. In fact, this map was published by the Geology Department of the University of Mississippi in 1974—but, sometimes it's an old map that's needed. With the recent Gulf oil spill and such disasters as Hurricane Katrina, the *Environmental Geologic Map, Jackson County, Mississippi*, provides a valuable baseline to compare the coastal environments of 1974 with those of today (after such disasters). It also provides a baseline to measure the possible effect of rising sea level associated with global warming. The map contains 41 environmental geologic mapping units.

Figure 1. At left, "dedicated" Ole Miss graduate students David Dockery (in front) and Merle Duplantis (in back). At right, Merle Duplantis and others in route to the Jackson County flyover. Pictures (slides 7-1 and 7-7) taken in November of 1973.

The Environmental Geologic Map of Jackson County was drawn using remote sensing to determine the extent of coastal and highland geologic environments in the county. The low marshes of Jackson County and the rest of the Mississippi coastline, which are regularly flooded by tides, are dominated by the salt-water smooth cord grass *Spartina alterniflora*. The color signature of this grass is easily distinguished and mapped by remote sensing. Thus marsh damage and deterioration due to hurricanes or oil spills can be detected in new imaging and compared with the 1974 *Environmental Geologic Map*. If the salt-water marsh expands upstream on the Pascagoula River estuary due to sea-level rise or local subsidence, that can also be detected.

Figure 2. At left, the meander belt of the Pascagoula River in northern Jackson County, Mississippi. At right, Mississippi coastal marshes along the Pascagoula River in Jackson County. Pictures (slides 8-8 and 8-14) taken in November of 1973.

Jackson County's Pascagoula River and estuary were touted in the Mississippi Public Broadcasting (MPB) film *The Singing River, Rhythms of Nature*, which premiered on MPB on November 13, 2003, as the last unimpeded major river system in the lower 48 states (i.e. not confined by dams or levees). The Pascagoula River system has the second largest basin in Mississippi, comprising most of southeastern Mississippi, and covering some 22 counties. It is 164 miles long and 84 miles wide and drains an area of about 9,000 square miles.

Figure 3. At left, tidally-influenced saltwater marshes of the Pascagoula River estuary in Jackson County, Mississippi. At right, tidal marshes on the lower Pascagoula River with Marsh Lake at upper right and the coastline beyond. Pictures (slides 8-15 and 7-15) taken in November of 1973.

Figure 4. At left, Pascagoula Bay in Jackson County, Mississippi. At right, Belle Fontaine Point in Jackson County, showing sand shoals produced by westward flowing longshore currents. Pictures (slides 8-16 and 8-17) taken in November of 1973.

The Singing River featured the Pascagoula River system from its headwaters in the bedrock of the Tallahatta Formation along the Chunky River in Lauderdale County to Pascagoula Bay and the adjacent coastal environments. While the writer was a graduate student at the University of Mississippi in 1973, the Department Head, Dr. Minshew, took the students of the fall semester Advanced Stratigraphy class on the Ole Miss airplane for a flyover of the river, estuary, and the adjacent coastline as a "field check" of the *Environmental Geologic Map* before its publication. Figure 1 shows "dedicated" Ole Miss graduate students and the Ole Miss airplane before the flyover. Figure 2 shows the meander belt of the Pascagoula River and the river's upper estuary. Figure 3 shows the lower estuary of the Pascagoula within the view of the coastline. Figure 4 shows the mouth of the Pascagoula River and the beach and sand shoals at Belle Fontaine Point. Figure 5 shows the saltwater marsh behind the beach at Belle Fontaine Point and an eroded beach nearby. Figure 6 is the *Environmental Geologic Map, Jackson County, Mississippi*. A digital copy of this map was made available to us by Charles Swann of the Mississippi Mineral Resources Institute at the University of Mississippi.

Figure 5. At left, tidal marsh on Belle Fontaine Point in Jackson County, Mississippi. At right, retreating shoreline and black beach where erosion has exposed marsh sediments underlying the beach sand at an unknown location in Jackson County. Pictures (slides 8-18 and 7-19) taken in November of 1973.

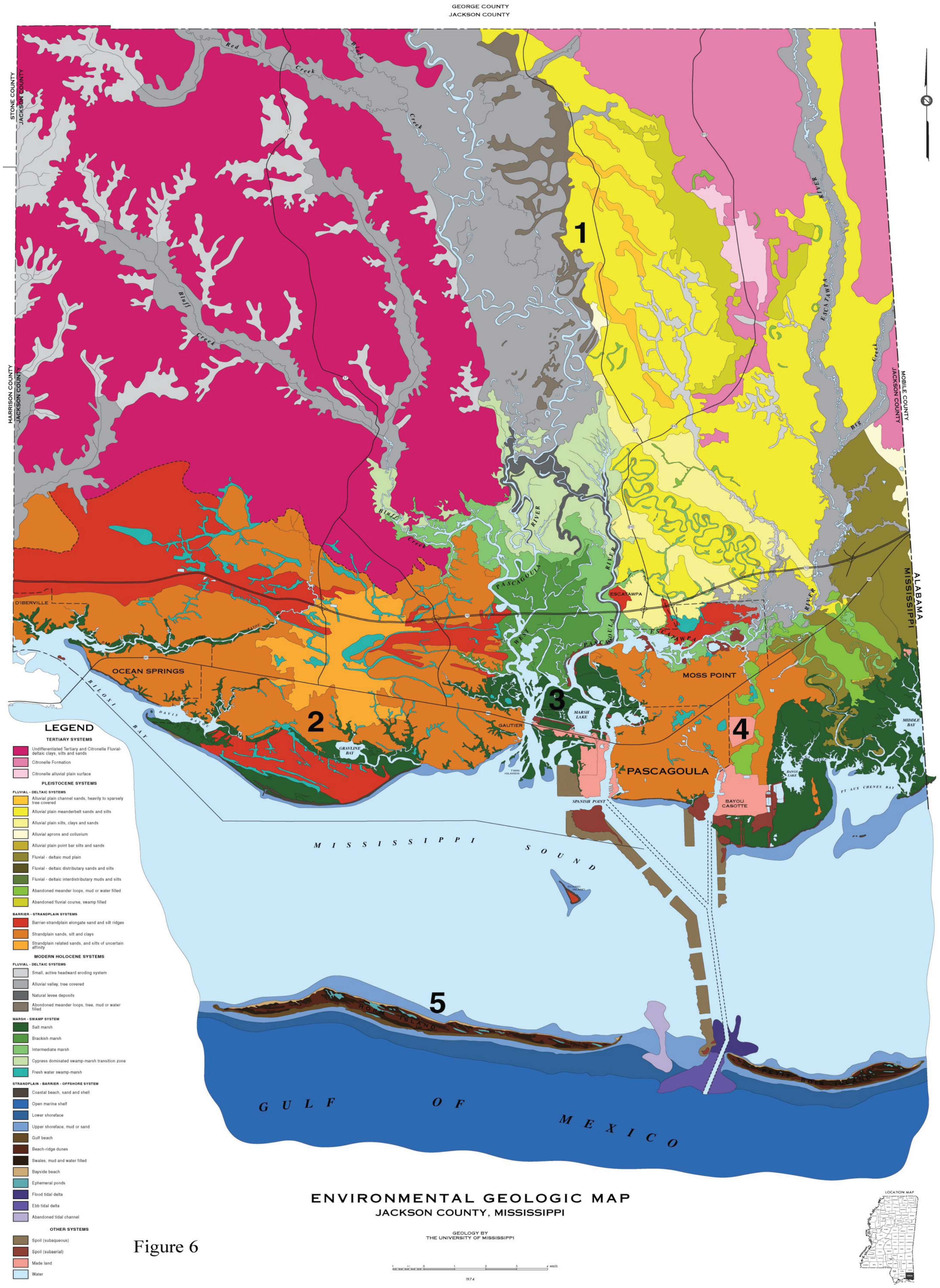

GEORGE COUNTY
JACKSON COUNTY
STONE COUNTY
JACKSON COUNTY
HARRISON COUNTY
JACKSON COUNTY
MOBILE COUNTY
JACKSON COUNTY
ALABAMA
MISSISSIPPI
Red Creek
Black Creek
Bluff Creek
Big Creek
PASCAGOULA RIVER
ESCATAWPA RIVER
ESCATAWPA
D'IBERVILLE
OCEAN SPRINGS
GAUTIER
MOSS POINT
PASCAGOULA
BAYOU CASOTTE
SPANISH POINT
MARSH LAKE
GRAVELINE BAY
BILOXI BAY
MIDDLE BAY
PT AUX CHENES BAY
MISSISSIPPI SOUND
GULF OF MEXICO
1
2
3
4
5
LEGEND
TERTIARY SYSTEMS
Undifferentiated Tertiary and Citronelle Fluvial-deltaic clays, silts and sands
Citronelle Formation
Citronelle alluvial plain surface
PLEISTOCENE SYSTEMS
FLUVIAL - DELTAIC SYSTEMS
Alluvial plain channel sands, heavily to sparsely tree covered
Alluvial plain meanderbelt sands and silts
Alluvial plain silts, clays and sands
Alluvial aprons and colluvium
Alluvial plain point bar silts and sands
Fluvial - deltaic mud plain
Fluvial - deltaic distributary sands and silts
Fluvial - deltaic interdistributary muds and silts
Abandoned meander loops, mud or water filled
Abandoned fluvial course, swamp filled
BARRIER - STRANDPLAIN SYSTEMS
Barrier-strandplain elongate sand and silt ridges
Strandplain sands, silt and clays
Strandplain related sands, and silts of uncertain affinity
MODERN HOLOCENE SYSTEMS
FLUVIAL - DELTAIC SYSTEMS
Small, active headward eroding system
Alluvial valley, tree covered
Natural levee deposits
Abondoned meander loops, tree, mud or water filled
MARSH - SWAMP SYSTEM
Salt marsh
Brackish marsh
Intermediate marsh
Cypress dominated swamp-marsh transition zone
Fresh water swamp-marsh
STRANDPLAIN - BARRIER - OFFSHORE SYSTEM
Coastal beach, sand and shell
Open marine shelf
Lower shoreface
Upper shoreface, mud or sand
Gulf beach
Beach-ridge dunes
Swales, mud and water filled
Bayside beach
Ephemeral ponds
Flood tidal delta
Ebb tidal delta
Abandoned tidal channel
OTHER SYSTEMS
Spoil (subaqueous)
Spoil (subaerial)
Made land
Water
ENVIRONMENTAL GEOLOGIC MAP
JACKSON COUNTY, MISSISSIPPI
GEOLOGY BY
THE UNIVERSITY OF MISSISSIPPI
1974
LOCATION MAP

Figure 6

Environmental News, February 2011, volume 8, issue 2, pages 16-18

LOESS ART

David T. Dockery III, Office of Geology

The Loess Hills Physiographic Province, a band of rugged hills on the eastern edge of the Mississippi River Alluvial Plain, is underlain by a thick sequence of windblown silt called loess. The hills around Vicksburg, Mississippi, are capped in loess cover that can be as much as one hundred feet in thickness. The loess was deposited during the last ice age some 18,000 years ago and has a rather unique property in that it is stable when cut as a vertical wall (Figure 1). Such cuts are often smoothed to the appearance of a plastered wall to prevent rain and sheet wash from following any irregularity and causing erosion. Loess cuts thus make a wonderful canvass for those who wish to carve their initials or for those who wish to create art—loess art. It was a loess canvass that led to the mysterious writing on the wall in 1973 as recounted below.

Figure 1. Apartments above a vertical loess bluff on the Interstate 20 frontage road at Vicksburg, Mississippi. Picture (digital; Image 1329) taken on September 29, 2009.

For those who regularly travel I 20, the mysterious writing appeared on February 3, 1973, in letters elevated ten feet above ground level, seven feet in height, and stretching 100 feet in length reading: “REMEMBER DUANE ALLMAN.” Duane Allman was co-founder, with his brother Gregg, of the Allman Brothers Band. In 2003 *Rolling Stone* magazine listed Duane as number 2 (behind Jimi Hendrix) on a list of the alltime greatest guitarists. But Duane’s career was cut short in a fatal motorcycle accident on October 29, 1971. A little more than a year later, the writing on the wall appeared. It received international notice when it was featured in the April 11, 1974, issue of the *Rolling Stone* magazine. Of geologic interest was that the writing was carved in a vertical wall of loess, and thus was a form of “loess art.”

Figure 2. View of Allman tribute from Interstate 20 some six miles east of Vicksburg, Mississippi.

This deed was recounted in the October 15, 2007, edition of *The Vicksburg Post* in a front-page article by Eric Brown entitled "4 who carved Allman tribute remember a star." The "4" were freshman college students attending Hinds Junior College: David Reid, Dennis Garner, Don Antoine, and Len Raines. They passed a vertical, almost pristine, wall of loess, located on the north side of the I 20 westbound lanes some six miles east of Vicksburg near the Bovina exit, on their daily commutes to classes at Hinds; it was during these commutes that they planned their tribute. According to a typed account by Reid just after the event, the carving began at 8:45 a.m. Saturday, February 3, 1973. They unloaded picks, axes, and a 9-foot ladder on a beautiful clear day, and, within four and a half hours after its initiation, the tribute was finished. They then signed their names in the loess. Though the message turned out OK, the group avoided disaster halfway through when it come to their attention that the second M in REMEMBER was missing. Figures 2 and 3 show the finished inscription. Figure 4 shows the four artists by their work just before carving the last R in REMEMBER. The carving is no longer visible. Figure 5 shows more recent loess art on Highway 49 south of Yazoo City.

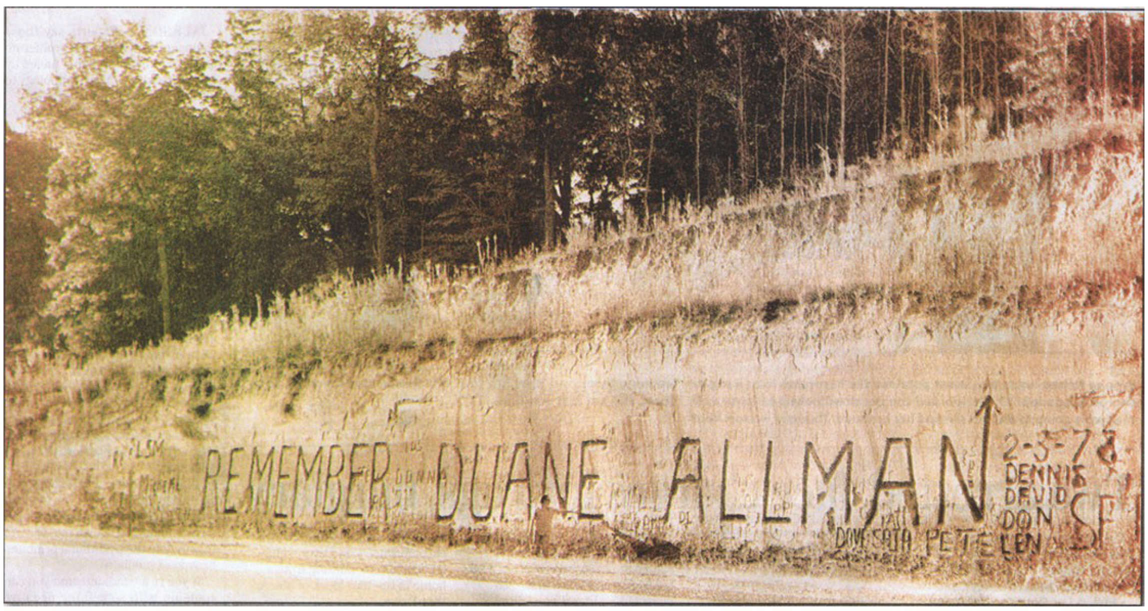


Figure 3. Carving in loess on Interstate 20 near Vicksburg: "REMEMBER DUANE ALLMAN," signed and dated 2-3-73. Picture is from the front page of the October 15, 2007, issue of *The Vicksburg Post*.

Figure 4. The four Hinds Junior College students who carved the "Remember Duane Allman" tribute in loess near Vicksburg, Mississippi, on February 3, 1973.

Figure 5. Close up view of loess art on the west side of Highway 49 south of Yazoo City and north of the Myrleville Road intersection. Picture (digital; Image 926) taken July 25, 2007.

Environmental News, March 2011, volume 8, issue 3, pages 8-11

MISSISSIPPI WINTER WEATHER EMERGENCIES, 2011

David T. Dockery III, Office of Geology

The first winter emergency of 2011 came as Governor Barbour closed state offices until noon on Monday January 10 due to ice on roads. The next day, Brian Williams announced on the NBC Evening News, "I am about to present you with a really interesting fact…" that 49 of the 50 states had snow cover. The snow cover map in Figure 1 was shown on that newscast; Figure 2 is a satellite image of the snow cover in the mid-south region. This winter precipitation in the Jackson area (Figure 3) was followed by a cold spell of 37 consecutive hours below freezing, extending from 2:54 a.m. on January 12 to 3:54 p.m. on January 13. On January 13, I photographed a nearly frozen over lake (Figure 4) before coming to work with chapped, split, and sore fingers that were as bad as they had been during the January freeze of 2010. Try buttoning a button with a split thumb and index finger (or using dental floss).

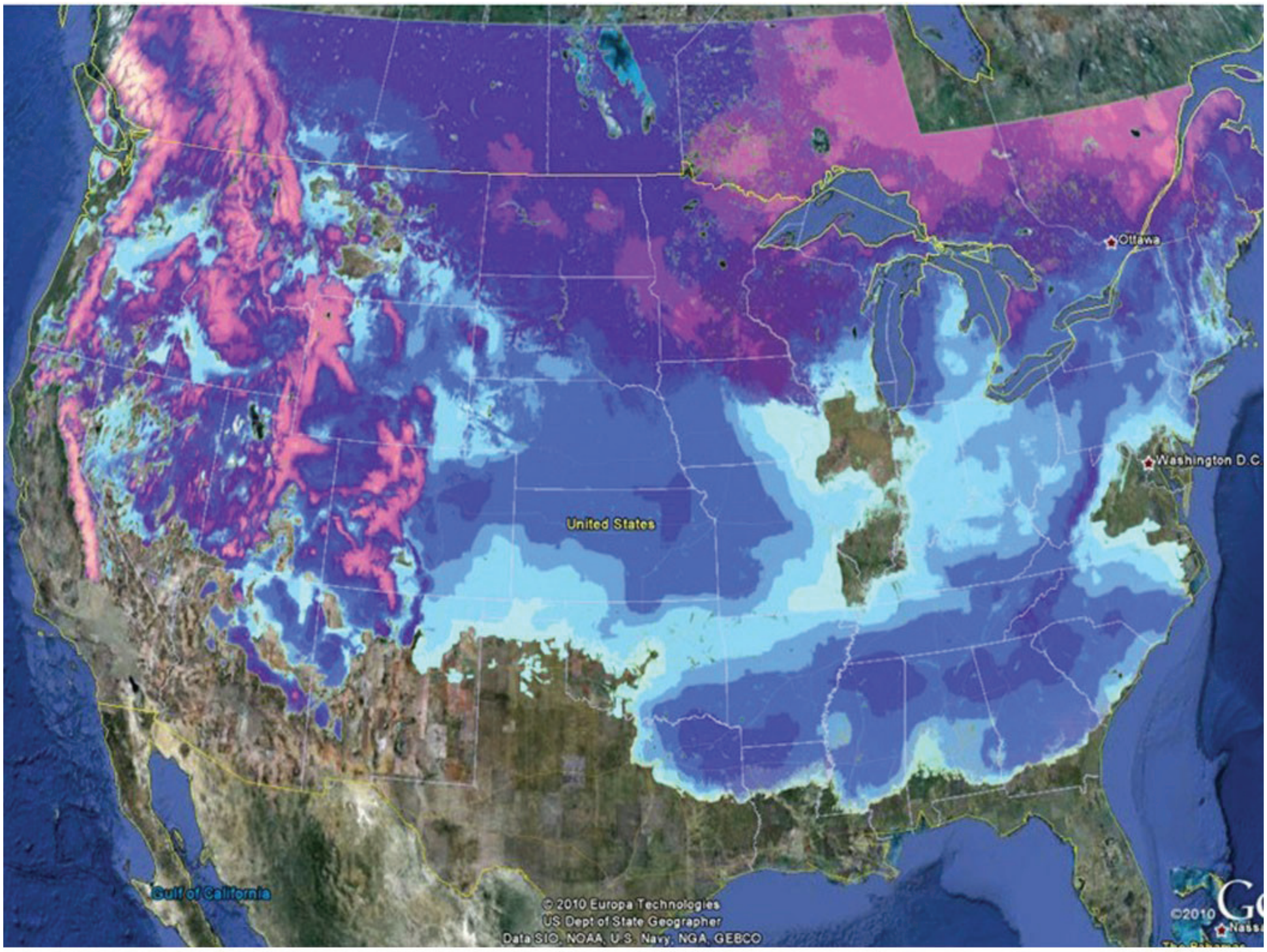


Figure 1. NOAA weather map for January 11, 2011, showing snow cover across the 48 contiguous states. Snow cover at this time covered 69.4% of the contiguous states to an average depth of 6.9 inches.

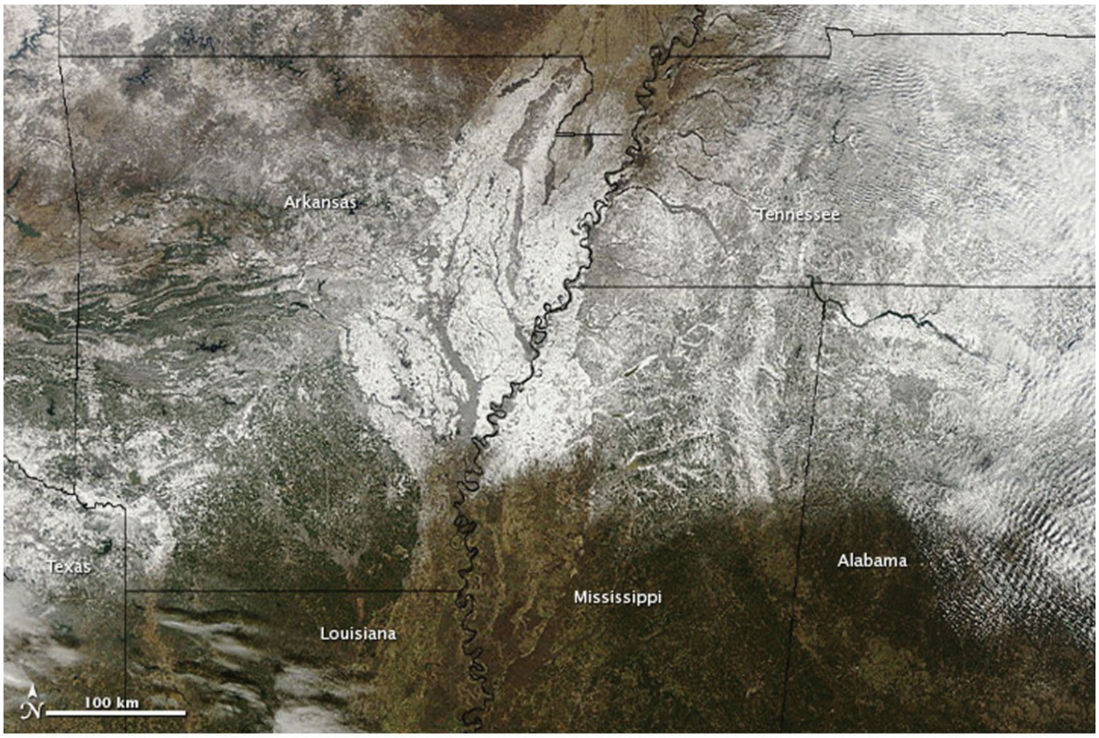


Figure 2. The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite caught this unusual view of snow across the southern United States on January 12, 2011. The swath of white follows the track of a winter storm that moved across the country between January 9 and January 11. The rare snow led governors in Alabama, Georgia, Louisiana, North Carolina, South Carolina, and Tennessee to declare emergencies, reported the Associated Press. From the distance of space, the snow is serene. The blanket of white highlights the countless rivers and lakes that branch from the Mississippi River. It emphasizes the east-west contour of the Ouachita Mountains in western Arkansas. Lines of clouds hide the snowy landscape in Alabama and Tennessee and states to the east.

Figure 3. Frozen precipitation on plants north of Clinton, Mississippi, after freezing rain. Picture (digital) taken on January 10, 2011.

Figure 4. A mostly frozen over lake north of Clinton, Mississippi, after 37 consecutive hours below freezing. Picture (digital) taken on January 13, 2011.

The second winter emergency was part of the "Groundhog Day Snowstorm," which affected 30 states (Figure 5, and #10 below). State employees were sent home at 4:00 p.m. on Thursday, February 3, 2011, and told not to come back until noon on Friday, February 4 due to sleet and freezing rain. Our own Mike Meadows and meteorologist, Rodney Cuevas, made the trip home as far as the stack, at the Interstate 55 south and Interstate 20 split, before their usual 30-minute drive became a five-hour ordeal. Rodney's ordeal was reported in the February 4 edition of the Jackson Free Press. Around 3:45 p.m. on February 3, an 18-wheeler jackknifed near the U.S. 49 South exit of Interstate 20 due to icy roads. Near the same time, the "flyover" of Interstate 20 East froze and became impassable, stranding 10 cars on the flyover. The Highway Patrol then closed the stack, backing up interstate traffic. It was between 9:00 p.m. and 10:00 p.m. before traffic finally began to move. Some motorists were stuck in traffic as long as seven hours with no water, food, medications, or restroom facilities.

The third weather emergency began as MDEQ employees were given a "Go Home" message at 4:37 p.m. on February 9, 2011, due to snow, sleet, and freezing rain. Governor Barbour closed all state offices north of Highway 84 until noon the following day. One to two inches of snow accumulated in the Jackson metropolitan area (Figure 6) with more falling in Yazoo City. The low temperature for February 10 was 19 degrees, and the high was only 28 degrees F. The next day the morning low was 18 degrees, tying the record made for that date in 1973 and nearly freezing over the lake that I photographed in January.

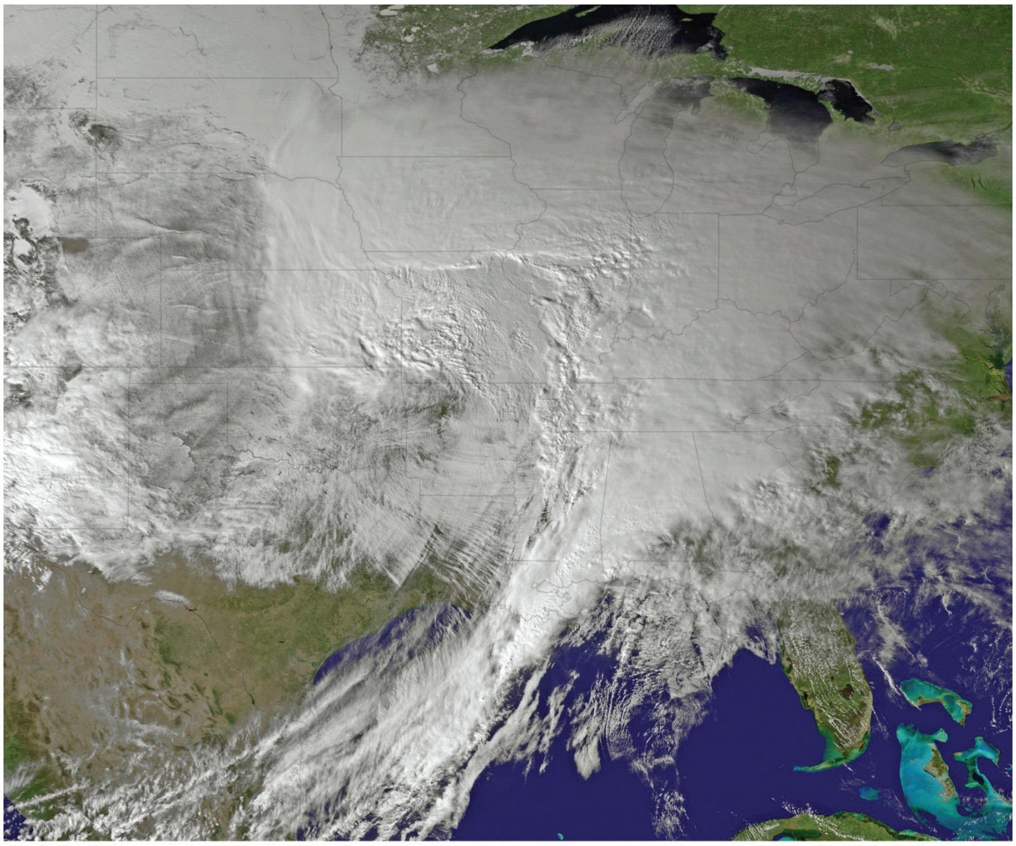


Figure 5. Satellite image of the "Groundhog Day Snowstorm" (also called Snowzilla), which affected 30 U.S states over 48 hours. Picture taken on February 3, 2011.

Figure 6. Snow north of Clinton, Mississippi, after a snowfall of one to two inches the previous evening. Picture (digital) taken on February 10, 2011.

Environmental News, April 2011, volume 8, issue 4, pages 20-23

THE SHELL FROM MARS

David T. Dockery III, Office of Geology

My first experience with the "shell from Mars" was around 1970 when I excavated one from an exposure of the Late Eocene Moodys Branch Formation on Town Creek in south Jackson, Mississippi. It was a large globose cowrie shell unlike any I'd seen before. Unfortunately, the anterior end of the shell had been eroded away when I found it (Figure 1). When I published the molluscan fauna of the Moodys Branch Formation in 1977, I requested the help of Crawford Cate, an expert on recent cypraeids (cowrie shells). Cate placed the fossil cowrie as a new species of *Notoluponia* despite the fact that this genus was endemic to the Miocene of southern Australia. Based on Cate's recommendation, I named the species *Notoluponia ampla*, *ampla* referring to the expansive aperture.

Figure 1. Partial *Sphaerocypraea jacksonensis* specimen from the Moodys Branch Formation at Town Creek in Jackson, Mississippi. This specimen was the type specimen for *Notoluponia ampla* Dockery, 1977, and now resides as holotype 8235 in the type collection of the Paleontological Research Institution in Ithaca, New York. The specimen is in excellent condition with the exception that the anterior end is missing. Picture (slide154-20; Image 1675) taken in September of 1972.

It was later that I met Luc Dolin, a French customs official and paleontologist with an expertise in fossil cypraeids. Dolin recognized two errors in the name of my new cypraeid species. The first error was that the species was a synonym of *Cypraea jacksonensis* Johnson, 1899, a species previously known only from shell fragments. The second error was that the species was neither a *Cypraea* nor a *Notoluponia* (both cowrie shells in the Family Cypraeidae) but was the extinct genus *Sphaerocypraea* (an egg cowrie in the Family Ovulidae). *Sphaerocypraea* was best known from the Eocene of Europe. Luc Dolin and his brother Cyrille came to Jackson, Mississippi, in 1981 and excavated their own specimen of this rare species (Figure 2). Shortly afterward they (Dolin and Dolin, 1981, *Mississippi Geology*, volume 2, number 2, pages 17-19) revised the scientific name of my species to *Sphaerocypraea jacksonensis* (Johnson, 1899). Figures 3-4 show additional *Sphaerocypraea jacksonensis* specimens from Town Creek.

Figure 2. Specimen of the large cypraeid *Sphaerocypraea jacksonensis* in the Moodys Branch Formation at Town Creek in Jackson, Mississippi (MGS locality 1) as collected by Luc Dolin. Picture (color print; Image 682) was taken in September of 1981 and was featured in the December 2008 issue of the *American Conchologist* on page 3.

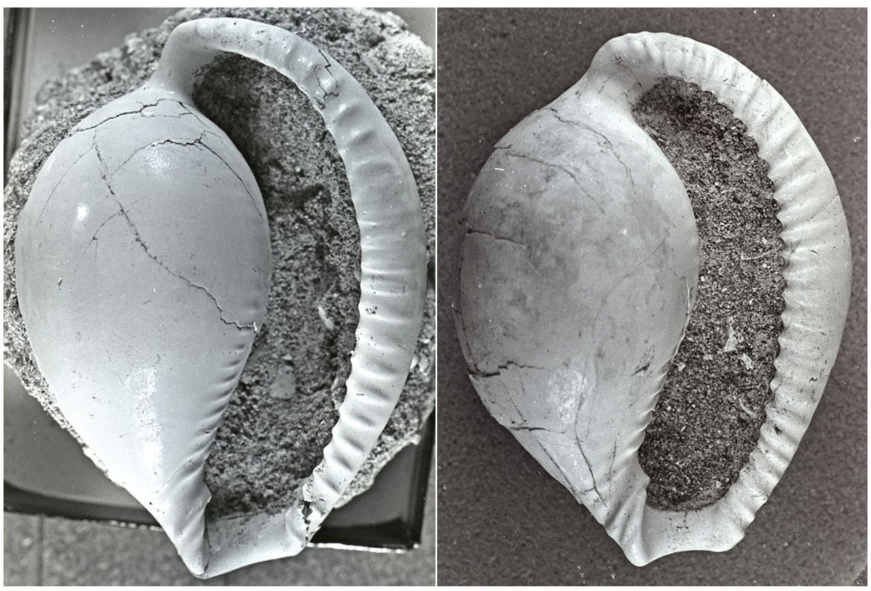


Figure 3. Two *Sphaerocypraea jacksonensis* specimens from the Moodys Branch Formation at Town Creek in Jackson, Mississippi, both complete only from the apertural view. Picture (negative 63-6 on left taken in December of 1980 and negative 96-25 on right taken in August of 1981; Composite Image 1678). The specimen on the left has a height of 86 mm and a width of 63 mm.

Figure 4. Apertural and dorsal views of a juvenile specimen of *Sphaerocypraea jacksonensis*, in which the apertural teeth are not well developed, from the Moodys Branch Formation at Town Creek in Jackson, Mississippi. Shell height is 83 mm, and width is 63 mm (as laterally compressed). Picture (negative 87-3 on left and 87-5 on right) taken in March of 1981.

The baffling genus *Sphaerocypraea* was involved in a more recent tale of molluscan intrigue as told by Peter Dance, an author on recent seashells, in the December 2007 issue of the *American Conchologist*. Dance recounted his conversation in 2005 with Bruno Briano, a diver and shell dealer from Savona on the Italian Riviera. Briano told of a couple of strange shells he received from a Somalian fisherman in 1993. These shells had been dredged up by a Russian trawler operating somewhere near the coast of Somalia at a depth of 100 meters. Dance quoted Briano's words, concerning his thoughts when he first saw one of the shells: "It was like a shell from Mars. A shell dreams are made of, a shell beyond imagining. I could not believe my eyes, it was so extraordinary. It made my heart beat faster." Though Briano was not an authority on mollusks, he hurriedly published his two shells as a new genus and species, *Chimaeria incomparabilis* Briano, 1993. One of Briano's two shells was selected as the type specimen of the species and placed in the French Natural History Museum in Paris.

Before Briano acquired his strange shells, another shell dealer, Donald Dan, traveled to Moscow in 1991 during the time of the Cold War to see a shell rumored to exist among various Russian shell collections that could neither be clearly identified as a *Cypraea*, *Ovula*, nor *Marginella*. As Dan told the story in the September 2008 issue of *American Conchologist*, he traded for one shell and paid for another shell of this strange new species. When he showed the shells to Luc Dolin in Paris, Dolin instantly identified them as belonging to the supposedly extinct genus *Sphaerocypraea*. Dolin explained, "It is truly a living fossil." With Dan's permission, Dolin immediately made drawings of the shells for the U.S. National Museum and began a scientific description of the new species. Dolin's manuscript, with Gary Rosenberg of the Academy of Natural Sciences of Philadelphia as coauthor, was entitled "*Sphaerocypraea neotenica* n. sp., a Northeastern Indian Ocean Relict." About a month after the manuscript had been reviewed by referees for publication, Dolin and Rosenberg had the misfortune of discovering Briano's 1993 publication in which the new species was both named and misidentified (Briano's new genus *Chimaeria* was later placed as a synonym of *Sphaerocypraea*). Dolin's drawings were later published in Dolin and Ledon, 2002, *Geodiversitas*, volume 24, number 2, pages 329-347, figure 4 C-D.

Dan sold the two specimens studied by Dolin to a collector who agreed to donate them, along with a collection of other shells, to the American Museum of Natural History in New York. To appraise this collection, the American Museum selected an appraiser who was a shell dealer from Florida. The appraiser found the new species too tempting and pocketed one of the shells (Figure 5). He then advertised the shell for sale over an internet web site and sold it for $12,000 to Guido Poppe, a well-known shell dealer in Belgium. Poppe, unaware that the shell was stolen, resold it for $20,000 to an Indonesian shell collector in Jakarta. In 1997, the theft of a "remarkable and rare seashell" made news on both sides of the Atlantic. The Florida shell dealer was arrested for having committed a federal offense, and Poppe was detained by U.S. authorities when he passed through Los Angeles. Eventually, the Indonesian collector was reimbursed and returned the stolen shell.

Figure 5. Dorsal (left) and apertural (right) views of *Sphaerocypraea incomparabilis* (Briano, 1993). This is the specimen stolen from the American Museum of Natural History and eventually sold for $20,000. It is 66.3 mm in height and 42.1 mm in width. Image received from Tom Eichhorst, editor of the *American Conchologist*.

The return of a rare stolen shell to the American Museum would be a happy ending to this story if not for the misfortunes of those who admired or coveted the "shell from Mars." Dance gave an account of these events in *American Conchologist* as noted above. Bruno Briano, who named the new species, had an extensive stock of specimen shells stolen from a shell exhibition in Italy. Thieves then broke into his house and stole additional shells. Briano's remaining stock of shells was buried in mud when a mountain stream overflowed its banks and flowed into his home. Briano's young son convinced him to sell his "unlucky" S*phaerocypraea* specimen, which he did to a Japanese collector. Shortly afterwards, the collector's family suffered disastrous results from the Kobe earthquake, which occurred on January 17, 1995. The Indonesian collector who paid $20,000 for the specimen sold by Poppe moved his communication-cable business to an impressive new building in Jakarta. Shortly afterwards, the building was destroyed during the Jakarta riots of May 1998. When Dance agreed to write the story of the stolen shell, he was frustrated in his search for a picture of the specimen. A Belgian shell enthusiast from Ghent, Yves Teryn, agreed to send Dance a picture of the shell he took at the Lutry, Switzerland, Shell Show in 1993. Sadly, the day after the picture was sent by email, Teryn's computer crashed and the image and five years of research notes were lost.

Environmental News, volume 8, number 5, May 2011, pages 12-14

THE EIGHTH ANNUAL FOSSIL ROAD SHOW

David T. Dockery III, Office of Geology

The eighth annual Fossil Road Show was held at the Mississippi Museum of Natural Science on Saturday March 5, 2011. MDEQ staff who helped with this event were David Dockery and James Starnes (Figure 1) of the Office of Geology and Robert Seyfarth (Figure 2) of the Office of Pollution Control. Many of those who helped with previous Fossil Road Show events were back with the addition of some new faces. One of those was Dr. Louis Zachos (Figure 3), a new faculty member of the Geology and Geological Engineering Department at the University of Mississippi and a former resident of Austin, Texas. My first acquaintance with Dr. Zachos came when he published an article on the Eocene echinoids of Texas in the *Journal of Paleontology* in 2003. In that article he compared an echinoid locality in Texas with a similar site in Mississippi of the same geologic age. Now he brings his echinoid and Mississippi stratigraphy expertise to Ole Miss.

Figure 1. James Starnes identifying rocks and fossils at the Fossil Road Show. The dinosaur models at his table catch the interest of children.

Figure 2. Robert Seyfarth displays his Pleistocene fossil bones from Natchez, Mississippi, at the Fossil Road Show.

Figure 3. At middle, Dr. Louis Zachos of the University of Mississippi at the Fossil Road Show; at right is Jeremy Dew of the Mississippi Mineral Resources Institute.

The Fossil Road Show brings in fossils, not just from Mississippi, but from other states as well. Figure 4 shows a family with a fossil from Birmingham, Alabama. The fossil print in the rock looks like the scales of a reptilian skin, but it is the bark of a Carboniferous-age scale tree named *Lepidodendron*.

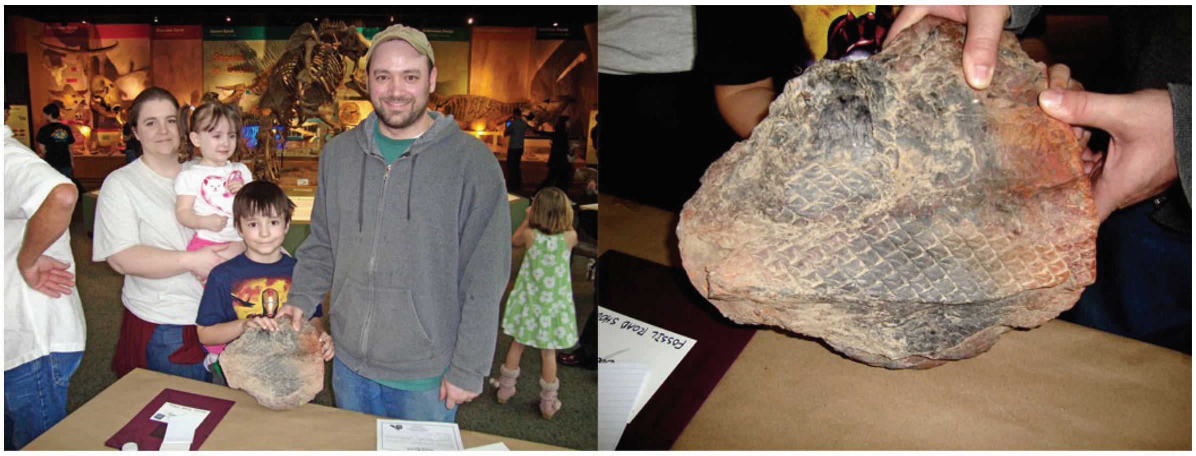


Figure 4. A family with their fossil from Birmingham, Alabama, which is the bark imprint of the fossil scale tree *Lepidodendron*.

Also at the Fossil Road Show were visitors from my spring and last fall semester classes in Physical Geology at the Rankin County Campus of Hinds Community College. These students and their families are shown in Figure 5. Sometimes it's not easy to pick out the student in such pictures. Before you make your final pick, you should know that the current student population at the Rankin County Campus ranges in age from 16 to 67 with an average age of 26. In the 2010 fall semester class, when we began the chapter on earthquakes, I asked this question, "How many of you watched the third game of the World Series on October 17, 1989, when the Loma Prieta quake knocked out power and the television screens went black?" Four hands went up, and to my surprise one of the students, Dennis Adams, said, "I was there." He then told a riveting story of his experience at age twelve, watching the Padres come on the field, while the fans were cheering so much that it shook San Francisco's Candlestick Park—at least that's what they thought until the columns began to shear, shatter, and rain concrete onto nearby fans. He also heard the collapse of a nearby double-decked section of Interstate 880, which crushed cars in rush-hour traffic. Now, as to the Hinds students in Figure 5, they are the fathers in both pictures. At left is Craig Passons of the current spring semester with his wife and son, and at right is Douglas Hester of the 2010 fall semester with his wife, daughter, and his daughter's friend.

Figure 5. Rankin County Campus Hinds students: at left, Craig Passons of spring semester 2011 with his wife and son; at right, Douglas Hester of fall semester 2010 with his wife, daughter, and his daughter's friend.

Environmental News, volume 8, number 5, May 2011, pages 20-22

THE APRIL 15, 2011, CLINTON TORNADO

David T. Dockery III, Office of Geology

We were given a day's notice that bad weather was on the way. A cold front down the country's mid-section on April 14 produced snow in the upper Midwest and tornadoes in Oklahoma and Arkansas. On the morning of April 15, 2011, conditions were right for severe weather in central Mississippi. When the sirens sounded in Jackson, MDEQ employees were told to stay away from windows and retreat to the stair wells. However, downtown Jackson was not the target of the storm's wrath. The funnel cloud touched down in Clinton south of Interstate 20 (Figure 1) and skipped across Clinton and northwest Jackson and on to the Ross Barnett Reservoir (Figure 2), where it was captured on video as a waterspout.

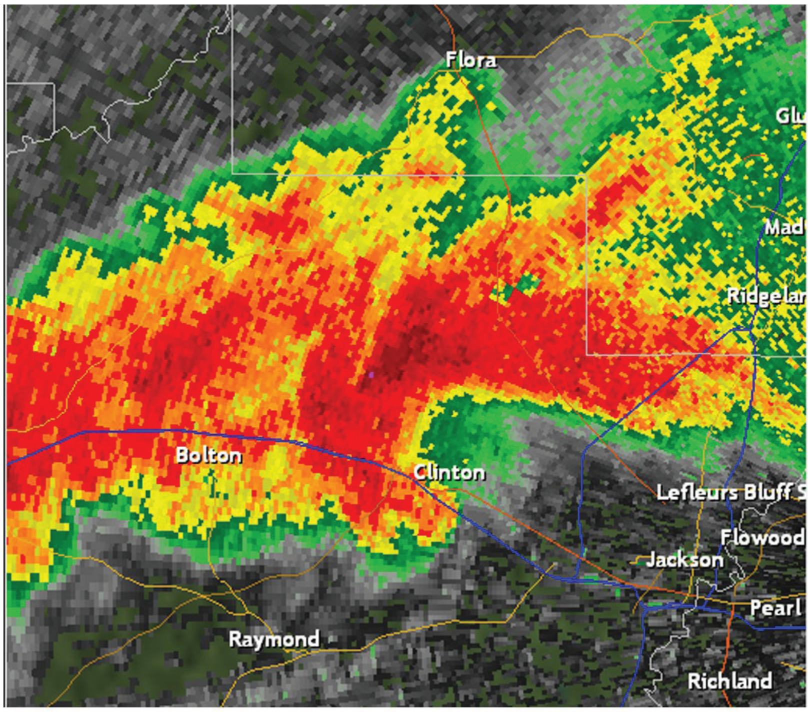


Figure 1. Images from the Brandon Doppler radar show the tornadic thunderstorm at 10:57 am as the tornado was crossing I-20 in Clinton. Image from the National Weather Service in Jackson.

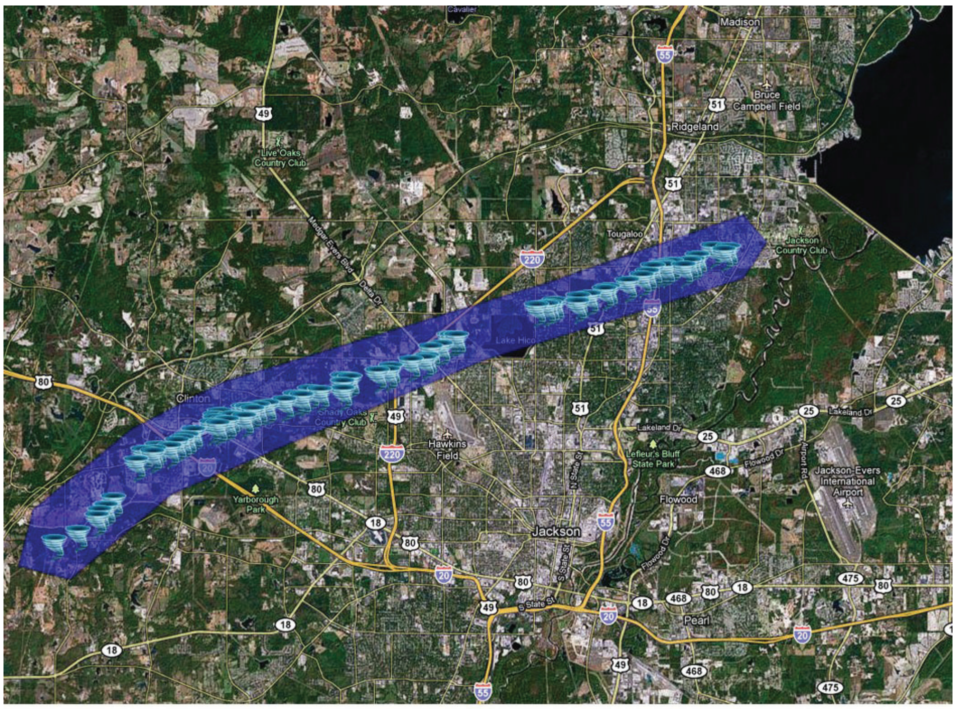


Figure 2. Tornado damage track across Clinton and northern Jackson, Mississippi, on April 15, 2011, from the National Weather Service. The tornado was given an EF-3 rating based on the houses destroyed southwest of Highway 80 and just south of Clinton Boulevard in Clinton.

In Clinton, storm chasers focused their camera on the funnel cloud around 10:57 a.m. as it traveled northeast across Interstate 20 at the Springridge Road interchange. When the tornado hit the Bank Plus building south of the interstate (Figure 3), one storm chaser noted the debris in the air and stated, “That’s bad!” A car was captured on video flying from the bank parking lot onto the interstate, as if fired from a cannon. Another car was blown onto the interstate entrance ramp. These and other storm-damaged cars were towed to Obie’s Chevron Station in Clinton where they were lined up like a Smithsonian exhibit of tornado damaged cars (Figure 4). Christy Martin of Bank Plus said that the employees huddled in a hallway just before the roof blew off. She felt her ears pop and then the hail hitting her on the head. Christy’s car was one of the damaged cars on exhibit at Obie’s Chevron.

Figure 3. The Bank Plus building south of I-20 in Clinton, Mississippi. Cars from the bank’s parking lot were blown onto the interstate.

Figure 4. Cars from the Bank Plus parking lot that were towed to Obie’s Chevron in Clinton. At left is a truck impaled by a tree limb; at right are two mangled cars towed from the interstate right-of-way.

The tornado lifted and then touched down in the Lakeside Subdivision, causing extensive damage to homes, trees, and power lines. The April 17, 2011, edition of *The Clarion-Ledger* reported how Jamie Barnes pulled Ina Hinton, age 84, from her flipped and shattered home (Figure 5). Her worst injury was only a broken nose. No one was killed in the subdivision, even though two homes were cut in half by fallen trees. The tornado lifted again before taking out power lines on Highway 80 (Figure 6) and then threaded its winds between a daycare with 150 children and an elementary school with 450 children. Figure 7 shows the contrast between damage in the Easthaven neighborhood and the undamaged Eastside Elementary School just on the other side of Easthaven Drive. The Clinton tornado is now an entry in *Wikipedia* under "April 14-16, 2011 tornado outbreak."

Figure 5. Damage in the Lakeside Subdivision south of Highway 80 in Clinton. At left a home was ripped from its foundation. At right a home was cut in half by a fallen tree.

Figure 6. Driving into Clinton on Highway 80 at 11:56 am on April 15, 2011, about an hour after the tornado struck; lights were out on Highway 80 and I-20 traffic was at a standstill.

Figure 7. Storm damage in the Easthaven neighborhood on the north side of Highway 80 in Clinton, where the tornado threaded its way between a daycare and school with a total of 600 children. At left is the Eastside Elementary School; across the street at right is a scene of major storm damage.

Environmental News, volume 8, number 6, June 2011, pages 12-19

THE MISSISSIPPI RIVER FLOOD OF 2011

David T. Dockery III, Office of Geology

This year's April showers brought not only May flowers, but higher than normal pollen counts, an increase in allergy sufferers, and "a rising tide" down the Mississippi River. Heavy April rainfall accumulations in the Ohio River Valley and melting snow packs in the upper Mississippi River Valley have produced record flood crests on the Mississippi River in what has been called "The Great Flood of 2011." MDEQ personnel have put a tremendous effort into flood response, with: (1) continuous activity in every river county from DeSoto to Wilkinson County, (2) many meetings with city and county officials and with state and federal officials, (3) presence in the state Emergency Operations Center, (4) contributions and coordination of GIS data, (5) planning and preparations for debris handling and disposal, (6) status of wastewater treatment facilities, (7) removal of hazardous materials, (8) response to oil spills, and (9) the daily issuance of situation reports on MDEQ flood-related activities.

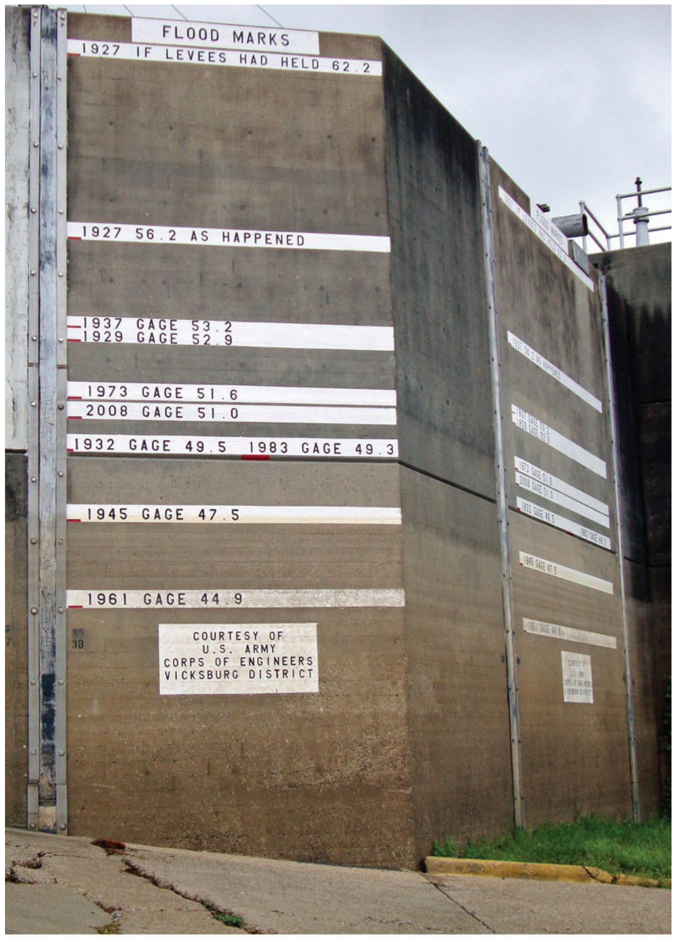


Figure 1. Vicksburg flood wall with historical flood crests marked by the U.S. Army Corps of Engineers. The water lines (bathtub rings) for the 2008 and 2009 floods can be seen to the right of the facing wall. Picture was taken on September 26, 2009.

Figure 2. The 2008 Mississippi River flood crest as seen at the Vicksburg flood gate and on the flood wall, just below the 1973 level. Pictures were taken on April 20, 2008.

On the May 12 edition of NBC Evening News, Brian Williams stated, “This flooding is a disaster, some of it historic, epic proportions, but something else is also true. It was predicted. We knew it was coming.” He then gave this year’s record snowfall accumulations for certain northern cities (see “Mississippi Winter Weather Emergencies, 2011” in the March 2011 edition of *Environmental News*). Oddly enough, the flood crest arrived in Mississippi during some of the coldest mid-May temperatures on record, with a record low day-time high in Jackson of 62 degrees F on May 16 and low the following morning of 42 degrees F. Mid-May was both cold and dry, which was fortunate in two ways: (1) rainfall did not add to the flood crest, and (2) the dry Delta soil soaked up enough water to significantly diminish the predicted flood crest. Another factor that lowered the flood crest in Mississippi was a breach in the 18-mile-long Bunches Bend farm levee in East Carroll Parish, Louisiana, across the river from Rolling Fork, Mississippi. The breach occurred on May 13, 2011, flooded 10,000 acres of prime Louisiana farmland, and dropped the river level half a foot at Greenville, Mississippi, before the river continued its rise. Due to the dry weather and breached levee, the predicted overtopping of the Yazoo Backwater Levee by one foot of flood water never happened.

The Great Flood of 2011 was unique, not only in its magnitude, but that it was the third Mississippi River flood in just four years. Back to back flood years in 2008 and 2009 had flood crests at Vicksburg, respectively, of 51.0 feet and 47.5 feet. The 2008 flood was the highest flood since the 51.6-foot flood crest of 1973, some 35 years earlier. The U.S. Army Corps of Engineers placed the 2008 crest level on the Vicksburg flood wall with those of other historic crests (Figure 1). Figure 2 shows the planked up flood gate in 2008, and a photograph of the crest against the flood wall as taken from the flood gate. The flood of 2009 did not require the closure of the flood gate, but, as seen on the flood wall, it rose to the level of an historic flood in 1945 (Figure 3). In both the 2008 and 2009 floods, Highway 465 was closed just west of Highway 61 due to flooding, which turned the farmland of the lower Yazoo River Basin into a large lake (Figure 4).

Figure 3. Vicksburg flood gate (left) and flood wall (right) at the crest of the 2009 flood, which rose to the level of the 1945 flood crest. Pictures were taken on May 26, 2009.

Figure 4. Highway 465 just west of Highway 61 during the 2008 (left) and 2009 (right) flood crests. Picture on left was taken on April 20, 2008; picture on right was taken on May 26, 2009.

The flood gates at Vicksburg were planked all the way to the top in preparation for the Great Flood of 2011. This planked closure had to be extended along the north end of the flood wall (Figure 5). Photographing the rising crest on the flood wall in 2011 (figure 6-7) required a 24-foot extension ladder and Homeland Security clearance from Vicksburg Emergency Management Director Anna Booth and notification of Lieutenant Davey Barnett of the Vicksburg Police Department. The Great Flood of 2011 not only covered Highway 465 (Figure 8) but also sections of Highway 61 (Figure 9) and many homes and businesses (Figure 10). With a crest of 57.1 feet on the evening of May 18, it is now the highest flood level ever recorded at Vicksburg (Figure 11).

Figure 5. Planking up and tarring the north end of the Vicksburg flood wall. Picture was taken on May 6, 2011.

Figure 6. At left, David Dockery takes pictures northward along the Vicksburg flood wall (as seen in Figure 7). At right, WLBT's Skycopter3 films the flood crest along the flood wall. Pictures were taken on May 19, 2011, by Mary Dockery.

Figure 7. The Mississippi River flood crest of 2011 on the flood wall at Vicksburg. Picture was taken on May 19, 2011.

Figure 8. 2011 flood waters have submerged all but a small peninsula of Highway 465 and threaten to cover Highway 61. Pictures were taken on May 11, 2011.

Figure 9. Flood waters submerge Highway 61 in Vicksburg. Picture taken on May 16, 2011.

Figure 10. Flood waters of the Mississippi and Yazoo rivers merge at their confluence and extend their shores to the bluff line at Vicksburg, leaving a jacked-up office building surrounded by the swift currrents of the Mississippi River (behind) and the backwaters of the Yazoo River (in front). Picture was taken on May 16, 2011.

Figure 11. The rising tide of the Great Flood of 2011, climbing the Vicksburg flood wall. From left to right, pictures were taken around noon on: (1) May 9 below the 1929 flood crest of 52.9 feet, (2) May 11 below the highest recorded flood crest in 1927 of 56.2 feet, (3) May 16 above the 1927 flood crest, and (4) May 19 at a record crest of 57.1 feet. The bolt above and left of the 1927 mark was at water level on May 16 (3) and below water level on May 19 (4).

The Great Flood of 2011 continued its record breaking crests downstream with a crest of 61.8 feet, or 13.8 feet above flood stage, at the City of Natchez on May 21, a level significantly below the predicted crest of 64 feet. The previous record at Natchez was 58.04 feet set on February 21, 1937. Figures 12 and 13 compare Natchez under the Hill during the flood crests of April 21, 2008, at 57.03 feet, and May 21, 2011, at 61.8 feet. On April 21, 2008, backwater flooding north of Natchez in the Port Gibson area was so high that Highway 61 was flooded just north of the Big Black River bridge and fields on both sides of the Natchez Trace Parkway were flooded just south of the Little Bayou Pierre bridge (Figure 14).

Figure 12. Left, flood crest at Natchez Under the Hill on April 21, 2008; water is at the base of the lower gate post; the upper gate post at the curb is high and dry. Right, flood crest at Natchez Under the Hill on May 21, 2011; water is at the base of the upper gate post; the lower gate is covered except for the top of the gate post.

On May 9, 2011, the Mississippi River discharge at Vicksburg, Mississippi, exceeded two million cubic feet per second and rose to a maximum flow of over 2,330,000 feet per second on May 18 and 19, 2011. The following are some interesting flood statistics provided by Jared Wright of the U.S. Geological Survey (Pearl, Mississippi) based on USGS measurements:

The Mississippi River at Vicksburg, on May 19, 2011, had a total discharge of 2,321,000 cubic feet per second, a maximum depth of 185 feet, a maximum velocity of 18.1 feet per second, and an average velocity of 8.82 feet per second.

The Mississippi River at Natchez, on May 20, 2011, had a total discharge of 2,260,000 cubic feet per second, a maximum depth of 129 feet, a maximum velocity of 18.9 feet per second, and an average velocity of 9.31 feet per second. On May 21, it had a total discharge of 2,170,000 cubic feet per second, a maximum depth of 136 feet, a maximum velocity of 18.3 feet per second, and an average velocity of 8.76 feet per second.

Figure 13. Left, flooded street at the Isle of Capri landing in Natchez Under the Hill on the April 21, 2008, flood crest. Right, make-shift levee built around the Isle of Capri low spot and against the river, as seen on the May 21, 2011, flood crest; businesses inside the levee remained open.

The Mississippi River ranks seventh among the world's rivers in average discharge, with an average discharge of 611,000 cubic feet per second. The largest river in this ranking is the Amazon River with an average discharge of 7,500,000 cubic feet per second; second is the Congo River with an average discharge of 1,400,000 cubic feet per second. During the Great Flood of 2011, the Mississippi River's discharge of over two million cubic feet per second placed it, for a time, as second among the world's rivers. Another interesting fact of this flood was the rate of backwater flooding on the Yazoo River, which produced a negative flow rate at Redwood on May 12 of 46,000 cubic feet per second. The flow rate on the Pearl River at flood stage in Jackson is only 20,000 cubic feet per second. So, the Yazoo River's backward discharge was more than twice the Pearl River's forward discharge at flood stage.

Figure 14. Left, backwater flooding on Highway 61 in Warren County just north of the Big Black River bridge. Right, backwater flooding on the Natchez Trace Parkway just south of the Bayou Pierre River bridge. Picture on left was taken on May 18, 2011, by James Matheny; picture on right was taken on May 21, 2011, by David Dockery.

Environmental News, volume 8, number 6, June 2011, pages 23-25

BASILOSAURUS CETOIDES SKULL FROM YAZOO COUNTY

James E. Starnes and David T. Dockery III, Office of Geology

In May of 2009, the F. M. S. Stonecutting Yard in northern Italy, which cuts stone from around the world for high-end kitchen and bathroom countertops, sliced a massive block of Egyptian limestone, much like sliced bread. The stonecutters found the slabs to be riddled with fossil bones, which marred the slabs, rendering them useless for countertops. However, the stonecutters realized the scientific importance that the bones might have and contacted Italian experts. The bones were identified as those of a fossil whale. The cutters had inadvertently serial sectioned the skull of the 40-million-year-old fossil whale *Basilosaurus isis* (Figure 1).

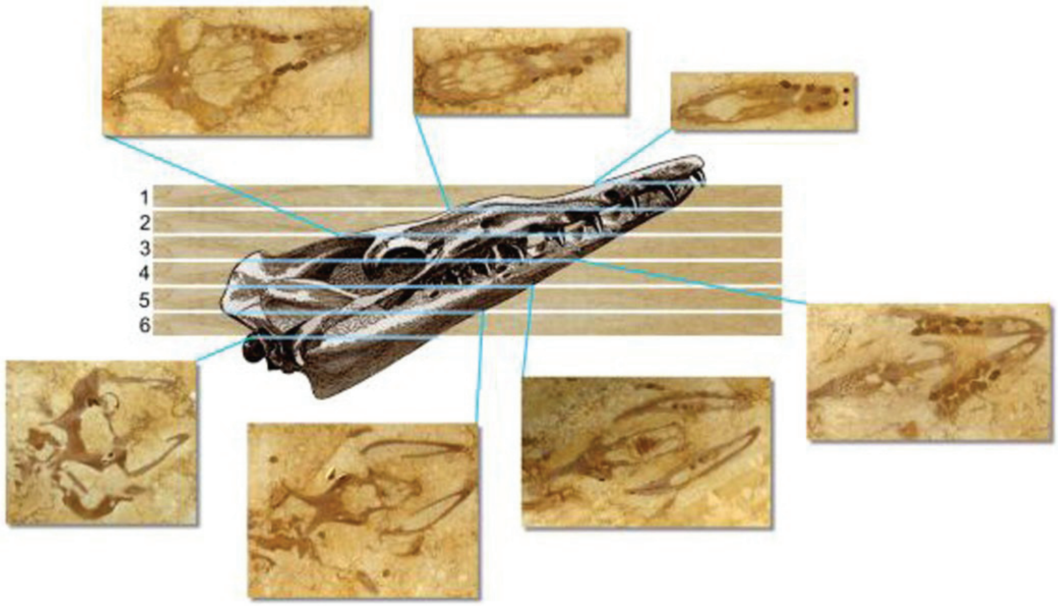


Figure 1. Skull of *Basilosaurus isis* of the Eocene of Egypt slabbed in a limestone block meant for table tops. The skull marred the slabs for use as a table top but was of great scientific interest. This image was provide by Philip Gingerich.

University of Michigan paleontologists Philip Gingerich, Gregg Gunnell, and Bill Sanders went to examine the stone quarry in Egypt from which the whale-skull slabs originated. This led to a segment (Episode 412) in the award-winning television series “Wild Chronicles,” produced by National Geographic Television, featuring the fossil skull and quarry site. Robbie Wilbur sent Dockery a link to the segment in early June of 2009. Dockery then traded fossil whale pictures with Gingerich to get high-quality pictures of the “countertop” whale skull (i.e. figures 1 and 5), which he shared with Office of Geology director Michael Bograd.

On April 2, 2010, Jeff McCraw (Figure 2) discovered a fossil whale skull embedded in the lower Yazoo Clay on a tributary of Techeva Creek in Yazoo County, which he reported to the Mississippi Museum of Natural Science. The skull appeared to be that of *Basilosaurus cetoides* in an upside-down position, showing both empty tooth sockets and sockets with only the tooth roots preserved. The skull was also encased in a hard cocoon of oyster shells, which formed a small reef around it (Figure 3).

Figure 2. Jeff McCraw showing basilosaur skull he found in the lower Yazoo Clay on a tributary of Techeva Creek in Yazoo County, Mississippi. Picture (digital; Image 1353) taken by James Starnes on April 2, 2010.

Figure 3. Basilosaur skull right side up with top eroded and encrusted and surrounded with oysters of the species *Pycnodonta trigonalis* in the lower Yazoo Clay below water level in the creek bed of a tributary of Techeva Creek in Yazoo County, Mississippi. Picture (digital; Image 1354) taken by James Starnes on April 2, 2010.

Figure 4. Working to free the plaster jacket containing a basilosaur skull from the Yazoo Clay on the Pearce Road tributary of Techeva Creek in Yazoo County. Picture (digital; Image 1374) taken by Krista Clark on April 13, 2010.

The excavation of the whale skull occurred on April 12-14, 2010, with volunteers from the Mississippi Museum of Natural Science, the Mississippi Office of Geology, and students from Millsaps College. A trench was dug around the skull, after which it was encased in a plaster jacket. Figure 4 shows the extraordinary effort required to dislodge the plaster jacket containing the skull from the Yazoo Clay bedrock. Once back at the Mississippi Museum of Natural Science, volunteers began the excavation of the "top side" of the skull from the plaster jacket. As their work proceeded they found the tooth sockets to contain teeth pointing upward. It was then that the remembrance of the sliced Egyptian whale skull pictures came to Michael Bograd of the Office of Geology like an epiphany. The skull was not found upside down—it was found right-side-up with the top half eroded away at the creek bottom. Figure 5 shows a comparison of the cut Egyptian whale skull with that from Yazoo County.

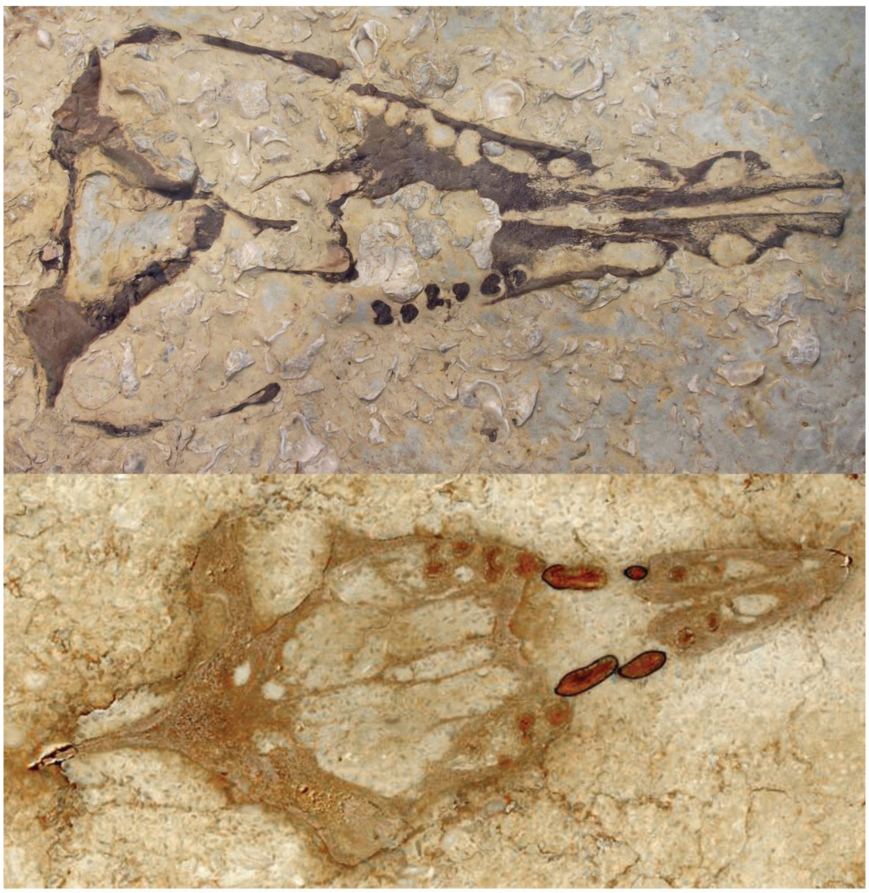


Figure 5. Top, *Basilosaurus cetoides* skull from Yazoo County, Mississippi; bottom, *Basilosaurus isis* skull from Egypt. The top halves of both skulls are missing.

Environmental News, volume 8, number 7, June 2011, pages 19-22

TROPICAL STORM LEE AND THE PEARL RIVER FLOOD OF 2011

David Dockery, Office of Geology

Tropical Storm Lee entered southwest Mississippi on Sunday evening, September 4, 2011, as a tropical depression with maximum sustained winds of 35 miles per hour and heavy rainfall (Figure 1). The heaviest of the rainfall fell in a southwest-to-northeast line within the Pearl River Basin (Figure 2). Within 24 hours 10.68 inches of rain fell at the Jackson International Airport, and 12.34 inches fell at Walnut Grove in Leake County. The Town of Forest in Scott County received some 12 inches of rain as the storm moved through on Monday. Homes, businesses, and parking areas full of cars were flooded by the initial rains as creeks overflowed their banks. When the flash floods subsided, the Pearl River rose 22.74 feet at Jackson in just 24 hours. The river was predicted to crest at 33.5 feet at Jackson on Saturday, September 10 (Figure 3) but crested a day earlier at just over 32 feet as measured at the Highway 80 gage with a discharge of 32,300 cubic feet per second (figures 4-5). This crest level spared Jackson streets, homes, and businesses from flooding, but did not spare the roads at LeFleur's Bluff State Park (Figure 6). The difference in the predicted and actual flood crest was attributed to flood water being absorbed by the dry ground faster than anticipated due to the area's prolonged drought. Also, Ross Barnett Reservoir officials were proactive in releasing water ahead of the projected inflow of storm water into the reservoir, which decreased the flood level by about half a foot and brought the crest a day early. The strong currents seen south of the Highway 80 bridge in Figure 4 are due to the constricted river channel at the bridge, which backs up water north of the bridge.

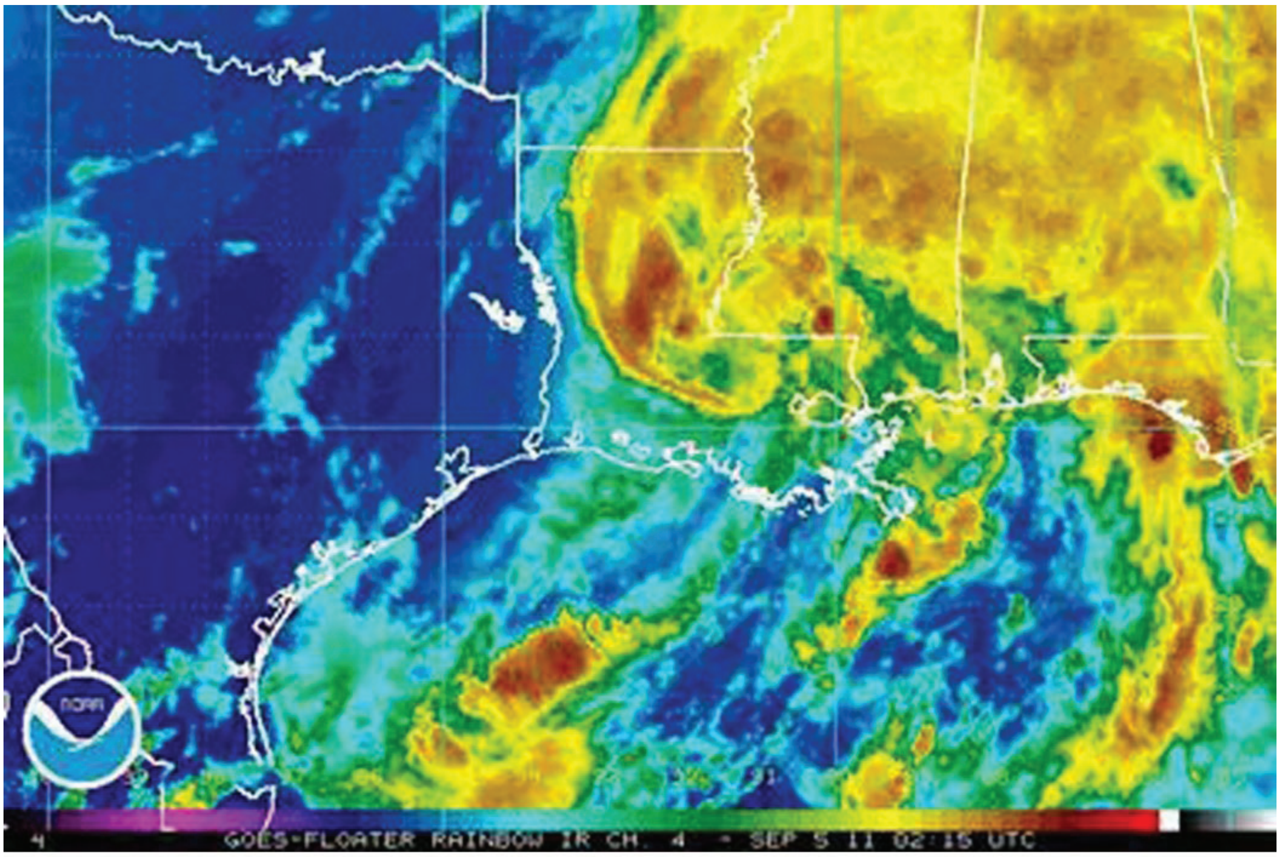


Figure 1. Tropical Depression Lee on Monday, September 5, 2011, when the eye was about 55 miles southwest of McComb, Mississippi. The higher cloud tops are shown in yellow and brown. Image from NOLA.com.

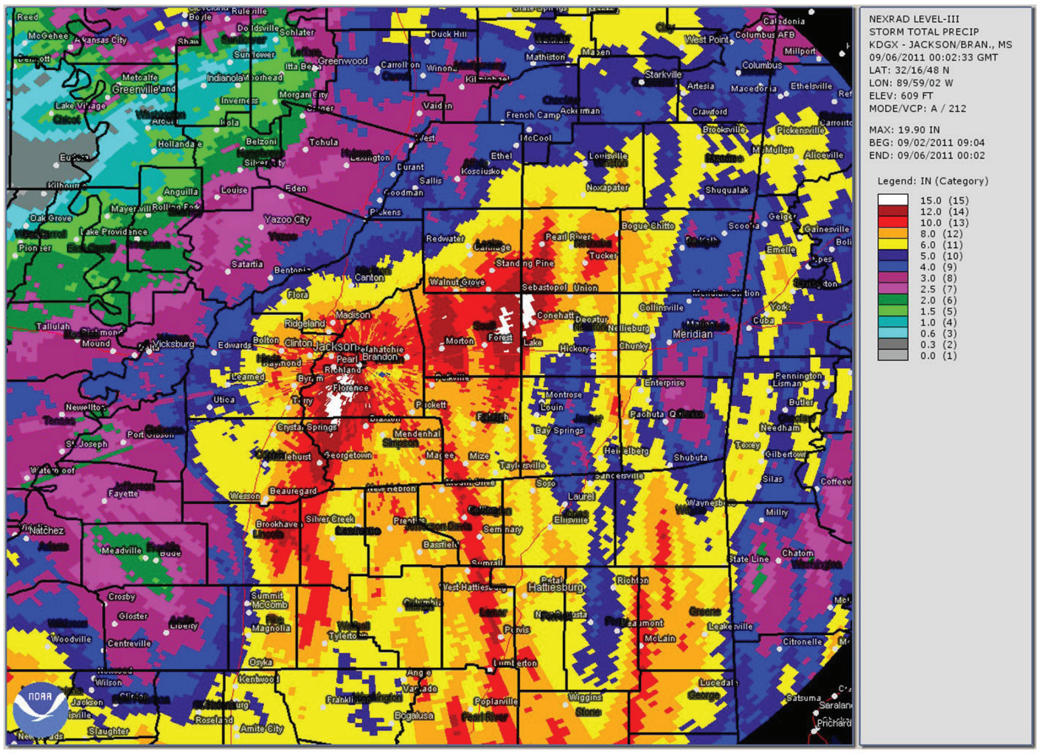


Figure 2. Rainfall accumulations from Tropical Depression Lee as of Tuesday, September 6, 2011. Areas in white received more that 15 inches of rain, dark red more than 12 inches of rain, and light red more than 10 inches of rain. Figure provided by Rodney Cuevas.

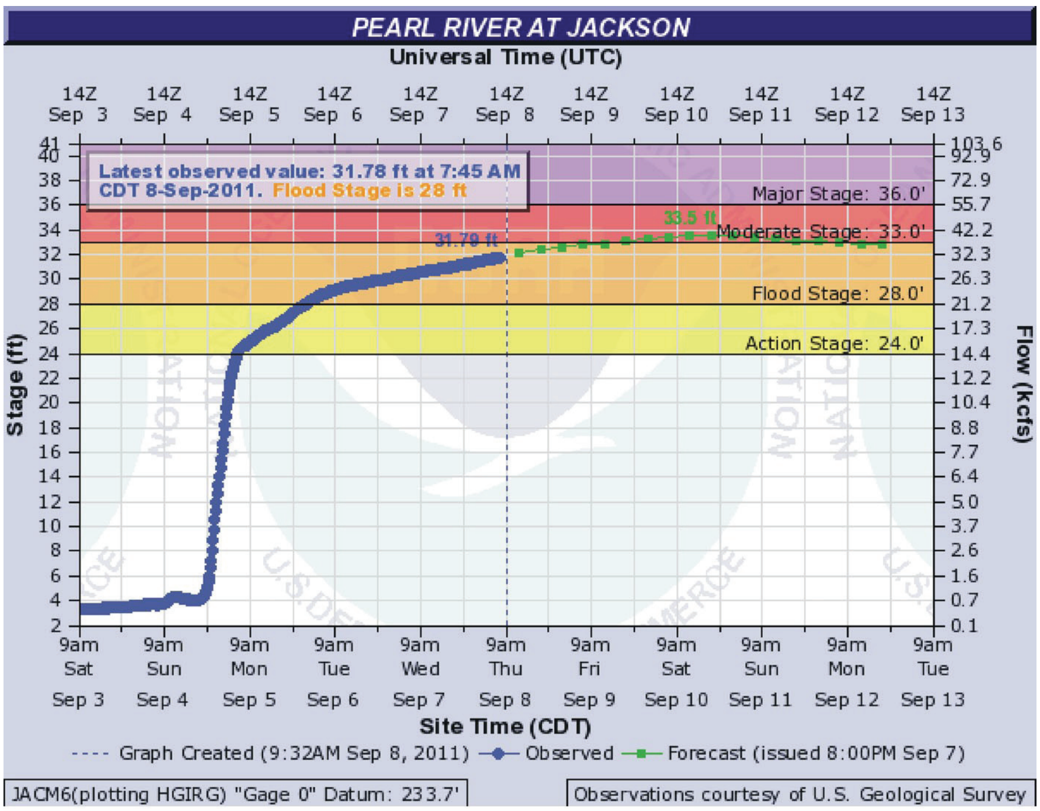


Figure 3. Flood crest of the Pearl River at Jackson, as predicted on September 8 to rise to 33.5 feet at Jackson on September 10, 2011. The actual crest came a day early at 32.1 feet. Figure provided by Rodney Cuevas.

Figure 4. Water swirls under the Highway 80 bridge, looking toward Jackson, with the Pearl River above flood stage. Picture was taken on September 7, 2011.

Figure 5. Radar gage measuring the river height from the Highway 80 bridge in Jackson. Picture was taken on September 7, 2011.

Geologists are interested in significant rainfall events because of: (1) flooding, (2) erosion as raindrops and runoff wear down the land, (3) sedimentation, which can cover fields and clog streams, lakes, and culverts, and (4) hydrologic modifications to stream channels and river bars. Floods are the #1 natural hazard in the United States, occurring in all 50 states and a common geologic hazard in Mississippi. The annual flood loss in 2010 was $5.04 billion, and, in the Hurricane Katrina year of 2005, was $49.66 billion. Flood damage data are compiled by the National Weather Service Weather Forecast offices across the United States and its Territories.

Figure 6. Flooded roads in LeFleur's Bluff State Park in Jackson. The boat ramp sign at left is just above water. Picture was taken on September 7, 2011.

Environmental News, volume 8, number 7, June 2011, pages 23-25

SPANISH MOSS, A NATURAL DETECTOR OF AIRBORNE METAL POLLUTION

David T. Dockery, Office of Geology

Spanish moss is not moss but is a flowering plant (*Tillandsia usneoides*) that grows on trees, especially on the Southern Live Oak (*Quercus virginiana*) and Bald Cypress (*Taxodium distichum*) in the southeastern United States and is associated with Southern Gothic imagery (figures 1-2). Actually (in my opinion) Spanish moss invokes a pre-Gothic image suitable for a world inhabited by dinosaurs. In a publication on the *Ecoregions of the Mississippi Alluvial Plain*, the U.S. EPA recognized the occurrence of Spanish moss in the Southern Holocene Meander Belts Ecoregion (Ecoregion 73k), which extends from Natchez to New Orleans. This region was characterized as having a longer growing season, warmer temperatures, and greater precipitation, and it was noted that "many plant species common to this region, such as live oak, Spanish moss, and laurel oak, do not occur, or are less common in regions to the north." Spanish moss was once more widely distributed in Mississippi, inhabiting not only river-bottom forests but upland forest areas as well. This distribution was greatly reduced over historic times by clear cutting of forests for agriculture and timber. Two upland refugium (an isolated relict population of a once widespread species) sites for Spanish moss in the Jackson Metro area include Camp Garaywa and vicinity in south Clinton and Camp Kickapoo and surroundings just north of Clinton. In the Camp Kickapoo area, Spanish moss is found on many tree species, especially on old-growth red oaks, where it hangs from limbs in both strands and curtains (Figure 3), and even on pine trees (Figure 4). Mississippi's upland occurrences of Spanish moss serve as breeding grounds for certain migratory birds, such as one of the smallest warblers, the Northern Parula (*Parula americana*), which nest in the moss.

Figure 1. Southern Gothic Imagery. The Natchez Trace Parkway logo at the entrance to the parkway from Highway 49 North at Jackson, Mississippi, contains the elements of a traveler on horse with Spanish moss hanging from tree limbs. Picture was taken on December 20, 2009.

Figure 2. Southern Gothic Imagery. A forest canopy draped in Spanish moss near Camp Kickapoo in northwest Hinds County. Picture was taken on June 20, 2011.

Figure 3. Curtains of Spanish moss draping the limbs of red oak trees greet the morning sun near Camp Kickapoo in northwest Hinds County. Picture was taken on June 7, 2011.

Figure 4. A pine tree with Spanish moss near Camp Kickapoo in northwest Hinds County. Picture was taken on June 5, 2011.

Some of the older generation in the Camp Kickapoo area once made a brew called “moss tea” by boiling green (live) Spanish moss, decanting the liquid, and refrigerating it for treatment of high blood pressure. Other such non-FDA approved medicinal uses of moss tea include: (1) once used by the Natchez Indians for expectant mothers to make the delivery easier, (2) used as a folk remedy for rheumatism, (3) used in Mexico to treat infantile epilepsy, and (4) used in the 1950s as an estrogen substitute. Of scientific interest, Spanish moss has been found to exhibit antibacterial properties and a few studies have found an oral extract of Spanish moss to reduce blood glucose in laboratory animals. In 2004, a Japanese cosmetics manufacturer discovered an anti-aging property in Spanish moss. Based on the company’s research, a Spanish moss-derived extract can strengthen and protect skin capillaries and help inhibit the functional decline of skin cells.

Unlike hemi-parasitic mistletoe, Spanish moss is an epiphyte, which absorbs nutrients directly from the air and rainfall. Oddly, Spanish moss and the pineapple are in the same plant family (Bromeliaceae). In the early 20th Century, Spanish moss was used for building insulation, mulch, packing material, mattress stuffing, fiber, and in the padding of car seats. In 1939, the production of processed moss was over 10,000 tons. Today, it is used in smaller amounts for arts and crafts and for beddings for flower gardens.

In 1973, the U.S. Geological Survey published a novel study on airborne chemical elements in Spanish moss (H. T. Shacklette and J. J. Connor, 1973, Airborne chemical elements in Spanish moss: U.S. Geological Survey, Professional Paper 574-E, 46 p.). As an epiphyte, Spanish moss soaks up whatever elements the air contains. The USGS study tested 38 chemical elements in 123 samples and proved that an elemental analysis of Spanish moss was "an economical and rapid method of estimating the kind and relative degree of local atmospheric metal pollution." Spanish moss sampled in rural settings had an elemental composition consistent with that of soil dust. Samples from industrial and highway locations had elevated amounts of arsenic, cadmium, chromium, cobalt, copper, lead, nickel, and vanadium. Those samples near the sea contained elevated amounts of sodium from ocean spray. Samples collected within 50 miles of the only tin smelter in the United States contained traces of tin. In Mississippi, Sample 52, taken 6 miles south of Monticello near the Pearl River, contained elements not commonly detected elsewhere, including cerium, neodymium, and niobium.

Figure 5. Looking Regal. A bob-tailed cat stretches atop a Hummer in front of a Spanish moss-covered forest in northwest Hinds County. Picture was taken on June 12, 2011.

Living with Spanish Moss.

The following are some positives and negatives of living with Spanish moss.

Positives:

1. It's great for that "Southern Gothic" look. Creatures and things look more regal with a backdrop of Spanish moss (Figure 5).
2. It serves as a natural weather vane, showing the strength and direction of the wind.
3. Small birds nest in it.
4. It makes great "Handy Wipes" if your hands get greasy from working with outdoor equipment. However, I've heard from an anonymous source that if you use it for toilet paper, you might get a rash.
5. It makes a great "Brillo Pad" for wiping the algae out of the dog's water dish.
6. It's handy for covering dog poop when walking the dog, so that you don't step in it on the way back.
7. It is used in arts and crafts and for beddings for potted plants and gardens.

Negatives:

1. It drops in small and large piles on your manicured, or not so manicured, lawn.
2. It can wrap around the axle of a lawn mower and choke it to a stop.
3. It can wrap around the sprocket of a chainsaw and choke it to a stop.
4. It can wrap around the rear wheel axle of a Bushhog mower and the power-take-off train of a tractor. The longer the equipment runs with this problem, the more tightly the moss is wound. Tightly wound moss and vines can break the oil seal of a Bushhog gearbox or the hydraulic seals of the front wheels of a four-wheel-drive tractor (both have happened to me).
5. It catches on car or truck antennae and rearview mirrors when driving through the woods.
6. Spanish moss is readily flammable and can be a fire hazard when used for interior purposes (Indians used Spanish moss to make fire arrows).
7. A surprise encounter with a dangling strand of Spanish moss feels like an encounter with a dearfly, horsefly, or wasp (or other members of the Hymenoptera) and solicits the same adrenaline rush and involuntary response to duck and cover.

Environmental News, volume 8, number 8, June 2011, pages 5-8

THE USGS BOAT *E. H. BOSWELL*

David T. Dockery III, Mississippi Office of Geology

Personnel of the U.S. Geological Survey (USGS) played an important role during the Mississippi River Flood of 2011 in measuring discharge rates at key gage stations along the river and its tributaries. This work required a presence on the river in USGS watercraft. Figure 1 of the Highway 84 Bridge at Natchez was taken by Jared Wright of the USGS while measuring the discharge rate on May 21, 2011. Figure 2 is a close up of the same bridge taken by James Matheny of the Office of Geology on May 17, 2011, while checking on flooded oil wells and storage tanks. Unlike the foot markers on the river gages, which increase with vertical height, the foot markers on the bridge piling photographed by Matheny decrease with vertical height, showing a decrease in clearance under the bridge as the flood height rises. Figure 3 shows the floodwall at Vicksburg from the river side as taken by Jared Wright on May 19, 2011.

Figure 1. The Highway 84 Bridge over the Mississippi River at Natchez during the 2011 flood. The white gage on the bridge piling at right gives the clearance between the bridge and water level. Picture was taken by Jared Wright on May 21, 2011.

Figure 2. Closeup view of the clearance gage on the Highway 84 Bridge at Natchez. Picture was taken by James Matheny on May 17, 2011.

Figure 3. The floodwall at Vicksburg during the 2011 flood crest. Beneath the water level is the marker for the 1927 flood crest as happened. Picture was taken by Jared Wright on May 19, 2011.

On August 24, 2011, James Starnes and I traveled to Vicksburg to photograph the bathtub ring left by the 2011 flood crest on the river side of the Vicksburg floodwall (figures 4 and 5). The reason we expected to find a bathtub ring was that rings had been left on the wall by the 2008 and 2009 Mississippi River floods. While there, we were just in time to see a new USGS boat, the *E. H. Boswell*, loaded onto its trailer (Figure 6). The *E. H. Boswell* was christened on the Ross Barnett Reservoir on April 16, 2011 (a day after the Clinton tornado came across the reservoir as a waterspout), as part of Waterfest 2011. The boat was named for the late Ernest H. Boswell (Figure 7) in honor of his outstanding 35-year career with the USGS and as lead groundwater hydrologist for the Mississippi Department of Environmental Quality, Office of Land and Water Resources. According to the USGS, "Mr. Boswell is widely recognized as one of the nation's premier groundwater scientists for his extensive work defining the geohydrology of the Mississippi Embayment." Boswell's son Harry now works for MDEQ as supervisor of the Database Administration Branch; he worked for the Mississippi Geological Survey from 1972-1975.

Figure 4. Historic flood crests marked on the Vicksburg floodwall. The uppermost marker is for the 1927 flood if levees had held (62.2 feet). Below that is the 2011 flood bathtub ring followed by the muddy marker for the 1927 flood as happened (56.2 feet). Picture was taken on August 24, 2011.

Figure 5. The 2011 flood crest bathtub ring along the length of the Vicksburg floodwall. The lower half of the wall was washed clean by the flood waters, while the upper half is gray from years of dust and dirt accumulation. Picture was taken on August 24, 2011.

Figure 6. Loading the *E. H. Boswell* onto its trailer at the Vicksburg waterfront. The boat was christened on April 16, 2011. Picture was taken on August 24, 2011.

Figure 7. The late Ernest H. Boswell.

Environmental News, volume 8, number 8, June 2011, pages 17-20

SEISMIC SURVEYS TO IMAGE JACKSON METRO'S DEEP ROCK FORMATIONS AND BURIED VOLCANIC VENTS

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

Seismic receivers, called geophones, appeared along Jackson Metro roadways this summer as Denbury Resources searched for new reserves of carbon dioxide and "shot" seismic lines across the city. These seismic surveys are of geologic interest in that they will image the structure of the Jackson Dome and the volcanic vents buried beneath the city. This project is of environmental interest as well, because Denbury Resources is piping carbon dioxide from such underground sources to old depleted oil fields, where it is injected to recover additional oil reserves. This process, and associated technologies, are in line with a federal government initiative to sequester anthropogenic carbon dioxide (i.e. electric power plants that use fossil fuels).

These current seismic surveys are utilizing vibrator trucks, rather than explosives, as an energy source in a process termed reflection seismology. Hydraulically produced, low-frequency, compressional waves are sent through a metal plate at the base of these vibrator trucks (four lined up single-file) and into the ground to image rock layers at depths up to 18,000 feet. Figure 1 displays vibrator trucks in action on Medgar Evers Boulevard, at the Jackson Campus of Hinds Community College. A vibrator truck in operation, with its metal plate to the pavement, is shown in Figure 2. While taking these pictures from across the street, I (Dockery) couldn't feel the vibrations, even though rocks at 18,000 feet could. Figure 3 is a picture of a seismic receiver (geophone) set up along Fortification Street in Jackson not far from MDEQ's 700 North State Street Building.

Figure 1. Vibrator trucks in operation on Medgar Evers Boulevard in Jackson at the Jackson Campus of Hinds Community College, with police car escort. Picture was taken on July 14, 2011.

Figure 2. Vibrator truck in operation with its metal plate to the pavement on Medgar Evers Boulevard in Jackson near the Jackson Campus of Hinds Community College. Picture was taken on July 14, 2011.

Figure 3. Seismic receiver (geophone) on Fortification Street in Jackson; a second receiver can be seen up the hill in the distance. Picture was taken on July 11, 2011.

In 2001, Keith Bowman, a geologist with Denbury Resources, stated (personal communication) that the estimated carbon dioxide reserves of Rankin and Madison counties amounted to 11 trillion cubic feet, or 8.5% of the U.S. national reserves of the lower 48 states. This volume of carbon dioxide was derived from the Jackson Volcano during its active phase. An indication of the importance of Central Mississippi's carbon dioxide reserves is the inclusion of certain artist illustrations in Denbury Resources' 2007 Annual Report. This report featured illustrations of the Jackson area as it was 75 million years ago, when it was a volcanic island in a Cretaceous seaway. The cover illustration of the annual report and an accompanying illustration on page 20 are shown in figures 4 and 5. Once the Jackson Volcano became inactive and the heat plume beneath it cooled, the island sank, and its lofty crest was truncated by the ocean surf.

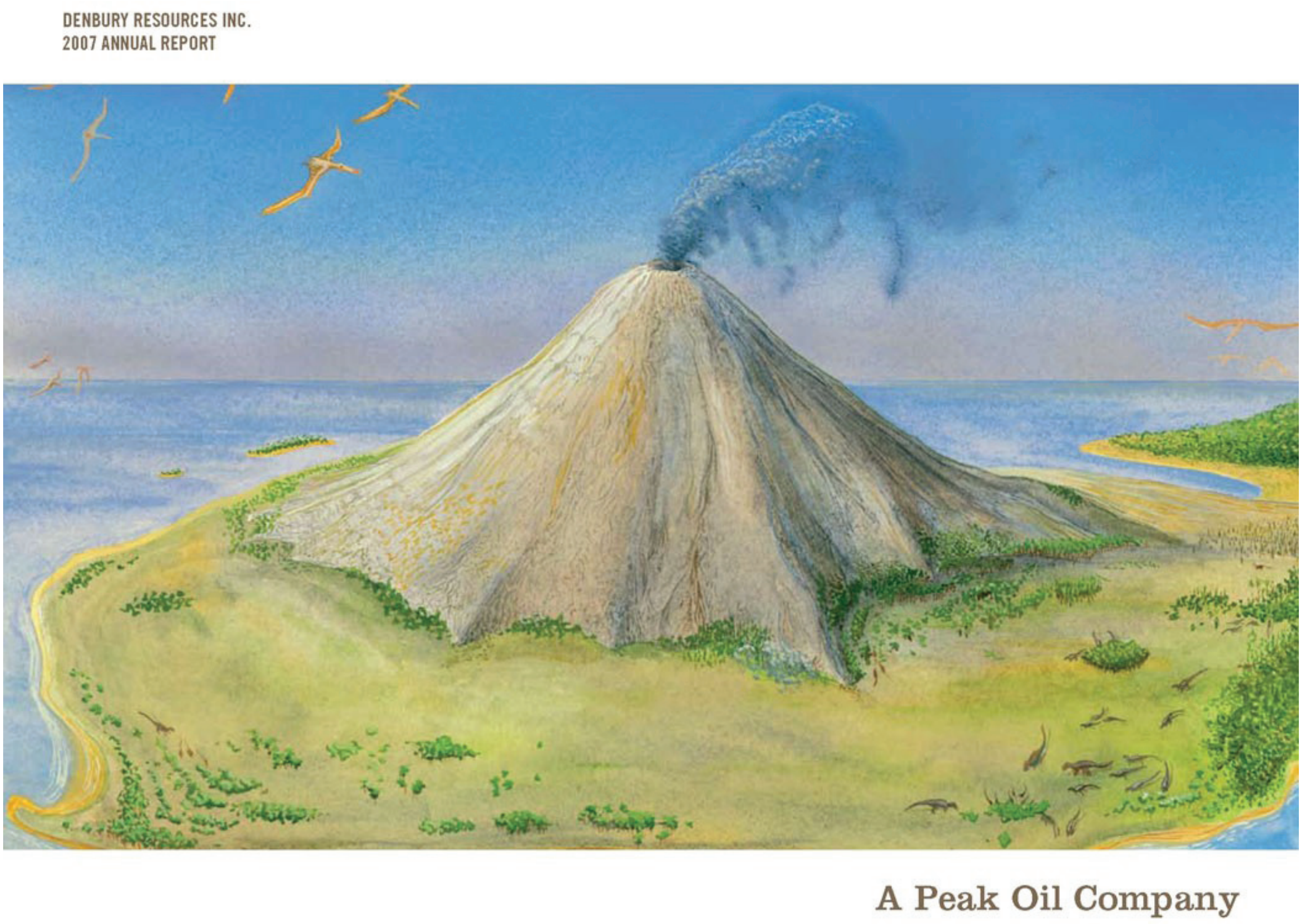


Figure 4. Jackson volcanic island 75 million years ago in the Campanian Stage of the Late Cretaceous, with a group of dinosaurs at lower right. Denbury Resources 2007 Annual Report, cover page.

Today the truncated surface of the Jackson volcanic island occupies some 420 square miles beneath the cities of Jackson, Ridgeland, Flowood, Pearl, Richland, and Clinton, where it is buried about half a mile or more beneath the surface. Figure 6 shows the buried island surface (subcrop) overlain by a Jackson area road map. The concentric bands of the island surface are geologic formations, which increase in age toward the center of the dome's uplift. Sedimentary rocks (in light yellow) at the center of the uplift belong the Late Jurassic Cotton Valley Group. These rocks have been uplifted some 10,000 feet. The pink oval within the Cotton Valley subcrop is the main vent of the Jackson Volcano. A second pink oval to the west is a secondary volcanic vent along the Jackson-Clinton city line; this vent is sometimes called the Clinton vent. These vents were identified from gravity surveys, which showed them to be areas of increased gravitation force due to the higher density of the volcanic (igneous) rock as compared to the sedimentary rocks. Anyone living above these vents actually weighs a little more than they would elsewhere.

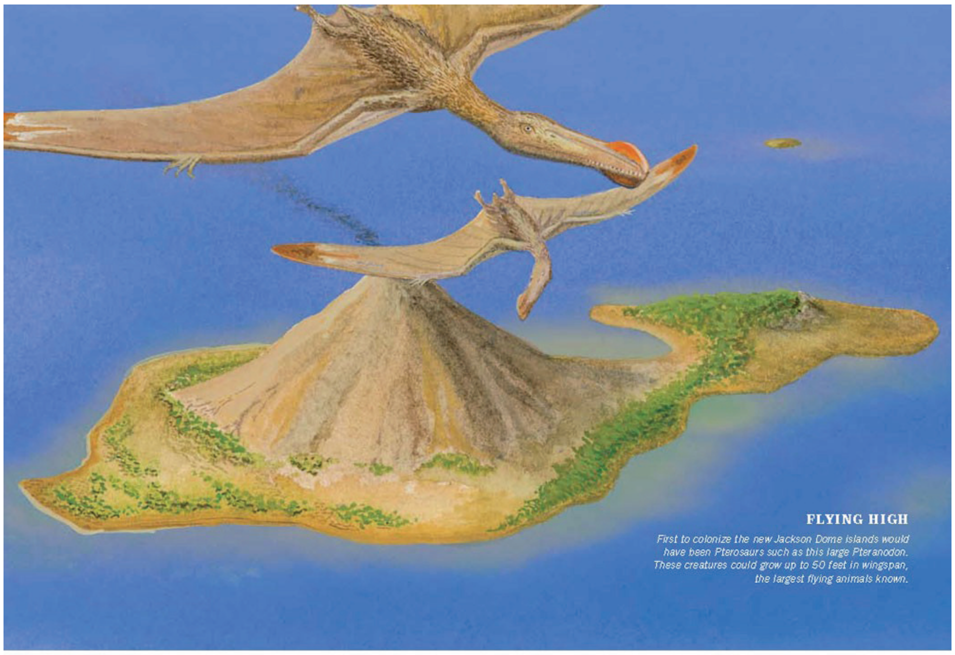


Figure 5. The caption reads: "Flying High. First to colonize the new Jackson Dome islands would have been Pterosaurs such as this large *Pteranodon*. These creatures could grow up to 50 feet in wingspan, the largest flying animals known." Denbury Resources 2007 Annual Report, page 20.

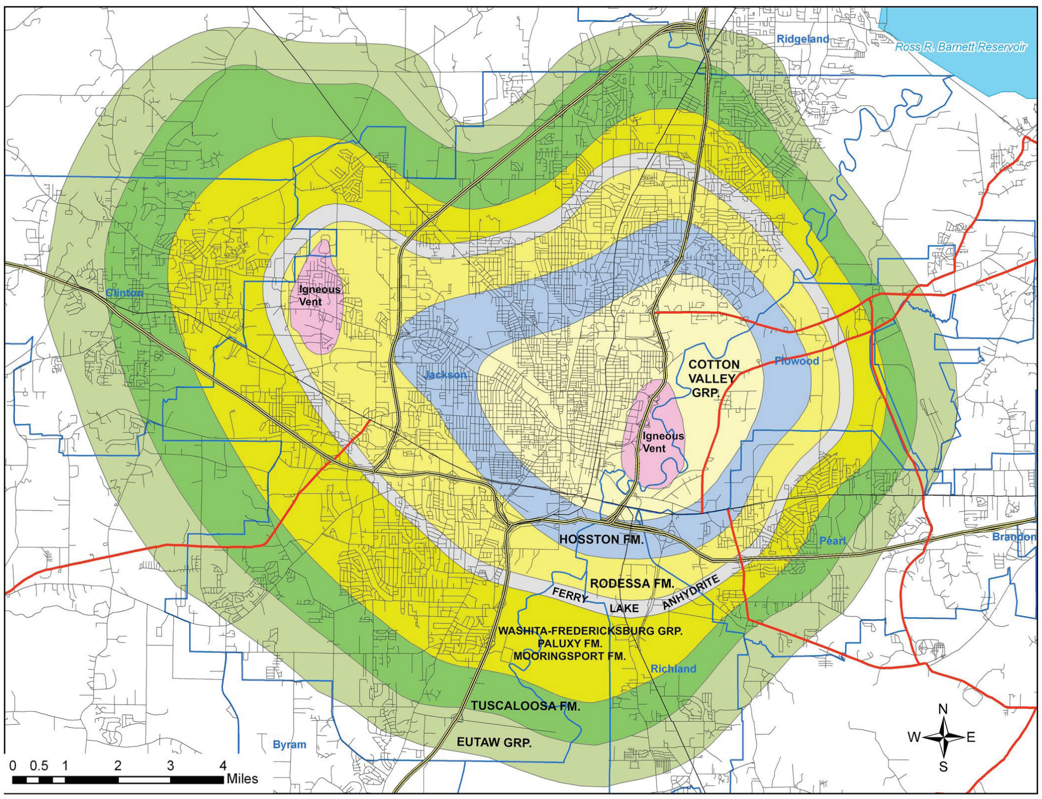


Figure 6. Subcrop map of the truncated surface of the Jackson volcanic island buried about one half mile beneath the Jackson Metro area, overlain with a map of the city streets. The Jackson (right) and Clinton (left) volcanic vents are in pink.

Environmental News, volume 8, number 9, June 2011, pages 8-12

MISSISSIPPI'S ANCIENT GREAT WHITE SHARK

David T. Dockery III, Office of Geology

Gary L. Stringer, Department of Geosciences, University of Louisiana at Monroe

The Yazoo Clay of Mississippi, Louisiana, and Alabama contains the fossil remains of the top two predators of the Eocene Epoch, the 65-foot-long whale *Basilosaurus cetoides* and the great white shark *Carcharodon angustidens*. These predators once battled for supremacy in the Late Eocene Sea that covered Mississippi some 38 to 33 million years ago. *C. angustidens* was named in 1843 by Louis Agassiz, who was Harvard's most famous professor; his natural history lectures in 1846 were acclaimed both on campus and in New York. Agassiz's shark species *C. angustidens* survived into the Oligocene Epoch, while *Basilosaurus* and all other related archaeocete whales became extinct near the end of the Eocene. *C. angustidens* is known in the Eocene and Oligocene of Mississippi from fossil teeth and calicified vertebral centra (Figure 1).

Figure 1. Tooth and calcified vertebral disk of the giant white shark *Carcharodon angustidens* from the Moodys Branch Formation at Techeva Creek in Yazoo County. Picture (digital) taken by George Phillips on January 5, 2007.

Agassiz recognized the teeth of *C. angustidens* to be related to those of the modern great white shark, the monster in the movie *Jaws*, *Carcharodon carcharias*. This relationship was disputed in 1964 when shark expert L.S. Glikman recognized a transition of *Otodus obliquus*, a Paleocene to Early Eocene shark (Figure 2), to *Carcharodon auriculatus* Blainville, 1818, a Middle Eocene shark, and moved both *C. auriculatus* and *C. angustidens* to the genus *Otodus*. In 1987, H. Cappetta hypothesized a lineage from *C. auriculatus* to the giant Miocene and Pliocene shark *Carcharodon megalodon* and placed the species of this lineage in the genus *Carcharocles*, a genus named in 1923 by shark researchers D. S. Jordan and H. Hannibal for the species *C. auriculatus*. Dockery and Manning followed the generic placement of Agassiz, but recognized *Carcharodon angustidens* as a synonym of *C. auriculatus* in an article in the September 1986 issue of *Mississippi Geology*, which illustrated the largest known shark teeth of *Carcharodon "auriculatus"* from the state. Some of these teeth are shown in Figure 3. The teeth of the upper jaw are more broad-bladed than those of the lower jaw.

Figure 2. *Otodus obliquus* Agassiz, 1843, collected by Gerry Powers from the Bashi Formation on Sowashee Creek in Lauderdale County, Mississippi (MGS locality 166). This is the largest shark tooth known from the Bashi Formation (scale on both sides in millimeters). Picture (digital) taken by George Phillips.

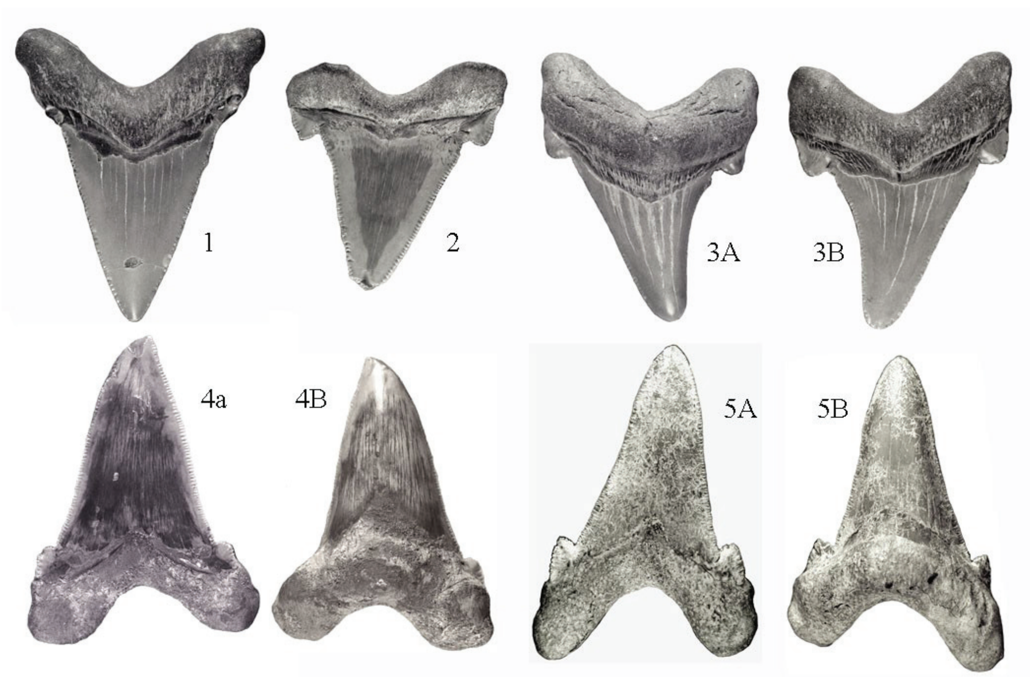


Figure 3. Upper (top) and lower (bottom) teeth of *Carcharodon angustidens* Agassiz, 1843. Figure 1 is from the Yazoo Clay in Yazoo City. Figure 2 is from the Byram Formation north of Redwood in Warren County. Figure 3 is from the Yazoo Clay in Yazoo City. Figure 4 is from the Byram Formation at Vicksburg and is the largest shark tooth known from Mississippi. Figure 5 is from the Yazoo Formation at Jackson and is the longest shark tooth known from Mississippi. These teeth were first illustrated in the September 1986 issue of *Mississippi Geology*.

Since the Dockery and Manning publication, shark expert David Ward of England suggested to Dockery that a specific difference in the serrations along the edges of *C. auriculatus* and *C. angustidens* could be used as a character in separating the species. The serrations of *C. angustidens* are more regular than those of the earlier shark *C. auriculatus*. Figures 4 and 5 compare specimens of *C. auriculatus* from the Cane River Formation in Louisiana to specimens of *C. angustidens* from the Moodys Branch Formation in Jackson, Mississippi; serrations on *C. auriculatus* grade from coarse to fine. In Mississippi, *C. auriculatus* has been found in the Winona Formation (a stratigraphic equivalent of the upper Cane River Formation) on the Chickasawhay River at Enterprise.

Figure 4. *Carcharodon angustidens* (left) from the Moodys Branch Formation at Town Creek in Jackson, Mississippi. *Carcharodon auriculatus* (right) collected by Jeff Brantly in May 1993 from the Cane River Formation on Interstate 49 at Natchitoches, Louisiana. Picture (digital, DVD #60) taken by George Phillips on July 8, 2009.

Figure 5. *Carcharodon auriculatus* (left) collected by Jeff Brantly in May 1993 from the Cane River Formation on Interstate 49 at Natchitoches, Louisiana, and *Carcharodon angustidens* (right) from the Moodys Branch Formation at Town Creek in Jackson, Mississippi. Picture (digital, DVD #60) taken by George Phillips on July 8, 2009.

Specimens of *C. angustidens* are known in Mississippi (in ascending order) from the Moodys Branch Formation, Yazoo Formation, Red Bluff Formation, Mint Spring Formation (Figure 6), Byram Formation, and the Chickasawhay Limestone (Figure 7). The Dockery and Manning article (cited above) illustrated the largest known shark teeth from Mississippi in hopes that the readers would report even larger teeth that they had found. The longest shark tooth (Figure 2, #5) was from the Yazoo clay at Jackson and had a height of 90.4 millimeters, a width of 66.3 millimeters, and a volume of 29.8 cubic centimeters. The largest (by volume) shark tooth (Figure 2, #4) was from the Byram Formation at Vicksburg and had a height of 87.7 millimeters, a width of 65.3 millimeters, and a volume of 34.8 cubic centimeters. The writers had no idea their publication would foster competition from the neighboring state of Louisiana. Figure 8 shows a large *C. angustidens* tooth collected by Gary Stringer on August 17, 2009, from the lower Yazoo Clay at Copenhagen in Caldwell Parish, Louisiana. It measures 91.5 millimeters in height and 70.8 millimeters in width, just edging out Mississippi's "highest" shark tooth of 90.4 millimeters.

Figure 6. *Carcharodon angustidens* (giant white shark tooth) from the Mint Spring Formation at MGS locality 99 in Rankin County. Picture (Kodachrome slide 237-6) taken on May 24, 1993.

Figure 7. Rare *Carcharodon angustidens* specimen from the Chickasawhay Limestone at excavation for the new Highway 84 in Wayne County (MGS locality 170). Picture (digital) taken by George Phillips on March 8, 2007.

Figure 8. Record-breaking large shark tooth of *Carcharodon angustidens* Agassiz, 1843, found by Gary Stringer in the Yazoo Clay at Copenhagen, Louisiana. The tooth is 91.52 mm in height, 70.83 mm in width, and weighs 66.34 grams.

Environmental News, volume 8, number 6, June 2011, pages 19-24

IN SEARCH OF THE BRANDYWINE STONE WALL

David T. Dockery III, Office of Geology

The November 7, 1900, edition of *The New York Times* contained an article entitled "Mississippi's Great Wall. A Mysterious Structure Whose Builder No One Now Knows," which gave the following account: "From *The New Orleans Picayune*. One of the scientific puzzles of the State of Mississippi is the 'Brandywine Stone Wall.' It has been a problem that is yet unsolved. Some time ago Mr. Thomas Watson of Hazlehurst sent Gov. Longino (the state's 35th governor, 1900-1904) a pencil drawing of an immense pile of stone in the southeastern portion of Claiborne County, suggesting that the stone might be utilized in building the new Capitol (the cornerstone of which was laid on June 3, 1903). In a letter which accompanied the drawing Mr. Watson stated that these stones, piled high on each other, cover an area of four square miles. Each stone is 6 feet long, 3 feet wide, and 2 feet thick, and they are joined together with an excellent quality of cement. No man knows how they came there. They may have been there for thousands of years." *The New York Times* then cited *The Jackson News* as thinking: "The builders were some prehistoric race—it could not be otherwise."

The *Times* added that: "This structure is supposed to be a continuation of the great 'Chinese wall,' which seems to begin below Raymond, in the southern part of Hinds County, and which is traceable through Copiah. It is broad enough to accommodate two or three wagons abreast, and is one of the wonders of the world." The *Times* cited *The Hazlehurst Courier*, which credited a Mr. Watson with the following account: "He (Mr. Watson) calls it the 'Brandywine Stone Wall,' and says this wonderful and massive structure or parts of the structure of masonry done in stone, which has withstood the ravages of time for perhaps many thousands of years, still stands an enduring relic of a prehistoric civilization and a knowledge of the art of building not inferior in many respects to the present day. These stone buildings lie, for the most part, buried in the earth in the southeastern portion of Claiborne County, and lying against the Copiah County line, on the slopes overlooking the valley of the Brandywine Creek from the west side."

The Hazlehurst Courier citation gave Mr. Watson's description of the Brandywine Stone Wall at other locations and concluded with these paragraphs:

"A personal inspection of these great structures as they lie partly buried in the earth would relieve the minds of the most skeptical of all doubt of it not being the work of the hands of man.

"In all that is above mentioned in connection with numerous cavings-in of the earth's crust, which represent the existence of underground caverns, abundant evidence is found to bear out the theory of the existence of a great buried city in that locality.

"The information above given is vouched for by other parties who have visited the scene in recent years, and bears out the theory advanced by Mr. Watson. Truly, there is work for the scientist here."

So, what have scientists said about the "Brandywine Wall?" Like debunked conspiracy theories, exotic stories of lost civilizations tend to resurrect themselves. The "Brandywine Wall" story began some time before 1860 and had been investigated and explained by State Geologist Eugene Hilgard, in his 1860 book on the geology of Mississippi. On page 152 of that book, Hilgard stated that weathered sandstones of the Grand Gulf Group showed "a tendency to cleave at right angles to the plane of stratification; hence such blocks frequently appear in the shape of short angular prisms, often of great regularity." He went on to explain that, in several instances, this led "to the belief that these forms were the result of human agency" and gave as example a hard cherty ledge of sandstone on a creek some distance east of Cato on Mr. J. Morrison's property in Section 13, T. 3 N., R. 4 E. [not 2 E. as originally cited], Rankin County.

Charles Peabody visited and photographed the Brandywine Wall on July 2, 1901, during his exploration of Indian mounds in Coahoma County, Mississippi. He published two pictures (Figure 1) of the wall in: Peabody, C., 1904, Exploration of Mounds, Coahoma County, Mississippi (Appendix II; plates 21-22): Peabody Museum of American Archaeology and Ethnology, Harvard University, volume III, number 2, 63 pages, plates 6-22. The following is his account in Appendix II:

"After the conclusion of the work in Coahoma County in 1901, the writer, in company with Mr. C. W. Clark, of Clarksdale, made an excursion to Brandywine, Claiborne County, Mississippi, for the purpose of looking at the so-called prehistoric wall of that district.

"July second was spent in examining and photographing the 'wall.' As far as can be asserted from such a brief study, the 'wall' is a perpendicular stratum of white sandstone of natural formation which presents several outcrops near Brandywine. At the surface the stone is broken by natural cleavage with blocks of a general size of, say 5'5" x 2'6" x 2' ½". Between these is a soft deposit of so-called "Cement," found upon examination at the Mineralogical Museum of Harvard University by Dr. Palache, to consist of decomposed sandstone, produced by weathering possibly, with perhaps some admixture of iron. Other outcrops of a similar formation occur not far distant."

Peabody Museum Papers. VOL. III, PL. XXI.

THE "COPIAH COUNTY WALL." OUTCROP NEAR BRANDYWINE, MISSISSIPPI. FROM THE SOUTH.

Peabody Museum Papers. VOL. III, PL. XXII.

THE "COPIAH COUNTY WALL." OUTCROP NEAR BRANDYWINE, MISSISSIPPI. LOOKING WEST.

Figure 1. The "Copiah County Wall" photographed on July 2, 1901, in plates 21 and 22 of: Charles Peabody, 1904, Exploration of Mounds, Coahoma County, Mississippi, 63 p., 22 pl.: Peabody Museum of American Archaeology and Ethnology, Harvard University, Appendix 2, plates 21-22.

State Geologist E. N. Lowe, in his 1919 (page 92) and 1925 (page 74) publications on the geology of Mississippi, gave the following description of the "Grand Gulf rock:" "In Rankin, Copiah, and Claiborne counties its resemblance to massive masonry has lead to many so-called discoveries of ancient ruins." The "Grand Gulf rock" is now recognized as the Catahoula Formation, and it is the sandstones of this formation near the old community of Brandywine in Claiborne County that were thought by some to be such a ruin and gave the name to the Brandywine Wall. According to an article by C. McIntire entitled "Brandywine Wall a curious creation of nature" in the March 8, 1981, edition of *The Clarion-Ledger*, the regular size of jointed Catahoula sandstone blocks measuring six feet, by two feet, by three feet at several outcrops fooled some in the 19th Century, including Governor Andrew Longino, to believe the stones were an ancient wall on the scale of the Great Wall of China, extending some 50 miles through Copiah, Claiborne, and Hinds counties. Many saw this "archaeological find" as a possible world attraction.

Field work by the Mississippi Office of Geology has yet to find Mr. Watson's "immense pile" of stone in Claiborne County or evidence of the Brandywine Stone Wall. In 1988, Ed Luper of the Office of Geology led a fieldtrip to find the Brandywine Wall. The trip started with a visit to Brandywine Methodist Church, established in 1846 (Figure 2). The best rock outcrop near the church was found at Rock Falls, a waterfall over Catahoula sandstone on the Little Bayou Pierre (figures 3-4). Figure 5 shows a long rectangular block of Catahoula sandstone that forms a natural bridge in Jefferson County. Later fieldwork found several examples of rectangular blocks of Catahoula sandstone that appeared to be precision cut, including blocks at Rocky Falls on Turkey Creek in Copiah County (figures 6-8) and stones in the banks (Figure 9) and stream bed (Figure 10) of Flowers Creek in Claiborne County. These stones, and the investigations of the archaeologist and geologists mentioned above, indicate that "Brandywine Wall" is a natural phenomenon.

Figure 2. Chuck Peel (left) and Ed Luper (right) at Brandywine Methodist Church, established in 1846, near the site of the "Brandywine Wall" in southeastern Claiborne County along the west valley wall of Brandywine Creek. Picture (negative 320-12b; Image 1734) taken on June 24, 1988.

Figure 3. Ed Luper standing on Rock Falls on Little Bayou Pierre in the SE/4, SE/4, Section 28, T. 11 N., R. 4 E. in Claiborne County near Brandywine Church. Picture (negative 320-25b; Image 1735) taken on June 24, 1988.

Figure 4. David Dockery standing in a pothole in the Catahoula sandstone at Rock Falls on Little Bayou Pierre in Claiborne County. The pothole is so deep that only his head is visible. Picture (negative 320-42b; Image 1736) taken on June 24, 1988.

Figure 5. Natural bridge formed by a creek undercutting a slab of Catahoula sandstone at the Ed McKinney farm in Jefferson County. Picture (scanned print; Image 908) from Ed Blake, at far left in picture, taken on February 11, 1984.

Figure 6. Rocky Falls on Turkey Creek in the SW/4, NE/4, NE/4, Section 2, T. 1 N., R. 3 W., Copiah County, Mississippi. Left to right are Marty Barnes, Richard Mosley, and Ken Davis standing on a ledge of Catahoula sandstone. Davis worked for the Office of Geology at this time. Picture (digital, DVD #60) taken on June 2, 2009.

Figure 7. Stepping stone path to the north side of Turkey Creek below Rocky Falls in Copiah County, where a large sandstone block has fallen from the waterfall ledge along right-angle joints as if precision cut. Picture (digital, DVD #60) taken on June 2, 2009.

Figure 8. Large rectangular block of Catahoula sandstone at lower left below Rocky Falls on Turkey Creek in Copiah County. Another rectangular block is partially hidden in vegetation at far left center. Picture (digital, DVD #60) taken on June 2, 2009.

Figure 9. Blocks of Catahoula sandstone in the banks of Flowers Creek in Claiborne County. Picture (digital, DVD #60) taken on June 30, 2009.

Figure 10. Dimension-stone-looking blocks of Catahoula sandstone in the creek bottom of Flowers Creek near a bridge crossing just northeast of the center of Section 1, T. 12 N., R. 4 E., Claiborne County. Picture (digital, DVD #60) taken on June 30, 2009.

Environmental News, volume 8, number 10, June 2011, pages 14-18

MISSISSIPPI TECHNOLOGY THAT KILLED BP'S DEEPWATER HORIZON/MACONDO BLOW-OUT WELL

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

BP's leased Deepwater Horizon mobile offshore drilling rig, which had just completed drilling the BP Macondo well in the Gulf of Mexico, suffered a catastrophic blowout around 9:45 p.m. CDT on April 20, 2010, after high-pressured methane gas pushed up the drill column and exploded on the platform. Efforts by multiple ships to extinguish the flames were unsuccessful (Figure 1), and, after 36 hours on fire, the rig sank on the morning of April 22, 2010. That afternoon, oil was spotted on the ocean surface above the sunken rig. Early reports minimized the magnitude of the oil spill, but the final estimate for the leak was 62,000 barrels per day, decreasing to 53,000 barrels per day just before the well was capped on July 15, 2010. According to the Flow Rate Technical Group, the spill amounted to about 4.9 million barrels of oil, which made it the largest oil spill ever to originate in U.S. controlled waters and the largest in the Gulf of Mexico (Figure 2).

Figure 1. Fire on the mobile offshore drilling unit Deepwater Horizon is battled by platform supply vessels. This picture was taken by the crew of a Coast Guard MH-65C Dolphin Rescue helicopter on April 21, 2010.

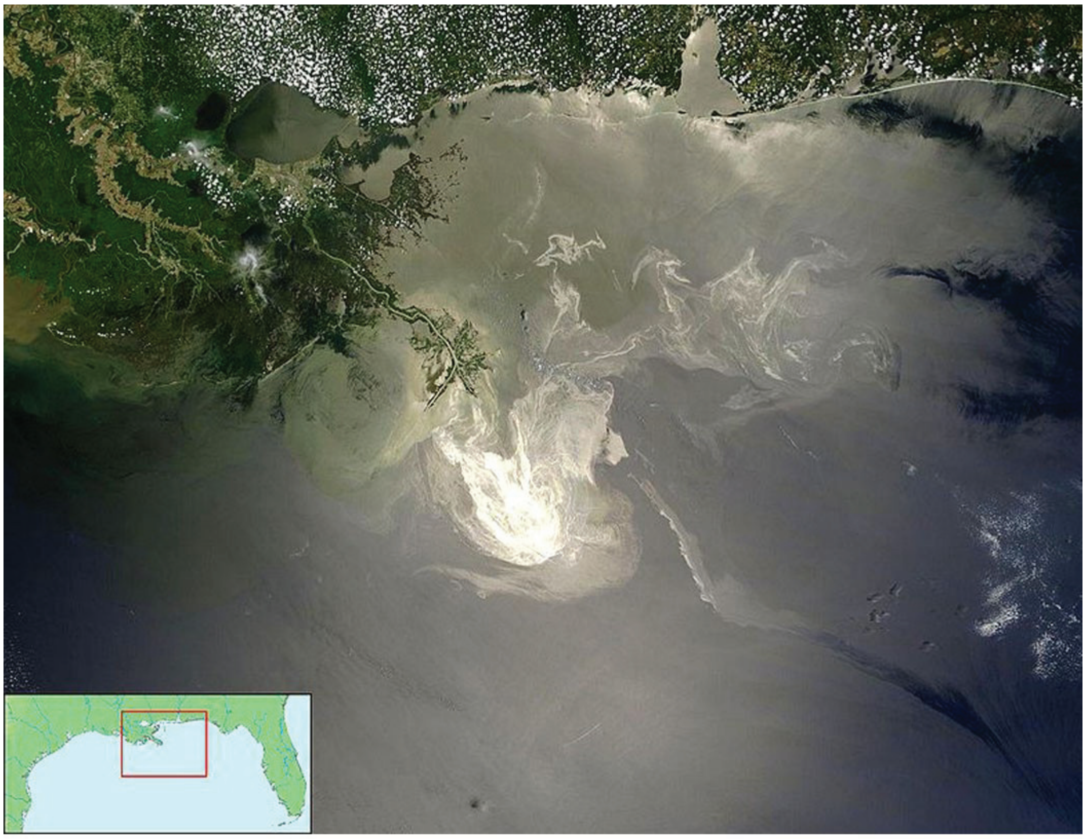


Figure 2. Picture from NASA's Terra satellite of the Horizon oil spill on May 24, 2010. The spill is illuminated by sunlight. The oil slick smoothes the ocean surface, making the sunlight brighter on the slick than the surrounding ocean.

Submarine robots and new technologies were tested in the efforts to cap the well head at a water depth of 5,000 feet. Initial efforts by remotely operated underwater vehicles to close the blowout preventer valves on the well head failed, as did the emplacement of a 125-tonne (138 ton) containment dome, which was soon clogged by gas hydrates. Attempts to kill the well by pumping heavy drilling fluids into the blowout preventer as a "top kill" were unsuccessful. However, the positioning of a riser insertion tube into the burst pipe was successful enough to collect some 22,000 barrels of oil at the surface aboard the drillship Discover Enterprise. The ultimate solution came from a cap consisting of a Flange Transition Spool and a 3 Ram Stack. On July 15, BP successfully tested this cap against the full force of the gusher. Mud and cement were later pumped through the new well head to reduce the pressure inside it and to provide a temporary stop to the flow of oil.

The permanent kill for the BP well came from two relief wells drilled on each side of the leaking Maconda well. These wells were drilled vertically to a specified depth and then directionally to intercept the well casing and fill it full of cement. This was accomplished using proven well interception technologies, technologies that were first developed and successfully used in an onshore blowout in Mississippi. Transoceans's Development Driller III began drilling a relief well on May 2, 2010; the GSF Development Driller II followed with a second relief well on May 16. The first relief well reached its total depth at about 18,000 feet on September 16, 2010 (Figure 3), and began pumping cement into the well bore. By September 19, the BP Maconda well was effectively killed.

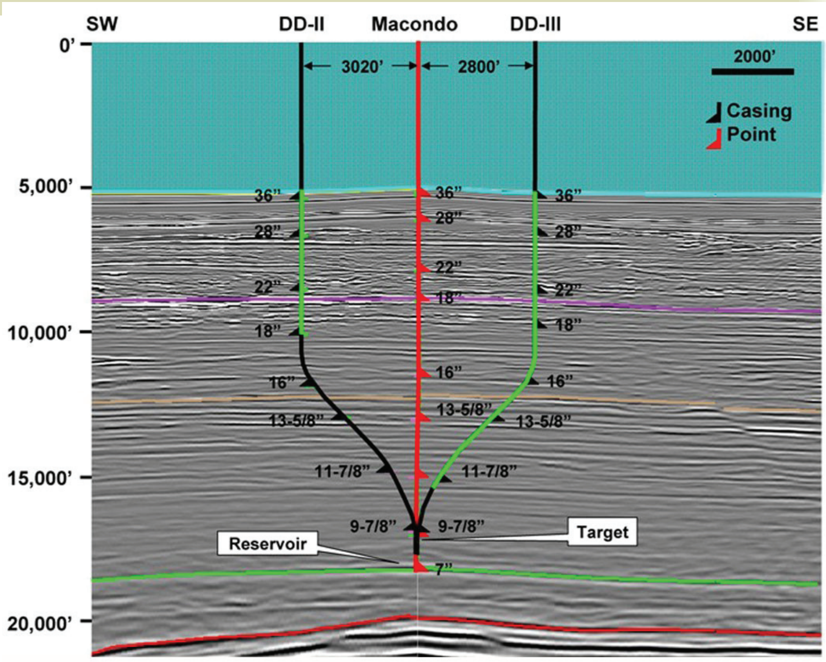


Figure 3. The Development Driller III and Development Driller II relief wells progress in intercepting the annulus of the Macondo well. Picture is from a slide presented by BP executive Ken Wells in a technical-update on June 28, 2010.

The first successful use of a relief well to intercept the annulus of a blowout well occurred in southwestern Mississippi's over-pressured Deep Smackover Gas Trend in 1970. After being successfully drilled to core depth, the Shell Oil Corporation Cox No.1 at Piney Woods in Rankin County, Mississippi, a deep Smackover exploratory well, surprised geologists with high-pressured, sour gas in the Jurassic at 21,122 feet (Figure 5). Sour gas, or hydrogen sulfide, is toxic to humans and highly corrosive to steel pipe. On the morning of March 25, 1970, as the rig crew pulled out of the hole with a Smackover core, the well started gaining mud from gas pressure below. When they had pulled the core up to 10,000 feet, the pressure at the well head was 6,000 pounds per square inch. The blowout preventers activated and shut the well in.

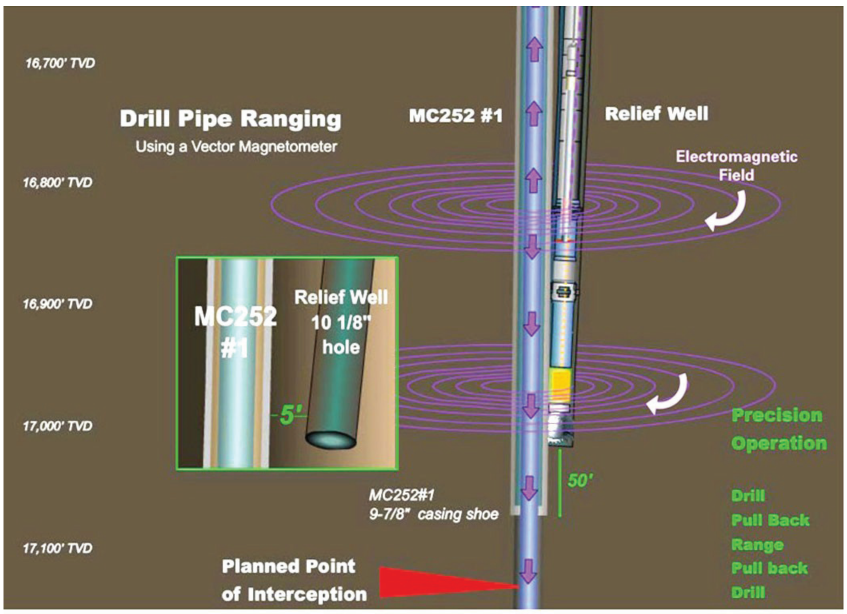


Figure 4. Diagram of the Development Driller III relief well closing in on the annulus of BP's Deep Horizon/Macondo well. Picture is from the last slide presented by BP executive Kent Wells in a technical-update briefing on June 28, 2010.

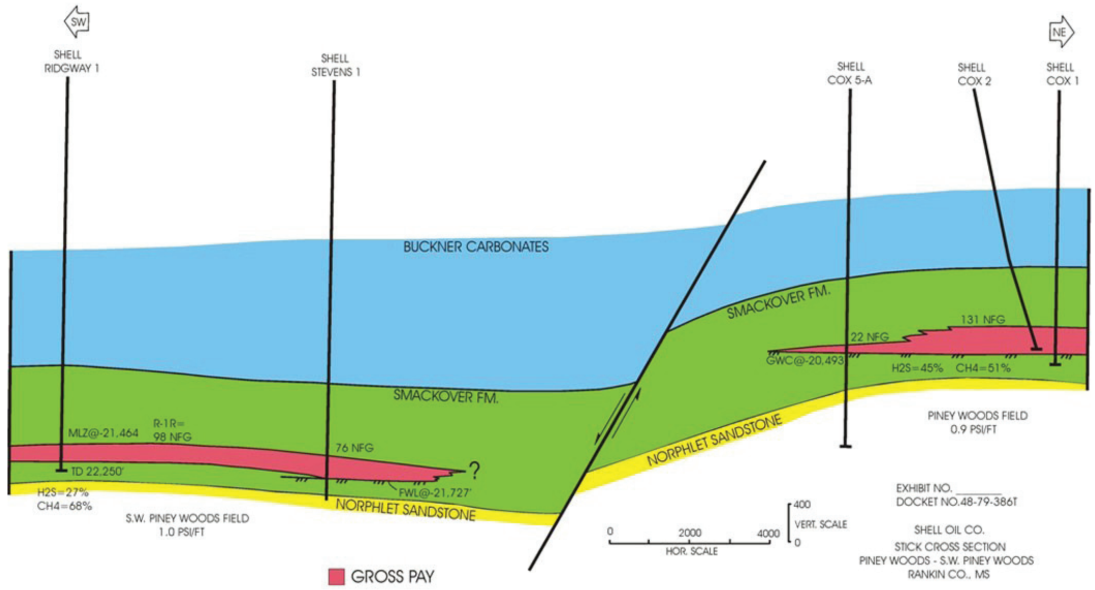


Figure 5. Cross section of the PineyWoods (right) and Piney Woods Southwest (left) gas fields. The gross pay zone contains over-pressured gas of about equal mixtures of methane and hydrogen sulfide in sandstones within the Smackover Formation. The Cox No. 1 blowout well is at the far right. Next to it is the Cox No. 2, which was later drilled as a development well. This cross section is modified from one provided by Julius Ridgway.

High-pressured gas ruptured the well's casing, invaded the shallow aquifers, and blew the pump out for the water well that supplied water for the drilling activities. A worker was overcome by gas fumes at the well site, even though he was wearing a gas mask; attempts to revive him off site were unsuccessful. An autopsy indicated that toxic gas entered the man's body through a perforated eardrum.

Within thirty minutes, the crew had abandoned the well site. The blowout preventer stack rose and fell over, releasing a stream of gas and oil-emulsion mud. Within minutes the mixture exploded, blowing over the derrick and creating a crater at the well site. Surface control of the blowout was impossible. The Highway Patrol and Civil Defense were notified, and an area within a three-mile radius of the well was evacuated. Police evacuated 350 students from nearby Piney Woods School. The famous oil well firefighter Red Adair was called and asked to fly to Jackson.

When Shell's New Orleans On-shore Division Manager, Charlie Blackburn, flew to Jackson with a team of company specialists, he first circled the burning well. According to Alan Cockrell's (2005) account in his book *Drilling Ahead, The Quest for Oil in the Deep South 1945-2005*, Blackburn described the well site in the quotes: "It looked like a volcano," and "It looked like a crater." After Blackburn landed at Jackson, he was appalled to see National Guard troops and the Governor of Mississippi waiting for him. The Governor asked what was happening and if Red Adair was coming; he seemed satisfied when Blackburn said that Adair was on his way. The well fire was easily visible from downtown Jackson some 25 miles away and could be monitored by geologists from their office windows in the Petroleum Building. Within a week of the disaster, shifting winds carried the rotten egg smell of hydrogen sulfide to Jackson. Safety assurances from Charlie Blackburn narrowly averted a frantic evacuation of the Capital City.

Monitor wells were drilled to bleed gas from the local aquifers, and Shell bought the forty-acre tract around the burned-out well. The well eventually bridged itself, and the flow of gas stopped. However, it would be a full year before another drilling rig intercepted the well and sealed it with cement.

The volume of gas that invaded local aquifers from the # 1 Cox blow out was impressive. The Shell #2 Shell-Cockfield monitor well in Section 28, T. 3 N., R. 3 E., Rankin County, was completed May 26, 1970, and produced one million cubic feet of gas per day from a two-foot interval at 1,317-1,319 feet with a tubing pressure of 350 pounds per square inch on a 27/64ths-inch choke. The Shell #5 Shell-Sparta in the same section was completed on July 4, 1973, and produced 583,000 cubic feet of gas per day at 1,495 feet with a tubing pressure of 285 pounds on a 25/64ths-inch choke.

Several other monitor wells also produced respectable volumes of gas from shallow aquifers. There were probably many anxious moments for the monitor-well drillers. John Marble recalled arriving to log one monitor well as the drill crew was fleeing the rig expecting it to blow. They had panicked at the smell of H_2S bubbling from their drilling mud. Fortunately, most of the gas produced from the shallow aquifers was in the form of methane.

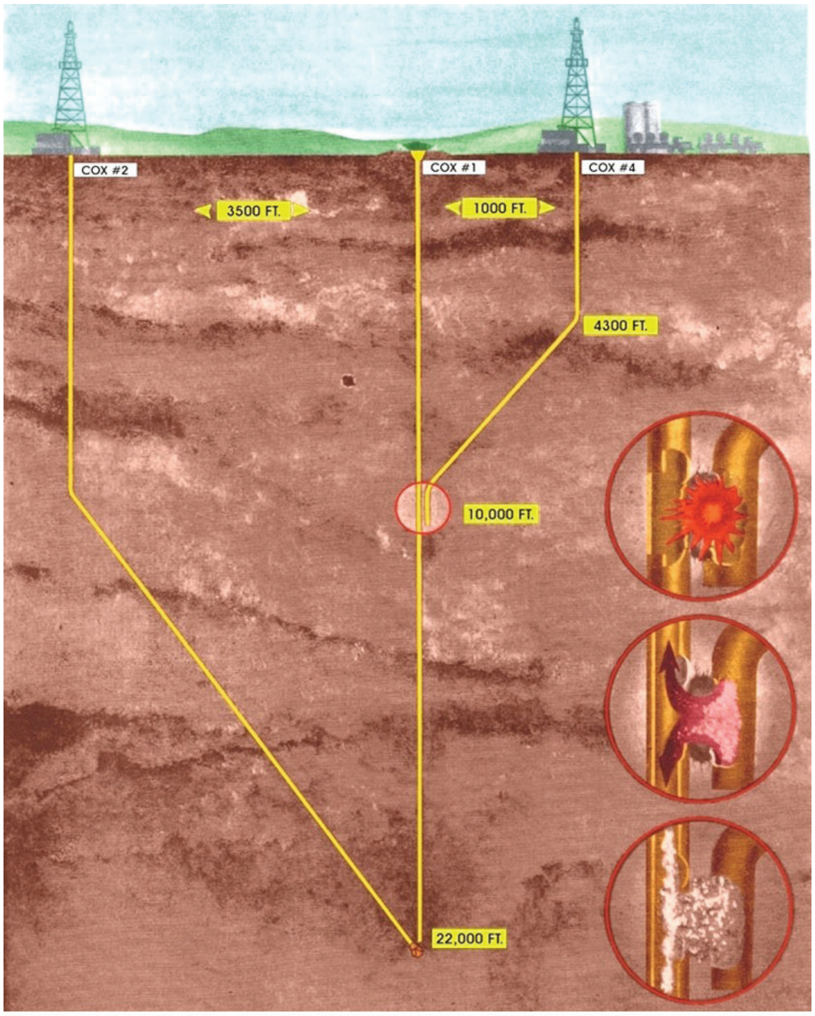


Figure 6. Shell Oil Company's plans to permanently seal off the Cox No. 1 gas well as announced on November 24, 1970. The Cox No. 2 relief well (at left) was a conventional intercept well, but its success was deemed problematic due to the depth required. The Cox No. 4 (at right) represented a new concept to intercept the annulus of the blowout well, perforate the casing, and fill the blowout annulus with cement for a permanent kill (see inserts at right).

The challenge to kill the #1 Cox led to the first direct intersection of a blowout well using a detection method. Specifically, wireline instruments were used for the first time to detect the location of a well bore by measuring distance and direction from the relief well to the blowout casing, and to home in on the magnetism of the blowout casing. Shell's plan consisted of: (1) drilling an intercept well to about 10,000 feet in such a way that the intercept well casing and the blowout well casing were in contact, (2) cementing the two strings together, (3) perforating the strings to create communication, and (4) pumping cement into the blowout well to kill it (Figure 6). The plan worked, and the well annulus was intersected and perforated at 10,500 feet and sealed with cement. According to Wright and Flak (website), "This success was the beginning of the modern relief well, establishing strategy and planning for future relief well projects and the basis for commercial casing detection instruments."