

THE DEPARTMENT OF ENVIRONMENTAL QUALITY

# mississippi geology

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## EXTENSIVE PROPERTY DAMAGE TO BELLE FONTAINE BEACH, JACKSON COUNTY, MISSISSIPPI, DUE TO WINTER COLD FRONT

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### INTRODUCTION

Belle Fontaine, located in southern Jackson County, Mississippi, was greatly affected by a winter cold front that passed over the area during the night of February 15-16, 1998. The area is bordered to the south by the Mississippi Sound, to the west by the city of Ocean Springs and to the east by the city of Gautier. The only natural beach left on the mainland in Mississippi is located on this coastal area, Belle Fontaine, which is 9 miles long and 2.5 miles wide (Figure 1). Within the Belle Fontaine Beach area a 2.5-mile spit formed in the center of the 9-mile long area. Most of the source sand for the spit development is from the exposed cliffs of the Gulfport Formation sands directly to the east of the study area, which recently has been completely blocked by bulkheads.

Erosion is a continuous occurrence in the study area due to a couple of different factors. Decrease in source sediment to the area has occurred because of natural sea level rise. Another factor is the development of private homes, with bulkheads, on top of the cliffs of exposed Gulfport Formation source sands just to the east. From 1850 to 1996, the estimated shoreline retreat was 25.2 meters, which results in a total of 21.2 acres of total land loss (Oivanki, 1994) for the 2.5-mile spit. Although the average land loss comes to 0.5 ft/year (0.17 m/

year) over a 146-year period, the area has undergone extensive development over the past few decades. The development of the area consisted of not only homes, but also bulkheads that have contributed to decreasing the amount of sediment supplied to the area, thus increasing the erosion rates (Figure 2).

Property owners in the study area are faced with major problems when a storm approaches. Tide levels rise, and without a beach to protect properties, waves directly hit bulkheads and can cause severe damage (Figure 3).

### STORM EVENT AND TIDAL LEVELS

The weathercasters in the area called for rain and thunderstorms as a normal wintertime cold front was scheduled to pass over the area on February 15-16th. Just three hours north in the state's capital, Jackson, there was only a sprinkle of rain detected for that storm event. The coastal counties all experienced high winds and rain, which caused high erosion rates and unusually high tidal levels throughout the night.

The tidal regime of this area is microtidal with tides well below 6.56 ft. (2 meters). The astronomical tide noted for Biloxi Bay (6 miles west of Belle Fontaine) was predicted to reach a low point of 0.37 feet at 7:44 p.m. on Saturday, February 15th, and the next high tide phase was predicted to occur at 1:32 a.m.

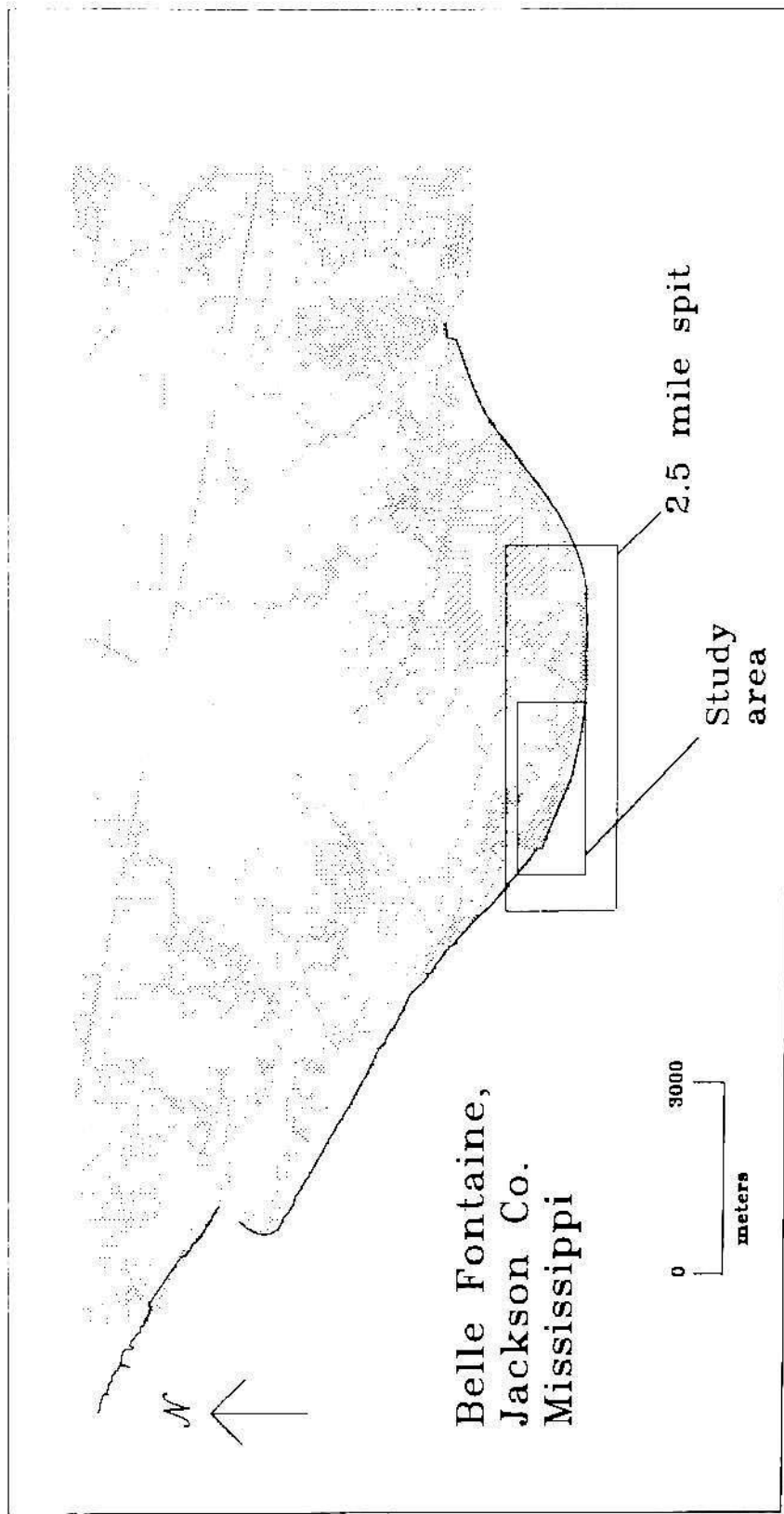


Figure 1. Map of Belle Fontaine region; the study area is outlined.

at a level of only 0.48 feet. The tide gauge located on the now walking/fishing bridge that spans the Biloxi Bay had recordings of 2.1 feet at 8 p.m. on the 15th and at 2 a.m. it was 2.73 feet. Biloxi's highest reading was at 9 a.m. with levels of 3.75 feet as the storm was approaching. Gulfport recorded a high for the evening at 3.15 feet at 7 p.m. on the 15th as the storm passed over (Figure 4). The levels represent a six-fold increase from the predicted to the actual tidal levels during the storm.

To areas such as the Bay of Fundy-Gulf of Maine where tidal ranges (between high and low levels) reach 53.46 feet (16.3 m) (Dalrymple, 1992), the low levels of the Mississippi Gulf Coast may not seem very severe. Also, unlike the northern Atlantic seaboard where water depths of over 5 feet often may occur within 100 feet from water's edge, Belle Fontaine has a very low beach angle due to its location within the shallow Mississippi Sound. The Mississippi Sound is a very shallow water body bordered to the north by Gulf coastal states and to the south by several barrier islands located 5-10 miles offshore. In the past, surveys of Belle Fontaine beach indicated that going out 300 feet from water's edge will put you in water depths of only 3.11 feet in the Mississippi Sound. In any coastal area a six-fold increase from expected to actual tidal levels during a storm event is detrimental and would be nearly impossible in some areas such as the Bay of Fundy-Gulf of Maine. Factors such as having a low beach angle in a microtidal environment along with having a six-fold increase of predicted tidal levels during the storm event contributed to the extensive damage at Belle Fontaine during this February cold front event.

## OUTCOME OF EVENT

Residents of the area were taken by surprise by the intensity of the storm. With the water and wave energy rising, some were going to evacuate the area and move to higher ground but sections of the only road out of the area were blocked by water. The Holifield family remember seeing their bulkhead destroyed and then mother nature took action on the support beams of their house as they sat inside and "heard the support beams for the house cracking" (Figure 5). Luckily, only property damage occurred and no one was injured. Another couple, the Seymours, long-time residents of Belle Fontaine, said they had never seen anything that strong hit the area before.

At the easternmost end of the spit, nourishment of 25,000 cubic yards of sand was placed just a few years ago. The beach assisted in absorption of wave energy rather than having it directly hit bulkheads (Figure 6). After the water and winds subsided, the next day, piers, bulkheads and other structures were found to be broken and some destroyed. Bulkhead damage occurred mainly because these homeowners, at the western end of Belle Fontaine (Figure 7), had no beach for protection from rising water levels and wave action. The rising

water along the whole coast easily overtook low-level piers because once the water level rose and waves attacked the shore, the piers were under water and easily came apart. The piers that withstood the storm forces were considerably higher above mean sea level than those which perished. Another factor in pier construction that was evident was that piers built by bolting rather than nailing pieces together withstood the storm forces better and were less likely to be completely destroyed. Rising water levels and wave action caused a lot of damage, and large debris was transported by the water (Figure 8).

## CONCLUSION

A hurricane is understood to cause damage on coastlines, but coastal Mississippi residents need to realize that even a small storm event (such as passing of a winter cold front) can cause major geologic and property changes to an area. The cost of the winter cold front for affected homeowners ranged from a few hundred in repairs to over \$12,000 for some to completely replace destroyed bulkheads and piers. Piers that were replaced so far have been built higher than they were before and some are using bolts instead of nails. One pier was only 3 feet above the average water level before the storm and was totally destroyed during the storm because of the high water and wave levels. The property owner rebuilt the pier structure to be 5 feet over the water level.

The alternative to repairing or replacing piers and bulkheads after every major storm affects the study area is sand nourishment. This has been studied and estimated that for an initial investment of \$1,500 per property and approximately \$150 a year a 25-foot beach can be placed in front of the houses and maintained. Not a bad price to pay for protection and beachfront property.

Currently during normal high tide the water/waves lap directly against bulkheads in front of the homes on the western end of the spit in Belle Fontaine. Bulkheads are their only current means of protection during storm events. As of the completion of this article Hurricane Georges made landfall in Biloxi late Sunday night-early Monday morning, September 27-28, 1998. This storm caused severe damage throughout the Gulf of Mexico coastal region and more research on the effects from the hurricane will soon follow. Homeowners in the study area had planned a sand nourishment project, but it has been postponed so that the residents can concentrate on rebuilding and repairing bulkheads and houses that were damaged during the hurricane. Constantly renourishing the area with sand will provide not only for protection from non-hurricane storm events, but allow the residents to enjoy their waterfront property. It may be the only way to halt or reverse 146 years of shoreline retreat at this location.



Figure 2. This large bulkhead is to the east of the study area and was constructed directly on the Gulfport Formation cliffs. This cliff is a major source of sand, which has been blocked off, for the beaches of the study area.

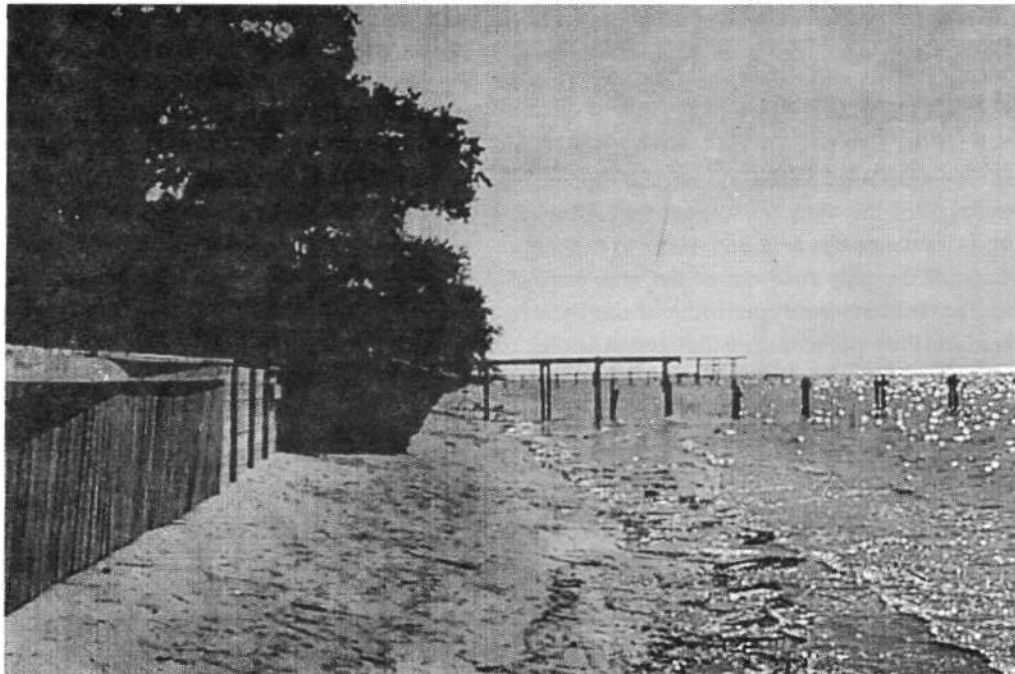


Figure 3. The western end of the 2.5-mile spit in the Belle Fontaine area. Notice how at low tide the water is only feet away from bulkheads.

## February 15-16 Winter Cold Front Storm Event

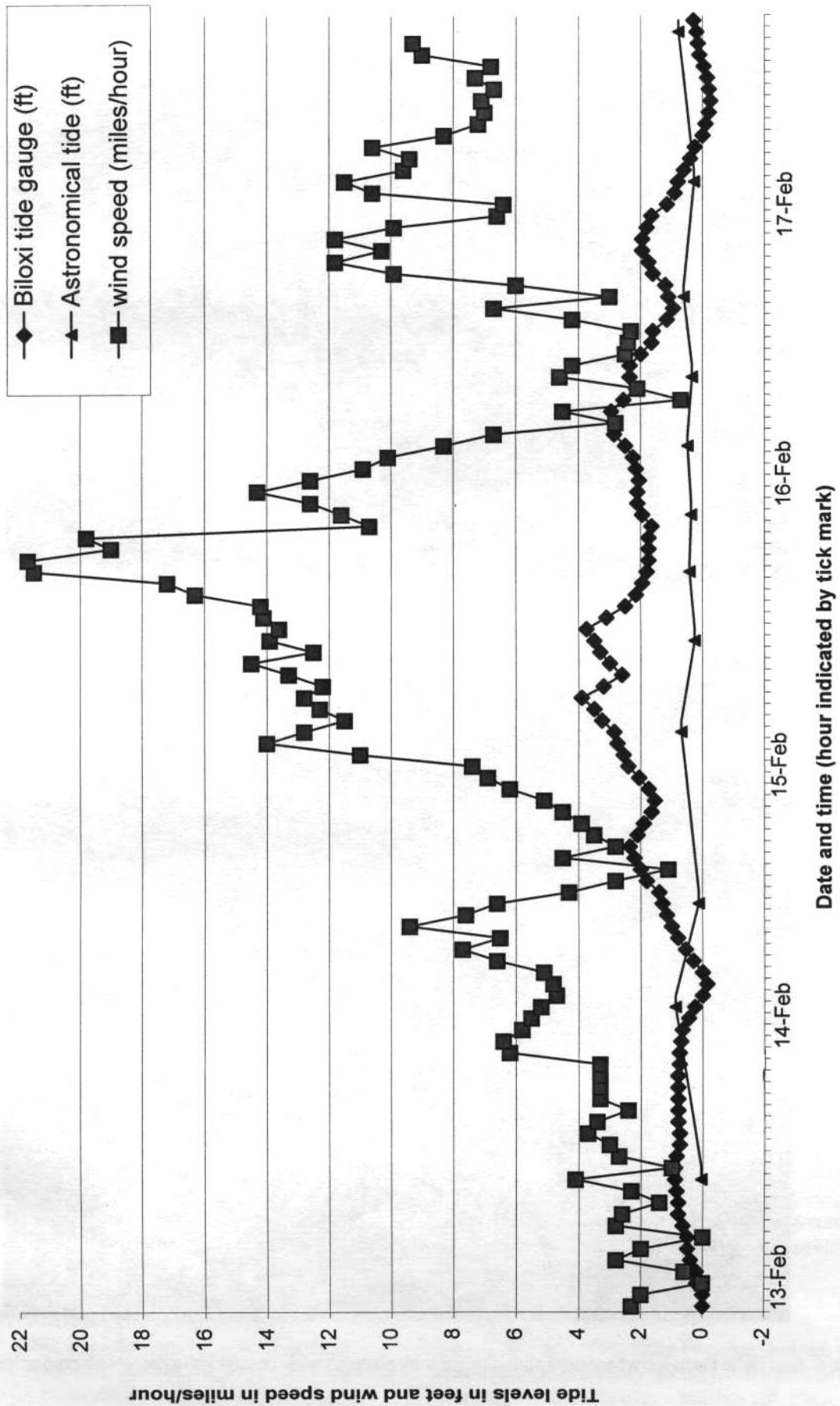


Figure 4. Mississippi coast tidal levels February 13-17, 1998.

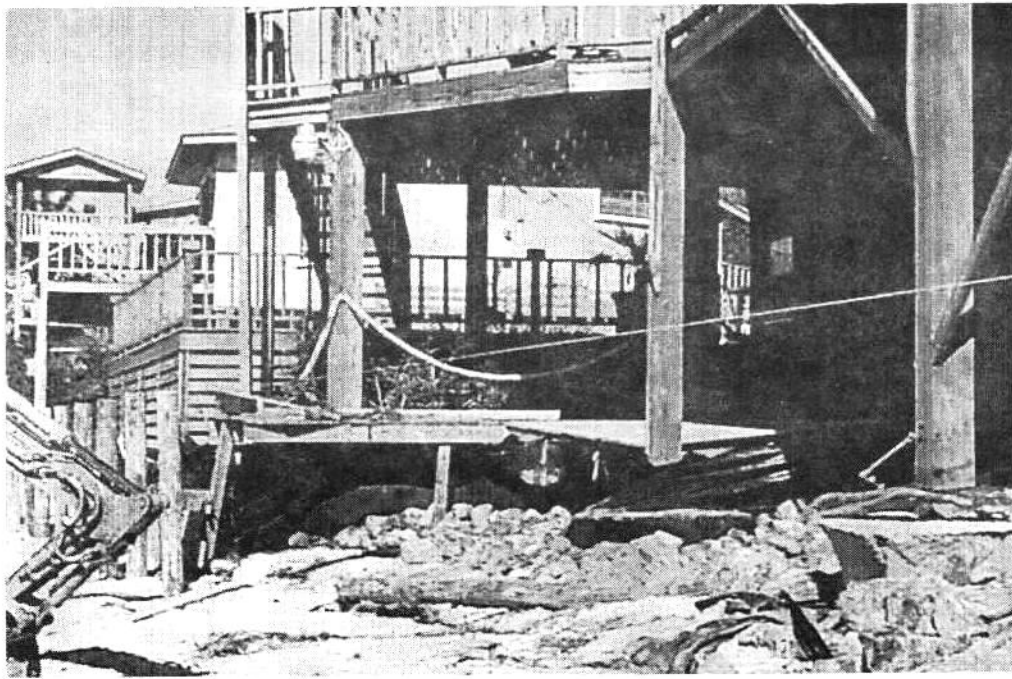


Figure 5. Holifield residence the day after the storm. After their bulkhead was destroyed (removed) by tide/wave action, the storm's energy was focused directly on the house, causing structural damage.



Figure 6. East Belle Fontaine where sand nourishment took place. A wide beach aids in protecting properties behind it.



Figure 7. Before the storm event occurred, all properties in the area had bulkheads. The Seymour family had a strong, well-built bulkhead, while their neighbors to the left and right completely lost bulkheads and had property damage (notice scarps to the left of the picture).



Figure 8. This piece of wood (note radio for size comparison) was one of many pieces of debris that was transported by wave/water action during the storm. Debris this size can cause major damage to structures when they collide with structures such as bulkheads.

#### REFERENCES CITED

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p. 195-218.

Oivanki, S. M., ed., 1994, *Belle Fontaine, Jackson County, Mississippi: human history, geology, and shoreline erosion*: Mississippi Office of Geology, Bulletin 130, 136 p.

# MISSISSIPPI OFFICE OF GEOLOGY PUBLICATION SALES FOR FISCAL YEAR 1998

Margaret Allen and Michael B. E. Bograd  
Mississippi Office of Geology

The Map and Publication Sales office is the means used by the Office of Geology to fulfill its mandate to distribute the publications resulting from its various research projects. This article is a tabulation and brief analysis of the maps and publications sold by the Map and Publication Sales office of the Office of Geology during Fiscal Year 1998, which ended June 30, 1998. The following tabulation helps identify those publications and areas of research found most useful by industry and the public.

## FY 1998 Sales

Maps	11,096
Bulletins	743
Circulars	155
Cross Sections	28
Environmental Geology Series	4
Information Series	23
Open-File Reports	101
Reports of Investigations	18

The Office of Geology has several series of publications. The Bulletin series, the original and still the flagship series, was begun in 1907. Of the 103 titles in the series that are still in print and available for sale, all but 9 had sales of at least one copy during the year. The best seller in the Bulletin series was the new title, B131, *Atlas of Shallow Mississippi Salt Domes*, at 84 copies. The other top-selling Bulletins (with abbreviated titles) were B113, water resources of Mississippi, 37 copies; B105, Hinds County geology, 35 copies; B115, Rankin County geology, 31 copies; and B88, Madison County geology, 30 copies. Circular 6, *Windows into Mississippi's Geologic Past*, was again the top-selling Circular at 93 copies. C4, the Frankstown vertebrate fossil locality, remained a good seller in FY98 with 32 copies. The three titles in the Reports of Investigations series sold 18 copies, lead by RI3, electrical resistivity values and chemical data on formation waters, at 14 copies. Sales of Open-File Reports were spread among 14 of the 29 titles available, with the top seller being OF65, *Surface Mining Permits*. This year four geologic quadrangles were released in this series: OF51, Sturgis; OF52, Ackerman; OF54, Tomnolen; and OF55, Reform. The biggest seller among the maps and charts again was the Geologic Map of Mississippi, with 107 copies. Other titles include the economic minerals map, structural features map, stratigraphic column, chart of producing formations, and Mississippi Sound lease block maps. At the end of the year, Cross Section 1, from the Tennessee state line to Horn Island in the Gulf of Mexico, went out of print.

In addition to the geological reports published by the Office of Geology, Map and Publication Sales stocks all of the topographic maps available for the State of Mississippi. These excellent maps are produced by the U.S. Geological Survey, and are made conveniently available by the Office of Geology as a public service. The majority of the "Maps" in the tabulation above are topographic maps, mostly 7.5-minute quadrangles (scale 1:24,000) with some 15-minute quadrangles (scale 1:62,500), with total sales of 10,045 maps. Also sold during FY98 were 605 copies of the 1:100,000-scale topographic maps, 71 copies of the 1:250,000-scale topographic maps, and 133 copies of the state topographic map at 1:500,000.

The Map and Publication Sales office also handles the distribution of back issues of the Office of Geology's quarterly journal *Mississippi Geology*. This publication contains technical and popular articles dealing with the geology, paleontology, and mineral resources of Mississippi. Some of the articles are useful for educational purposes. There is no charge for a subscription or for back issues of the journal so it is not included in the publication sales tabulation. The circulation is just over 1000, and approximately 200 additional copies are distributed to staff and visitors in the office. An index to *Mississippi Geology*, updated after each issue is published, is available as Open-File Report 15, "Current Index to *Mississippi Geology*," for \$2.00 (\$4.00 by mail).

The figures presented here were compiled by Margaret Allen and analyzed by Michael B. E. Bograd. They represent only a partial report on the map and publication sales activities of the Office of Geology. Many other items not mentioned in this brief overview are available as well. For additional information about the available publications of the Mississippi Geological Survey/Office of Geology, please visit our Map and Publication Sales office at Southport Center, intersection of Highway 80 and Ellis Avenue, Jackson, Mississippi, weekdays from 8 a.m. to 5 p.m. You may call the Office of Geology for information at (601)961-5500. The direct number for Map and Publication Sales is (601)961-5523. Our fax number is (601)961-5521. The mailing address is:

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The List of Publications may be viewed on the Office of Geology Web site on the Internet. The address is: <<http://www.deq.state.ms.us/dominio/geoweb.nsf>>.



# REVIEW OF MISSISSIPPI ROAD ATLAS AND MISSISSIPPI ATLAS & GAZETTEER

Michael B. E. Bograd  
Mississippi Office of Geology

*Mississippi Road Atlas*, cartography by the Mississippi Department of Transportation: University Press of Mississippi, Jackson, 1997, 128 p., \$40 hard cover, \$20 soft cover (see end of review for information about availability)

*Mississippi Atlas & Gazetteer*: DeLorme, Yarmouth, Maine, 1998, 64 p., \$16.95 (see end of review for information about availability)

In the last two years we have seen publication of two useful atlases for the State of Mississippi. The *Mississippi Road Atlas* was published by the University Press of Mississippi in 1997 using cartographic work prepared by the Mississippi Department of Transportation. The *Mississippi Atlas & Gazetteer* was published by DeLorme, a commercial mapping company based in Maine, in 1998. The two atlases are organized in different ways; they have some features in common, and some that are unique.

The *Mississippi Road Atlas* contains, as stated on the title page, "highway maps of Mississippi's 82 counties and street maps for 50 Mississippi cities." All are printed in black and white. The dimensions of the atlas are 15½ inches high by 11¼ inches wide. There is a common cartographic style for each county road map, with some variation in maps of different vintage. Each map includes townships, ranges, and sections (the Public Land Survey System); roads and highways; cities and towns, with their populations; railroads, pipelines, and other cultural features; streams, lakes, swamps, and other water bodies; supervisor districts; and a standard title block with county name, north arrow, index county outline map of the state 1.5 inches high, scale bar in miles and kilometers, and date. The names of adjacent counties are given. The scale of each map varies, as each county was printed at the largest size that would fit on the page, in either portrait or landscape orientation. The dates of the county maps range from 1982 to 1994. In addition, each map has a standard box of information about the county. The information for Newton County is given as illustration. "Named for Sir Isaac Newton, English scientist and mathematician; Established 1836; County Seat Decatur; Size 580 square miles; Population 20,291 (43rd of 82)."

The city maps are presented in the same manner as the county maps. PLS lines are not shown, but section corners are indicated and numbered. The city maps date from the 1980s and 1990s, with one dated 1976. The atlas also includes a set of six maps of Mississippi, showing the history of development of the road system in the state from 1822 to 1990, and a chronology

of counties (with dates of creation) and their seats of justice. There is a four-page index to county maps, city maps, and to cities, towns, and communities. The latter gives the place name, the county, and page number. All population figures in the atlas are from the 1990 U.S. Census.

The soft cover version of this book has an attractive photograph of an old road through the woods cut deeply into the loess; it comes with a state highway map. The materials, printing, and binding are up to the usual excellent quality of University Press of Mississippi books.

The *Mississippi Atlas & Gazetteer* by DeLorme includes 47 topographic maps covering the state. The maps are topographic quadrangles covering 30 minutes of longitude and 35 minutes of latitude. The maps are in color and have a similar appearance to the topographic maps published by the U.S. Geological Survey. Roads are shown in red, with yellow added on U.S. highways and blue on the interstates. Water features are blue, wooded areas are green with national forests a darker shade, urban areas are yellow, and military installations are gray. Contour lines are brown, but appear gray to me. However, with a contour interval of 80 feet, the contours are difficult to find and of very limited value. Section and township lines are not shown. One very useful feature is that many of the rural, county roads are named. Also, this atlas provides a seamless view across county lines that is particularly user-friendly.

Place names and other geographic features are listed in an extensive index, giving locations by grid reference. The maps are gridded with coordinates A through H and 1 through 10 on the sides and top of each page. The borders of each map have latitude and longitude ticks at one-minute intervals. The scale of the maps is 1:182,000, or one inch equal to 2.9 miles (4.6 km). The page size is 15½ inches high by 11 inches wide. The atlas also includes tables or lists with information about attractions/museums, campgrounds, casinos, fishing, golf courses, historic sites, hunting, recreation areas, scenic drives, and trails.

Both atlases are useful for traveling or outdoor activities throughout Mississippi. If you need to locate yourself by the Public Land Survey System, you would reach for the *Mississippi Road Atlas*. If you are navigating by latitude and longitude, or county roads by name, you may want the *Mississippi Atlas & Gazetteer*. I have found both atlases useful in the field.

*Mississippi Road Atlas* is available in bookstores throughout the state for \$40 for the hard cover edition and \$20 for the soft cover edition; the soft cover edition is more likely to be seen.

You may order this atlas from the Mississippi Department of Transportation, Map Sales, P.O. Box 1850, Jackson, MS 39215-1850; telephone (601) 359-7045. The shipping charge is \$4.00 per order. You may also order it from the University Press of Mississippi, 3825 Ridgewood Road, Jackson, MS 39211; include 7% sales tax for orders in Mississippi and \$5.00 for shipping and handling for the first book and \$.75 for each additional book. You may order by phone (8 a.m. to 5 p.m.

central time) by calling the Press at (800) 737-7788 or (601)982-6246.

*Mississippi Atlas & Gazetteer* is available from DeLorme, P.O. Box 298, Yarmouth, Maine 04096, (207)846-7000 or Sales (800)452-5931, [www.delorme.com](http://www.delorme.com). The price is \$16.95 plus \$5.00 shipping and handling for mail and on-line orders. This book is starting to become available in some bookstores.

**An up-to-date index of *Mississippi Geology* is available from the Office of Geology.  
Open-File Report 15, "Current Index to *Mississippi Geology*," compiled by Michael B. E. Bograd,  
is available for \$2.00 (plus \$2.00 postage by mail) from the Office of Geology, P.O. Box 20307, Jackson, MS 39289.**

# HAROLD ERNEST VOKES

## JUNE 27, 1908 — SEPTEMBER 16, 1998

Emily H. Vokes

Harold E. Vokes, retired Professor of Geology, Tulane University, passed away September 16, 1998, at Heritage Manor Nursing Home in Hammond, Louisiana, following a long illness. He was 90 years old. Dr. Vokes is survived by his wife Emily, four children, and six grandchildren.

Harold went to New Orleans in 1956 to replace the retiring Chairman at Tulane University's Department of Geology, and to establish a graduate program in the department. He served as departmental chairman from 1957 to 1966.

Prior to going to Tulane Harold was associated with a number of prestigious institutions. Following his doctoral degree in 1935 from the University of California, Berkeley, he received a Post-Doctoral fellowship at the Peabody Museum, Yale University, under the mentorship of the great Carl Dunbar. Professor Dunbar was so impressed with his ability that he recommended Harold for a post as Assistant Curator of Invertebrate Paleontology at the American Museum of Natural History, New York. He held this position from 1937 to 1941, when he was promoted to Associate Curator of Fossil and Recent Invertebrates, which position he held until 1943.

With World War II upon us, Harold felt that he could contribute something more to the war effort than identifying fossils and he became Senior Geologist for the U.S. Geological Survey, searching for uranium in the Green River Desert. He continued as a WAE (when actually employed—i.e., summer-time) for the Survey until 1956, mapping the Coast Range of Oregon, and looking for gas and oil beneath the Columbia Lava Plateau.

After the war Harold turned to academics, taking a position at the Johns Hopkins University, where he taught from 1945 until 1956, when he went to Tulane University. He remained at Tulane until his retirement in 1978, and was named W. R. Irby Professor of Geology in 1972.

Dr. Vokes' early work varied from the Eocene marine fossils of California and freshwater bivalves of India, to the Cretaceous mollusks of Lebanon, based on material collected while he was a Guggenheim fellow studying the geology of the Lebanon Mountains.

During his professional career he served a number of societies, being Secretary of the Paleontological Society from 1940 to 1949 and President in 1951. He served as Secretary to

the International Paleontological Union from 1949 to 1958. He was a member of the International Commission of Zoological Nomenclature from 1944 to 1978, and a Fellow of the Geological Society of America for over 50 years, serving as Vice-President in 1952. He was long associated with the Paleontological Research Institution, being a member of the Board of Directors, Vice-President, and finally President in 1974-1976.

In 1952-1953 he took leave from Johns Hopkins to serve as Geological Consultant to the Philippine Bureau of Mines to study coal deposits in the Cebu and Mindanao areas (during which he also availed himself of the opportunity to collect the fabulous Recent molluscan fauna). Subsequently he served as Malacologist on the 9th Indian Ocean Cruise of the *Anton Bruun* and Chief Scientist for her Cruise 10, from Florida to Panama. In 1971, while on sabbatical leave from Tulane he was a visiting professor of Paleontology at the Universidade Federal, Rio Grande do Sul, Brazil.

Under Dr. Vokes' guidance Tulane University became one of the premier institutions for the study of Cenozoic fossils, primarily of the Gulf and Atlantic Coastal Plain. He was responsible for the founding of *Tulane Studies in Geology and Paleontology*, which for 35 years published works on the fauna of the western Atlantic, especially the Chipola, Pinecrest, and Caloosahatchie formations of Florida.

Although he was forced to retire from teaching at the then mandatory age of 70, he continued to do research until failing health curtailed his activity. In the 60 years between 1935 and 1995 he published about 130 scientific papers (not including numerous abstracts and reviews), the most valuable of which unquestionably was his *Genera of the Bivalvia*, first published in 1967, with a revised edition in 1980, and a final addendum in 1990. In these papers he named over 200 species and 29 genera of invertebrates.

Reprinted with permission from *American Conchologist*, December 1998, volume 26, number 4, p. 22.

(Editorial note: For photographs of Harold Vokes, see David Dockery's article on the retirement of Emily Vokes in the December 1996 issue of *Mississippi Geology*, volume 17, number 4, p. 83-85.)



## **MISSISSIPPI GEOLOGY**

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