THE DEPARTMENT OF ENVIRONMENTAL QUALITY

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A LETTER FROM THE GOVERNOR

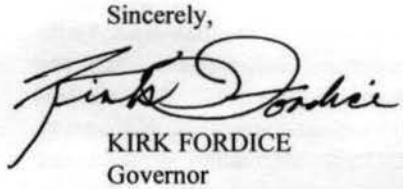
Dear Mr. Palmer, Mr. Knox, and the Office of Geology:

I have been informed that the December 1994 issue of *Mississippi Geology* contains an article on one of Mississippi's least utilized energy resources - lignite. The appearance of the article, prepared by the chief geologist of Phillips Coal Company and the assistant state geologist, comes at a very opportune time, as you are aware. One of the better known reserves of lignite, located in Choctaw County, Mississippi, is near commercialization. This comes after years of economic uncertainty about the ability to produce competitively priced electricity using lignite. I am delighted that Phillips Coal Company and its partner, CRSS Capital, have proposed a mine-mouth operated, Mississippi lignite-fueled electrical generating station to be located at the Chester Prospect, a few miles north of Ackerman in Choctaw County. The price of the electricity produced from this plant, I am advised, will be cost competitive with other sources of electrical energy by the time the plant is ready to produce power. Without complications, this should be in 1999.

Mississippi's State Geological Survey has been studying our lignite resources for some time, going back to the Bulletin 3 published in 1907. Copies of a 1976 report on the subject (Information Series 74-1) were soon sold out. That report developed because of the interest in our lignites in the days following the Arab oil embargo and other events of the 1970s. I want to encourage you to continue your excellent research of the Mississippi lignites, as I am convinced that additional electrical generation utilizing this indigenous resource is in Mississippi's best interest.

I am most pleased to know that the work being performed by the scientific and technical community in state government, in conjunction with the private sector, is resulting in tremendous economic development opportunities for our state. I encourage you to keep up the great work.

Sincerely,



KIRK FORDICE
Governor

MISSISSIPPI LIGNITE - A VALUABLE ENERGY RESOURCE

James A. Luppens
Phillips Coal Company
Richardson, Texas

and

Michael B. E. Bograd
Mississippi Office of Geology

INTRODUCTION

Lignite is a geologically young, low grade form of coal. Its chief use is fueling electric generation plants. Other uses include chemical feedstocks such as activated carbon and synthetic oil and gas. Mississippi has substantial lignite resources that could be mined and used to generate electricity, while ensuring that the environment is not adversely impacted.

The economic benefits of a lignite mine and associated power plant are tremendous. Major advantages are experienced by the local communities and businesses located near a mining region. These mainly non-metropolitan areas gain industrial jobs that are competitive in pay with jobs in high technology industries. Additional industries are attracted to take advantage of cogeneration opportunities and power availability. The state gains some measure of energy independence. Furthermore, additional benefits are derived from royalty and other payments to landowners and increased state and local tax revenue.

LIGNITE GEOLOGY AND RESOURCES

The lignites found in Mississippi are part of the Gulf Coast lignite trend that extends from south Texas through Louisiana, Arkansas, Tennessee, Mississippi, and into central Alabama. Like the rest of this trend, essentially all of the economically significant lignites in Mississippi are found in two stratigraphic units. These are the Eocene Wilcox and Claiborne groups. Figure 1 shows the areal distribution of the outcrop of these groups. The areas shown on the map are those where lignite is more likely to be located, but the beds are not continuous throughout the trend. Furthermore, not all lignite beds can be economically mined due to such factors as quantity, quality, depth of overburden, man-made facilities, or environmental concerns. Outside the Wilcox and Claiborne groups, there is one lignite seam, the Oak Hill lignite, in the Paleocene Midway Group (Self and Williamson, 1977) and minor occurrences in other units, but these are relatively insignificant compared to the lignites in the Wilcox and Claiborne groups. Several thin, discontinuous lignite beds in the Forest Hill Formation (lower Oligocene), which lies above the Jackson Group, were also penetrated during reconnaissance drilling near Jackson, Mississippi (Phillips Coal Company).

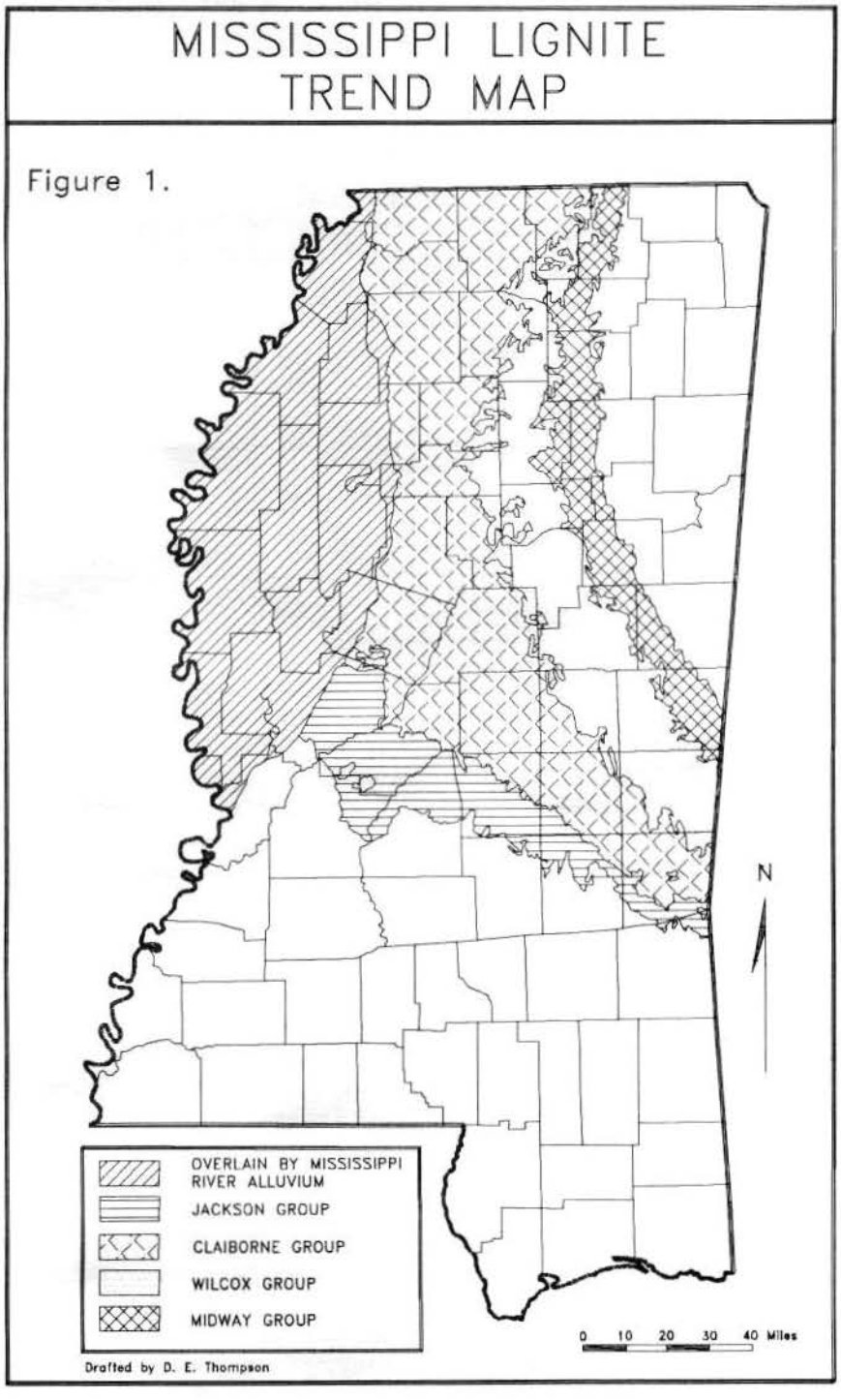
The lignite formed as peat deposits in a fluvio-deltaic environment similar to the modern Mississippi River delta (Self and Williamson, 1977; Cleaves, 1980; Luppens, 1978). Individual lignite beds (or seams) of economic importance typically range from 2 to 9 feet in thickness. In northwestern Mississippi, one Claiborne lignite bed locally exceeds 20 feet in thickness (Luppens, 1978).

The lignite beds are generally lenticular on a regional basis. However, individual seams may be continuous areally up to 20 square miles or more. The seams are dissected in places by sand channel deposits formed in streams that flowed through the original peat swamps. Typically, reserve areas contain multiple lignite beds.

Exploration drilling in the Mississippi lignite trend began in the mid-1970s. Reconnaissance drilling in most of the prospective outcrop areas was done on about 2-mile spacings. In areas of commercial potential, development drilling on 1/4- to 1/2-mile spacings was completed. In addition, extensive coring was done to determine the lignite quality. Land leasing activities were initiated in promising areas.

The greatest potential for economic lignite resources in the Wilcox Group in Mississippi is found in an area from Lafayette County south into Kemper County. The northwest corner of Mississippi north of Tallahatchie County holds the most potential for Claiborne Group lignite.

Total lignite resources for the state in lignite beds 2 feet thick or greater and less than 200 feet in depth are 5 billion tons (Luppens, 1978). Beds less than 2 feet thick are generally too thin to be recovered commercially. Two hundred feet is generally the maximum practical depth for mining the Gulf Coast lignite trend. With a total U. S. lignite resource of 40 billion tons (Couch, 1988), Mississippi lignite



resources represent about 13% of that total. This is the energy equivalent of about 9.5 billion barrels of oil.

LIGNITE QUALITY

Combustion tests and studies by boiler manufacturers indicate that Mississippi lignite will perform well as a boiler fuel in an electric generating plant (Phillips Coal Company). The quality of Mississippi lignite is slightly lower than some other U. S. lignite provinces. However, several mines and power plants in Texas are already producing and burning lignite at or slightly lower quality than that of the average Mississippi lignite.

Table 1 lists typical lignite qualities for various areas of the state. Table 2 is a comparison of the Mississippi lignite quality to other U. S. lignite regions. The ash content is typical of the Gulf Coast lignite trend. Due to an increased moisture content (slightly lower rank), the heat content is

Table 1. Typical Quality Analyses of Mississippi Lignite (Luppens, 1978; Phillips Coal Company)

	North Wilcox	Central Wilcox	South Wilcox	Claiborne
Moisture	43.51	42.08	43.19	41.69
Ash	12.08	12.05	11.84	13.89
Volatile Matter	25.26	24.59	24.33	30.11
Fixed Carbon	19.15	21.28	20.64	14.31
Sulfur	0.54	0.55	1.17	0.54
Btu/lb	5396	5534	5509	5855

lower than the lignites in the western portion of the Gulf Coast trend (Texas and Louisiana). An interesting feature in Mississippi is the higher heat content of the Claiborne lignites even though they are younger than the Wilcox Group lignites. This is due to a higher exinite content (waxy, hydrogen-rich coal macerals), which results in higher heating values. There is a slight increase in the sulfur content southward in the lignite trend as the environment of deposition becomes more marine in nature. The sulfur content is still relatively low compared to many other eastern U. S. coals. Essentially all the Mississippi lignites fall into the American Society for Testing and Materials (ASTM) rank category of Lignite A except for a few areas of the northern Wilcox trend that are borderline Lignite A/Lignite B.

LIGNITE MINING AND THE ENVIRONMENT

Lignite will be recovered using conventional surface mining techniques. The sand and clay material lying above the lignite, commonly referred to as overburden, will be removed by huge walking draglines supplemented by a truck-shovel fleet(s), scrapers, and other mobile equipment. A hydraulic backhoe or front-end loader will load the lignite into large off-road trucks which will haul the coal directly to the power plant stockpiles. Because the overburden materials are relatively unconsolidated, no blasting will be required.

A common misconception is that mining operations permanently destroy the land. The truth is that once lignite mining operations are completed, the land is reclaimed to its original level of productivity or higher. Surface mining is simply a "moving" hole or pit where reclamation is kept concurrent with mining. The overburden removed to expose the lignite is immediately placed in the adjacent mined-out pit in linear piles termed "spoil." The spoil is quickly regraded to the approximate original land contours, fertilized, and revegetated. Extensive reclamation experience in the Gulf Coast lignite trend has demonstrated the ability to restore the reclaimed land to farmland, pastureland, or forestland matching or exceeding its former productivity. The productivity is monitored to ensure compliance with state and federal regulations. During mining, runoff from disturbed areas is collected, tested, and treated, if necessary, prior to discharge, in order to protect surface waters and ground-water aquifers. Wetlands and drainages are also re-established after mining.

The entire mining and reclamation process will be done under stringent federal standards, regulated by the Mining and Reclamation Division of the Office of Geology, Mississippi Department of Environmental Quality (DEQ). The state regulatory program has been in place since the late 1970s and has been granted primacy by the federal Office of Surface Mining. The mine operation would obtain a number of air and water quality permits from DEQ's Office of Pollution Control, and water withdrawal permits from the Office of Land and Water Resources. DEQ has procedures for ensuring that all relevant environmental permits are obtained by any applicant. Regular inspections are conducted by DEQ during the mining and reclamation to ensure compliance with all permits.

UTILIZATION OF LIGNITE

The near-term use for lignite will be primarily fuel for the generation of electricity. In Texas, the fifth largest coal-mining state in the U. S., nearly 30 percent of the state's

Table 2. Comparison of Complete Analyses from the Gulf Coast and North Dakota lignites (Luppens, 1978; Phillips Coal Company)

	Wilcox Central TX	Claiborne Mississippi	Wilcox Mississippi	North Dakota*
Proximate Analysis (%)				
Moisture	31.66	41.69	42.08	40.00
Ash	11.42	13.89	12.05	6.70
Volatile Matter	29.95	30.11	24.59	25.90
Fixed Carbon	26.97	14.31	21.28	27.40
Sulfur	0.93	0.54	0.55	0.48
Btu/lb	7038	5855	5534	5940
Ultimate Analysis (Dry Basis, %)				
Carbon	59.69	54.30	54.38	59.52
Hydrogen	4.98	5.31	4.31	3.82
Nitrogen	1.03	0.64	1.04	1.07
Sulfur	1.36	0.92	0.95	0.80
Ash	16.71	23.83	20.80	11.17
Oxygen	16.24	15.00	18.52	23.62
Ash Composition (%)				
SiO_2	41.17	61.39	47.89	21.20
Al_2O_3	11.94	14.58	17.59	11.50
Fe_2O_3	7.42	6.56	5.99	5.80
CaO	19.54	7.27	13.24	21.10
MgO	2.04	1.50	2.70	3.90
K_2O	0.35	0.47	0.84	0.30
Na_2O	0.63	0.30	0.26	9.70
TiO_2	0.81	0.47	0.94	0.60
P_2O_5	0.01	0.04	0.03	0.80
SO_3	12.46	5.54	8.52	22.20
Fusibility Temperatures (reducing atmosphere, F°)				
Initial Deformation	2156	2318	2282	1910
Softening	2210	2336	2317	2050
Hemispherical	2246	2354	2360	2070
Fluid	2300	2450	2413	2140
Hardgrove Grindability Index	52	101	80	35-70

**from Bogot and Hensel*

Table 3. Average Yearly Economic Impact (Campbell, 1993)

	Construction Phase	*Operation Phase*
Jobs	**2,082**	**1,047**
Personal Income	**$59.0MM**	**$26.9MM**
Local Taxes	**$ 4.8MM**	**$ 4.9MM**

electrical generation is fueled by lignite coal. Lignite is also mined for power generation in Louisiana.

Because of the relatively low heat content of lignite, it is not economically feasible to transport it very far. Therefore, it is typically consumed at a power plant built adjacent to the lignite mine (termed a mine-mouth power plant). To fuel a 300 MW power plant for 40 years, a lignite reserve needs to contain at least 80 million tons of recoverable lignite.

New power plants will utilize new clean-coal technologies such as circulating fluidized bed combustors (CFBC). Lignite is particularly well suited for this process. CFBC offers several environmental advantages as well. First, crushed limestone is mixed with the lignite during combustion, removing sulfur oxides (S0x). This process is not only more efficient at removing S0x, but results in a dry by-product (gypsum rich) that is much easier to handle than the wet scrubber sludge from conventional coal-fired units. Also, the CFBC process operates at a lower temperature than conventional units which inherently reduces nitrogen oxide (N0x) emissions. Because the CFBC process can burn a wide variety of fuels, a limited amount of biomass (wood chips, sawdust, etc.) can be co-fired with the lignite, which could help relieve some local waste disposal problems. Bottom and fly ash from the plant, normally considered to be nuisance by-products, have commercial uses such as soil amendments and road construction.

Other uses for lignite include chemical and product feedstocks. Lignite is the ideal type of coal for conversion to synthetic oil and gas. However, due to the cost of the conversion processes, utilization will probably not be economically feasible in the near future. Underground conversion to gas of the in-place lignite beds, termed in-situ gasification, may be possible in the future, but the process needs to overcome significant technology and cost hurdles.

ECONOMIC BENEFITS OF MINING MISSISSIPPI LIGNITE

The utilization of lignite represents significant economic potential for the state. A recent study in Texas determined that for every lignite industry job, it requires three more jobs to support industry operations (House and Camp, 1994). Furthermore, this study emphasized that the lignite industry jobs were quality jobs. Lignite jobs, which have an average annual wage of $40,000, exceeded the average annual wages of $38,000 for all high-tech industries.

The existence of a mine-mouth power plant may also serve as a magnet for developing an energy park complex. Energy-dependent industries such as paper or plastic recycling may find it attractive to be sited adjacent to the power plant to take advantage of the availability of inexpensive process steam as well as other synergies such as shared wastewater treatment facilities. Other industries such as charcoal briquetting or chemical companies using lignite as a chemical feedstock like activated carbon may also be attracted by the availability of supplemental lignite from the mine.

A study that evaluated the potential economic impact of a proposed lignite mining, paper recycling, electric cogeneration project in eastern Mississippi was recently completed (Campbell, 1993). The study focused on a region within 50 miles of the project site. The estimated impacts of this project are listed in Table 3. The values represent both direct and indirect effects. The construction is a 5-year period and the total project life is 40 years. The additional tax revenues generated from the project are also estimated. From the values in Table 3, it is obvious that such a project would have a major effect upon both employment and income in the region. An important consideration is the fact that much of the money which would have left the state in the form of electrical costs to the consumer will be used to pay wages and make purchases in the local area through a mine-mouth plant. This is analogous to an actual injection of income into the area.

Another benefit of utilizing lignite is providing a secure, long-term, low-cost fuel supply that is not subject to the volatile market swings and transportation dependence associated with other fuels. This should help maintain relatively low, stable electricity rates for Mississippi consumers. Mississippi lignite represents a viable, important, untapped energy resource that offers substantial economic benefit for the state.

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NEW PUBLICATION BY THE OFFICE OF GEOLOGY

BELLE FONTAINE, JACKSON COUNTY, MISSISSIPPI: HUMAN HISTORY, GEOLOGY, AND SHORELINE EROSION

The Mississippi Office of Geology announces the publication of Bulletin 130, "Belle Fontaine, Jackson County, Mississippi: Human History, Geology, and Shoreline Erosion," edited by Stephen M. Oivanki.

Bulletin 130 contains introductory and concluding statements by Stephen M. Oivanki, who compiled and edited the bulletin, and four papers about the Belle Fontaine area of coastal Jackson County. Dr. Klaus J. Meyer-Arendt of Mississippi State University contributed a paper on the history of human settlement of the "Island of Belle Fontaine." Dr. Ervin G. Otvos of the Gulf Coast Research Laboratory joined Oivanki in a report on the geologic framework, erosion history, and physical setting of the Belle Fontaine area. Dr. Joseph N. Suhayda of Louisiana State University prepared a report on the development of a shoreline evolution model and evaluation of erosion control alternatives. Cathy Z. Hollomon of the Mississippi Bureau of Marine Resources summarized the government's role in coastal management in Mississippi.

Bulletin 130 may be purchased from the Office of Geology at Southport Center, 2380 Highway 80 West, Jackson, for $10.00 per copy. Mail orders will be accepted when accompanied by payment ($10.00, plus $2.00 postage and handling for the first copy and $.50 for each additional copy). Send mail orders (with check or money order) to:

Office of Geology
P. O. Box 20307
Jackson, MS 39289-1307

DR. WILLIAM SPILLMAN (1806-1886), PIONEER PALEONTOLOGIST OF MISSISSIPPI

Earl M. Manning
Department of Geology
Tulane University

ABSTRACT

While Dr. William Spillman (1806-1886), a physician and Methodist minister of Columbus, Mississippi, did not publish anything on paleontology, he made many outstanding contributions to the paleontology of Mississippi, and to the study of Cretaceous fossils of the Gulf Coastal Plain in general. His geological work and extensive fossil collection influenced early geological studies of the geological surveys of Mississippi and Alabama, and fossils he sent to specialists for description insured forever that Mississippi Cretaceous mollusks and vertebrates would be critical to the study of such material throughout the country. Because the material he collected became type specimens of taxa later found widely distributed, the influence of his work has become broadly felt. By bringing the Cretaceous fossils of Mississippi to the attention of some of the best paleontologists of the mid-nineteenth century (mollusks by Tuomey, Conrad, and Gabb; vertebrates by Leidy and Cope) he effectively brought this material to a national audience. Because nineteenth century specialists did not come to Mississippi to collect until the late 1880s, nearly all that was discovered about Mississippi Cretaceous fossils between 1854 and 1873 was discovered as a result of the efforts of Dr. Spillman.

INTRODUCTION

As has often happened to early fossil collectors who didn't publish on their finds, the work of Dr. William Spillman of Columbus, Mississippi, has, over time, been reduced (at times literally) to a footnote in paleontological research. While citations of his role as collector of numerous important type specimens (generally only in the form of the statement "collected by Dr. W. Spillman, of Columbus, Mississippi") are common, the man behind the simple statement has generally remained almost unknown. Even his birth and death dates have not generally been known. The purpose of this article is to fill in a bit more about the man and his work.

ACKNOWLEDGMENTS

Much of the personal detail of Spillman's life derives from references uncovered by Mary Bess Palluzzi, of the local history section of the Columbus, Mississippi, city library. Her efforts in digging up this important source material are gratefully acknowledged here. Gary Lancaster of Columbus assisted with the examination of newspapers on microfilm at the Columbus library and identified Spillman's Columbus house. Rufus Ward, of West Point, Mississippi, brought the Spillman archaeology article to the author's attention. George and

DR. W. SPILLMAN,

TAKES this method of informing those indebted to him, that he will continue to receive ALABAMA MONEY at PAR, for debts due him, unless it should fall to a much lower value than it is at the present time. It is therefore hoped that those indebted will call and settle their accounts as soon as practicable. He would also respectfully inform the public, that he has again returned to his office, with a good supply of

Fresh Medicines,

and is prepared to serve his old customers, and others who may choose to call on him, for another twelve months. Fresh vaccine matter just received.

Columbus, March 23d., 1843.

A.

DR. W. SPILLMAN

HAS moved his office to the South side of Main St., in the building occupied by George Frazee, Esq., as a Clothing Store, where he would be pleased to see his old customers and as many new ones as may see proper to call. He has on hand a good assortment of such medicines as are generally used in families. All medicines furnished by him will be warranted pure and genuine.

Columbus, Miss., Jan 3, 1852 49tf

B.

Figure 1. Advertisements for medicines placed by Dr. Spillman in Columbus, Mississippi, newspapers. **A.** *Democratic Whig*, for March 30, 1843; **B.** *Southern Standard*, for December 11, 1852.

Joseph Phillips of Artesia, Mississippi, assisted in finding Spillman-related material in Columbus. Joseph Phillips took the negatives of the photos used in this article, and James Mahany of Tulane University made the prints.

A SKETCH OF DR. SPILLMAN'S LIFE

His birth and family. William Spillman was born on August 31, 1806, in Blount County (south of Knoxville), eastern Tennessee (Jones, 1951, p. 309). He married Nancy Ambrister, of Wythe County, Virginia (Anonymous, 1954-1965, p. 106). Their two eldest children, John W. and Sarah E., were born in Tennessee (Thomas, 1978). According to tax records, they had moved to Lowndes County, in northeastern Mississippi by 1838 (Logan and Webb, 1992), when William was 32. By 1850, two more children, William J. and Teresa J., had been born in Mississippi (Thomas, 1978).

His medical work and financial success. By 1843, Spillman was apparently working in Columbus as a druggist, advertising medicines he had prepared (Anonymous, 1939-1941, p. 106) for sale in local newspapers (Figure 1). Relatively late in life he decided on a career in medicine, and he went east to medical school. At age 40, in 1846, he graduated from the Philadelphia Medical School (Anonymous, 1954-1965, p. 106). Upon his return to Columbus, he developed a large medical practice there (Lipscomb, 1909, p. 150), and practiced there for some 25 years (Jones, 1951, p. 309). His profession is listed as physician in the 1850 census (Thomas, 1978).

By 1850, at 44, he had become relatively prosperous. The 1850 census recorded that he had real estate valued at $2,000.00, and owned four slaves at the time (Thomas, 1978). The Spillman family lived in a large house, called "Beckrome," built in 1836, which still stands at 803 6th Avenue in Columbus (Figure 2).

His religious work. Dr. Spillman had a second career in addition to medicine - he was an ordained minister in the Methodist Church (Anonymous, 1954-1965, p. 106), and was active in church work nearly all his life. He served in the Mobile, Alabama, Methodist Conference from 1859 to 1870 (Jones, 1951, p. 103). He became a traveling pastor in the Mississippi Conference, and served at Enterprise, Mississippi, from 1870 (Jones, 1951, p. 103). He is listed as a "supernumerary" (probably as a substitute pastor) in the Mississippi Conference in 1873 (Jones, 1951, p. 71), and worked in an 1872 revival. He is listed as "superannuated" (pensioned) in the Mississippi Conference as of 1875 (Jones, 1951, p. 104), at the age of 69. He became editor of "The

Figure 2. Dr. Spillman's house in Columbus, called "Beckrome;" built in 1836.

Mississippi Methodist" in 1882 (Jones, 1951, p. 190), toward the end of his life, and served at camp meetings as late as 1881 (Jones, 1951, p. 210), at the age of 75.

His interest in natural history. Like many educated nineteenth-century men, Dr. Spillman had a lively interest in natural history. His interests are said to have lain in fields as diverse as botany, conchology, paleontology, and cave exploration (Jones, 1951, p. 309). The latter activity he may have done in the southern Appalachians of eastern Tennessee or northern Alabama. He sent modern freshwater river snails he'd collected in Alabama to mollusk expert Isaac Lea for description (Lea, 1861). He also sent fishes, reptiles, and shells from Mississippi to the Smithsonian Institution in 1855 (Johnson, 1936, footnote 98, p. 69).

Dr. Spillman was widely known for his geological collections at the time, and was as generous with those specimens as he was with his other natural history collections. He had "an extensive cabinet of minerals," which he had collected in his travels (Johnson, 1936, p. 62). He was one of relatively few people with an interest in geology in Mississippi in the 1840s (Johnson, 1936, p. 61-62). He presented geologic specimens to the Columbia, Tennessee, Female Institute in the early 1840s, in response to their published request for specimens (Johnson, 1936, p. 121). He donated Eocene fossils to the Academy of Natural Sciences at Philadelphia in 1861 (Anonymous, 1861), of which institution he was a member (Jones, 1951, p. 309). He had a geological exhibit in the New Orleans Exhibition of 1885 (Anonymous, 1954-1965, p. 106), near the end of his life. Of his interest in fossils, more will be said in the following sections.

His character. Spillman was said to be "a modest, unpretentious man" who "was extremely fond of natural science, to which he devoted much of his leisure time" (Lipscomb, 1909, p. 150). He was "a man of intelligence beyond the average" (Anonymous, 1954-1965, p. 106). Of his approach to the natural world, it was said that "He could see God in all things, even in all His creation" (Jones, 1951, p. 309).

His death. William Spillman died on December 11, 1886, at Mathersville, near Shubuta, Mississippi (Jones, 1951, p. 309), at the age of 80. He was buried in Friendship Cemetery in Columbus (Figure 3), between his wife Nancy (who had died five years earlier) and his eldest son, Dr. John W. Spillman (Parker, 1979). His son John was a surgeon in the Confederacy during the Civil War (Anonymous, 1954-1965, p. 107). Sadly, his gravestone has since been lost, and his grave is now unmarked.

Of his death it was said that "He was above all things an earnest Christian and died well, having the confidence of the brethren and the respect of all who knew him" (Jones, 1951, p. 309).

SPILLMAN'S WORK WITH SPECIALISTS

By the early 1850s, Dr. Spillman had begun sending fossils he had collected to specialists for study, and began working with geologists of the Alabama and Mississippi Geological Surveys. He had met Benjamin L. C. Wailes, the author of the Mississippi Geological Survey's first geologic report on Mississippi, in 1852 (Sydnor, 1938, p. 191), and was a friend of Wailes (Domning, 1969, p. 387), although Wailes didn't mention him in his report (Wailes, 1854).

He sent a number of Cretaceous invertebrates (nautiloids, ammonites, gastropods, and bivalves) to Michael Tuomey, the first State Geologist of Alabama, for study. Tuomey (1854) named nine of these as new species (including two, *Nautilus spillmani* and *Voluta spillmanii*, named for Spillman). Unfortunately, because the descriptions of these taxa were too short, the locations too vague, and the material all un-figured (Stephenson and Monroe, 1940, p. 18), all these Tuomey species are "essentially valueless" (Sohl, 1960, p. 5). Fortunately, this situation never occurred again to Spillman material sent for description.

Spillman worked with the authors of both the second and third Mississippi geologic reports, Lewis Harper and Eugene Hilgard. He was extensively cited in footnotes in the second report (Harper, 1857). Harper notes his fine collection of Cretaceous fossils (footnote 42, p. 280), and printed a faunal list of Lowndes County Cretaceous fossils provided by Spillman (p. 280-281), notes that he took him to one of his collecting sites, Barton's Bluff (footnote 44, p. 282), and notes that Spillman had determined the dip of the beds near Columbus (footnote 50, p. 283). The Barton's Bluff fossil site was also mentioned in an appendix to Tuomey's second geologic report on Alabama (Thornton, *in* Tuomey, 1858). While Tuomey's assistant, E. Q. Thornton, doesn't say so, it is likely that, as with Harper in 1857, he was taken to the site by Dr. Spillman.

Spillman sent Cretaceous and Eocene mollusks to the Academy of Natural Science at Philadelphia, to be studied by Timothy A. Conrad, an authority on Cretaceous and Tertiary mollusks, and later State Paleontologist of New York. Many of these were from the Owl Creek Bluff site in Tippah County, Mississippi, and many formed the basis for two of Conrad's most important Cretaceous mollusk papers (Conrad, 1858, 1860). Conrad named a snail (now called *Dircella spillmani*) and a clam (now *Pachycardium spillmani*) for Dr. Spillman. Some middle and late Eocene mollusks collected by Spillman in Alabama were described by Conrad's younger colleague at the Academy, William M. Gabb (Gabb, 1860), including a now widely known late Eocene pectinid now called *Chlamys spillmani*. An important Cretaceous snail, called *Gyrodes spillmani*, was later named by the same author (Gabb, 1862).

In the third geologic report on Mississippi (Hilgard, "1860"), much material is repeated from Harper's earlier (1857) report, but with fewer references to Spillman. The date

Figure 3. The Spillman family plot in Friendship Cemetery in Columbus. The gravestone in the left foreground is that of Dr. Spillman's daughter-in-law; that in the right foreground is that of her husband, Dr. Spillman's eldest son, Dr. John W. Spillman. According to the burial records, between these two headstones are buried (on the left) Dr. Spillman's wife Nancy, and (on the right) Dr. William Spillman. Currently, neither Dr. Spillman's, nor his wife's, grave is marked.

of the publication printed on it, 1860, is inaccurate, as Hilgard later (1901, p. 304-305) made clear that the report wasn't distributed (and therefore truly published) till after the Civil War, in 1866. Hilgard notes Spillman's determination of the dip of the beds near Columbus (p. 60), Spillman's fossil collection (p. 74), and (like Harper before) includes a list of Cretaceous fossils from Lowndes County provided by Dr. Spillman as an appendix (p. 389).

By the late 1850s, Dr. Spillman had begun sending Cretaceous vertebrates he had found in northeastern Mississippi to Joseph Leidy, at the Philadelphia Academy. Spillman may have met Leidy at the Philadelphia Medical School when he was a medical student there in the mid-1840s. When Leidy received the first fossil vertebrates from Spillman, he was at the beginning of a long career, which would eventually establish him unambiguously as the Father of American Vertebrate Paleontology. Leidy was 17 years younger than Spillman, and was only 35 when he described the first of many Cretaceous vertebrates sent him by William Spillman. The first (Leidy, 1858) was an obscure bony fish named *Hadrodus priscus*. While Leidy had described a few Cretaceous vertebrates from the East Coast (largely New Jersey) by this time, this may be the first he'd described from the Gulf Coastal Plain. In Leidy's major monograph on everything that was then known of American Cretaceous reptiles (Leidy, 1865), several of Dr. Spillman's specimens were described and figured, including the first plesiosaur remains described from Mississippi. One curiosity of this paper is that mosasaur limb elements had, at that time, not been described. A giant sea turtle humerus sent by Spillman was incorrectly identified as that of a mosasaur. Several of Spillman's specimens figured by Leidy (1865) were later re-identified and named by Leidy's younger associate, Edward Drinker Cope - himself also a major figure in American vertebrate paleontology. One partial mosasaur skeleton figured by Leidy (1865) from Spillman material was later made the type specimen of the type species of an important mosasaur genus, *Platecarpus*, by Cope (1869). The giant sea turtle humerus, now known as *Neptunochelys tuberosa*, was named by Cope later (1872). Leidy (1866) described the first Mississippi dinosaur bone (a toe bone sent by Spillman) only ten years after he had described the first known American dinosaur skeleton from New Jersey. Leidy (1868) described

teeth of the Cretaceous ray *Ptychodus* from Spillman material from near Columbus. A Cretaceous shark tooth from Texas, a Cretaceous shark tooth from near Columbus, and a bony fish tooth plate were named by Leidy in 1872, from Spillman material. Many of the earlier described Spillman specimens, including those of the 1872 paper, were re-described and figured in Leidy's 1873 monograph. Many of the Cretaceous vertebrates first described from Spillman material from Mississippi were later discovered from the great Cretaceous chalk beds of Kansas. As a result of Spillman's efforts many taxa (some rarely collected later) were put in the scientific record.

SPILLMAN FOSSIL COLLECTING SITES

As previously noted, Dr. Spillman was well known for his excellent fossil collection, which he made available for study to a wide array of specialists. Unfortunately, because the bulk of that large collection has since been lost (save for material sent to the Academy of Natural Science at Philadelphia and a few specimens sent to the Geological Survey of Alabama) and because many of the published specimens were recorded only as from "the Columbus area" (probably at least part of the time only because Spillman lived in Columbus) or simply as from "Mississippi," relatively little specific locality data exists on his collecting sites.

His most important invertebrate fossil collecting site was clearly the Owl Creek Bluff site, about 3 miles northeast of Ripley, in Tippah County, Mississippi (Stephenson and Monroe, 1940, p. 18; Sohl, 1960, p. 5, 22). This site, in the late Cretaceous Owl Creek Formation, is especially significant because of the excellent preservation of aragonitic mollusk shells, something usually lost to dissolution at most Mississippi Cretaceous sites. Most of the material Spillman sent to T. A. Conrad and published in Conrad (1858) and (1860) was from this site. As Sohl (1960, p. 6) noted, some of the Spillman material in Conrad (1860) likely came from another nearby area, in a lower bed. Based on preservation of the material and taxon ranges, it is likely that some of it was from the Ripley Formation of northeastern Union County, Mississippi.

Dr. Spillman did at least a little collecting in the late Cretaceous Prairie Bluff Formation as well. The type specimen of *Gyrodes spillmani* Gabb, 1861 is from the Prairie Bluff of Mississippi (Sohl, 1960, p. 119). A single ammonite specimen in the Geological Survey of Alabama collection (GSA 63-2, a specimen of *Sphenodiscus*) is recorded as collected by Dr. Spillman from the type locality of the formation, at Prairie Bluff Landing, in Wilcox County, Alabama.

Not all the fossil invertebrates collected by Spillman were Cretaceous (though apparently most were). A few middle and late Eocene mollusks collected by Spillman in Alabama were described by Gabb (1860).

Spillman's most important vertebrate fossil sites were those closest to his home - sites in the late Cretaceous Tombigbee Sand Member at the top of the Eutaw Formation, exposed in cut banks along the Tombigbee River northwest of Columbus. As noted by Harper (1857, p. 280) and Hilgard (1860, p. 74) most of Spillman's fossils recorded as from near Columbus, or from Lowndes County, are likely from Plymouth Bluff, about 4 miles west-northwest of Columbus, in north-central Lowndes County (see Stephenson and Monroe, 1940, p. 72-73, 68). It is likely that most of the Spillman vertebrate material described by Leidy and Cope came from that site. It is also likely that much of the Spillman material poorly described by Tuomey (1854) was also from this site, notably the inoceramids, which are common at the site. Some of the Spillman mollusks described by Conrad (1858, p. 335) may also have been from Plymouth Bluff.

While most of Dr. Spillman's Tombigbee Sand collections likely derived from Plymouth Bluff, especially since this prolific site is closest to Columbus, it is certainly true that he also collected at at least two other Tombigbee Sand sites north of Plymouth Bluff, in eastern Clay County. Harper (1857, p. 282, footnote 44) suggests that Barton's Bluff (see Stephenson and Monroe, 1940, p. 75-76, 68) was something of a favorite collecting site of Dr. Spillman's, as he "had the kindness to conduct me to this remarkable place" and "has given it the name of *Shark's Defeat*, on account of the thousands of shark's teeth which are continually found there" (Harper, 1857, p. 282). The shark tooth bed, like that at Plymouth Bluff, is a transgressive marine lag at the base of the bed. Unfortunately, none of the described Spillman vertebrates is recorded as coming specifically from either Plymouth or Barton's Bluff.

At least one piece of evidence shows that Dr. Spillman collected at another nearby Tombigbee Sand site in Clay County - Vinton Bluff, just north of Barton's Bluff (see Stephenson and Monroe, 1940, p. 76, 68). A small collection of uncatalogued Cretaceous shark teeth (Figure 4) in the Alabama Museum of Natural History (ALAM) collection in Tuscaloosa is identified as collected by Dr. Spillman at Vinton, in Lowndes County. These teeth are likely from Vinton Bluff, near the now-extinct town of Vinton. The site was originally part of Lowndes County, but later the area was removed from that county and made part of Clay County (Sohl, 1960, fig. 4). These specimens, and Tippah County mollusks in the ALAM collection also collected by Spillman, were likely sent by Spillman to mollusk-specialist Aldrich late in Spillman's life, probably in the 1880s, and are not part of the material sent to Tuomey in the 1850s.

Dr. Spillman was said to have traveled and collected extensively in the "western states" (now the southeast and south-central U.S.) between 1832 and 1840 (Johnson, 1936, p. 62). Besides material from Mississippi and Alabama, Dr. Spillman was reported as sending at least one Cretaceous

shark tooth (the type of *Otodus divaricatus*) to Leidy from a Texas site (Leidy, 1872, p. 162-163; Leidy, 1873, p. 305). It is likely that many of the sites collected by Dr. Spillman will never be known, probably mostly because he himself did not record the locality data as carefully as he might have.

SPILLMAN'S SCIENTIFIC WORK

William Spillman is sometimes thought of only as a doctor who collected fossils in his spare time, as one with no real scientific interests in the material (see discussion in the following section). While it is true that he published no reports on the fossils he collected, this portrayal is still inaccurate.

He did, in fact, write at least one scientific account of archaeological excavations he did of Indian mounds in Alabama for a Columbus newspaper (Spillman, 1839), soon after he arrived in Columbus. As previously noted, he also made important contributions to the second and third geologic reports on Mississippi. He contributed long, detailed faunal lists of the Cretaceous fossils of Lowndes County, which were included directly into these reports (Harper, 1857, p. 280-281; Hilgard, 1860, p. 389). Thurmond and Jones (1981, p. 227) make a bibliographic reference (though it does not occur in the text) to a paper by "Spellman, W. 1863." This citation refers only to Spillman's faunal list in Hilgard (1860, p. 389). His determination of the dip of the Cretaceous beds in the Lowndes County area (25 feet to the mile toward the south-southwest) was also included directly in these reports (Harper, 1857, p. 283-284; Hilgard, 1860, p. 60).

Besides his research on the archaeology, paleontology and geology of Alabama and Mississippi, it must be said that his assistance to, and correspondence with, professional geologists and paleontologists was well beyond that of a simple fossil collector, however avid. His work with these specialists did much to further their research. He acted in this capacity partly as a colleague.

The boundary between scientist and educated amateur (especially among physicians and ministers) in the mid-nineteenth century was not as sharp as it is today. Many non-professionals made important contributions to science.

ATTITUDES TOWARD SPILLMAN'S WORK

The approach of scientists to Dr. Spillman's work changed quickly from sincere respect to a subtle denigration of its significance. In recent years the trend has continued.

Early on, comments on his work were glowing. Harper (1857, p. 282) said "The importance of Dr. Spillman's collection of cretaceous fossils for the palaeontology of the State of Mississippi, will be evident from the above list [of the Cretaceous fossils of Lowndes County]. The doctor has most kindly tendered to me, not only his cabinet, for my use, but also his valuable assistance, for which I feel deeply indebted to him. It has hitherto been impossible for me to devote much time to the palaeontology of the State, but for the final report on the geology of the State, the cabinet of Dr. Spillman will be a real treasure, and save much time and labor." Likewise, Conrad (1858, p. 323) said of the Owl Creek Bluff mollusks Dr. Spillman had collected and sent to him, and which formed the basis of the paper, "The discovery of these beautiful organic remains is due to the indefatigable exertions of Dr. W. Spillman, of Columbus, ..."

Shortly afterwards, however, a subtle emphasis began to be made on the amateur nature of Dr. Spillman's work, making the compliments a bit backhanded. Hilgard (1860, p. 84) said of his work "Great credit is due to Dr. S. for the energy and enthusiasm with which he has for years pursued, *during all his leisure hours* [emphasis mine], the study of the cretaceous formation of Mississippi." Hilgard also rather peevishly complained that Dr. Spillman had received too much credit for sending the Owl Creek Bluff material to Conrad for description, when he (Hilgard) had material from the same site which Conrad was unable to come to Mississippi to see (Hilgard, 1860, p. 84; Hilgard, 1901, p. 292).

More recently, the separation between Dr. Spillman and the professionals has been further emphasized. As Sohl (1960, p. 5) has put it, "A great debt is due Dr. Spillman for his energy in collecting, *for although he did not himself publish and was not a paleontologist* [emphasis mine], he provided the impetus for the early study of the Cretaceous paleontology of Mississippi which no one else at the time could give." This status was also noted by Domning (1969, p. 387) in identifying Dr. Spillman as "the outstanding (in fact the only) amateur geologist in eastern Mississippi." Most recently, Dr. Spillman has been reduced to one of a number of "local hobbyists" who merely "wanted to have their finds identified" (Daly, 1992, p. 3). This kind of characterization unfairly belittles the importance of his work and his contribution to science.

CONCLUSION

Much of the credit for early on placing the Cretaceous fossils of northeastern Mississippi on the scientific record goes to the man who, through years of research and collection and liberal communications with some of the best specialists of his day on his findings, made the material known - Dr. William Spillman of Columbus, Mississippi.

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Figure 4. Late Cretaceous shark teeth collected by Dr. Spillman, probably from the basal Tombigbee Sand Member, upper Eutaw Formation, of Vinton Bluff, now in Clay County, Mississippi. The upper two rows of teeth are of the goblin shark *Scapanorhynchus texanus*, the third row is of the shark *Otodus appendiculatus*, and the lower three rows are of the shark *Squalicorax kaupi*. The arrangement of the teeth is by the author. Alabama Museum of Natural History collection, Tuscaloosa.

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