THE DEPARTMENT OF ENVIRONMENTAL QUALITY

mississippi geology

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

Volume 14, Number 3
September 1993

USE OF GEOPHYSICAL WELL LOGS TO DETERMINE LOESS THICKNESSES AND CORRELATE LOESSES AND GEOSOLS IN THE MEMPHIS, TENNESSEE - NORTHERN MISSISSIPPI AREA

William S. Parks
U. S. Geological Survey, Memphis, Tennessee

ABSTRACT

Total thicknesses of loess of Pleistocene age in the Memphis, Tennessee - northern Mississippi area were determined from the geophysical logs made in test holes and ground-water wells. Total loess is thickest on the Mississippi River bluffs that form the eastern boundary of the Lower Mississippi Valley. Maximum loess thickness measured in that area was about 70 feet. Eastward from the bluffs, total loess thins rapidly in the first several miles, but thereafter the rate of thinning decreases. Minimum thickness measured at a distance of about 70 miles east of the bluffs was 4 feet. A plot of total loess thicknesses shows that this rate of thinning follows a logarithmic curve.

Correlations of gamma-ray logs made in several ground-water observation wells in the bluff areas indicate the occurrence of four loess units (from oldest to youngest): the Crowleys Ridge Loess, the "Loveland/Sicily Island loess," the Roxana Silt, and the Peoria Loess. Correlation of these loesses on gamma-ray logs was based primarily on stratigraphic position, differences in natural gamma-ray emission, and thicknesses reported for the loesses in previous investigations. Increases in gamma-ray emission observed on the gamma-ray logs at the tops of the Crowleys Ridge Loess, the "Loveland/Sicily Island loess," and the Roxana Silt indicate the presence of geosols in the upper parts of these units.

INTRODUCTION

Total thicknesses of loess of Pleistocene age were determined generally in the Lower Mississippi Valley by Wascher and others (1948), who made field observations of the loess at more than 1,200 localities in Arkansas, Kentucky, Louisiana, Mississippi, and Tennessee. From these data, Wascher and others prepared a map showing the regional relations of the maximum thickness of "Peoria loess" or "total loess." East of the Mississippi River, loess thickness is shown on this map by eight areal zones trending generally northeast-southwest and paralleling the bluffs. In western Tennessee and northern Mississippi, loess was shown to be thickest (mostly more than 15 feet thick) along the Mississippi River bluffs in western Tennessee and northwestern Mississippi and thinnest (mostly less than 2 feet thick or absent) in central Tennessee and northeastern Mississippi. In the bluff areas, Wascher and others recognized three loess units (from oldest to youngest): the "Third loess," the "Sangamon loess," and the "Peorian loess."

Snowden and Priddy (1968) determined total loess thicknesses specifically in the Vicksburg area of Mississippi by measuring loess thickness at 11 localities on the ridge tops

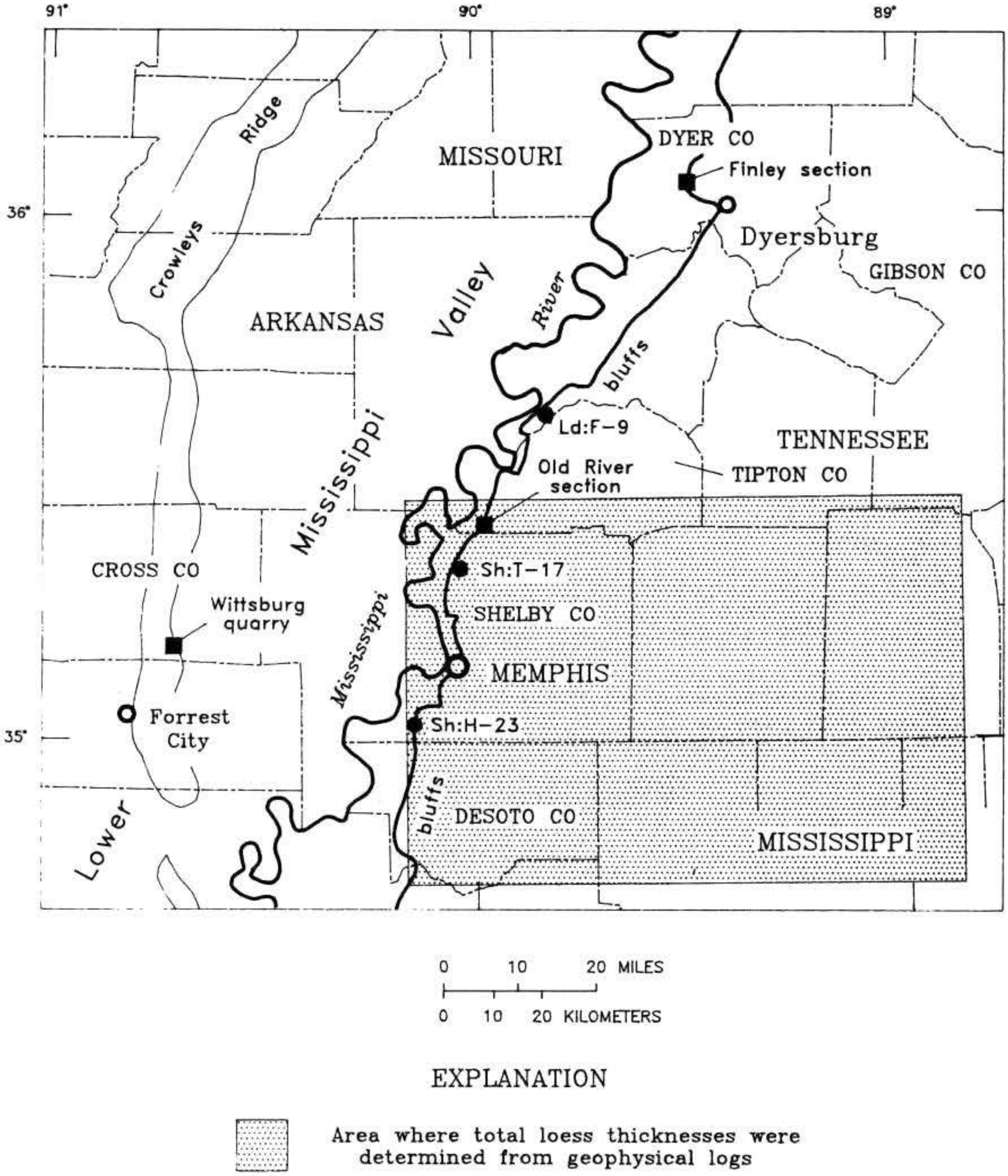


Figure 1. Area where total loess thicknesses were determined from geophysical logs and location of the Wittsburg quarry, Old River section, Finley section, and wells Sh:H-23, Sh:T-17, and Ld:F-9.

east of the Mississippi River bluffs from Vicksburg to Jackson. Snowden and Priddy plotted their measurements on a graph to show the relation between ridge-top loess thickness and distance from the Mississippi River bluffs. This plot resulted in a logarithmic curve showing that in the first few miles east of the bluffs the loess thinned rapidly, but the rate of thinning decreased thereafter. In the Vicksburg area, Snowden and Priddy recognized three loess units (from oldest to youngest): the "pre-Farmdale loess," the "Farmdale loess," and the "Peorian loess."

Buntley and others (1977) determined loess thicknesses by using power augers to drill auger holes in the Dyer and Gibson counties area of northwestern Tennessee. They included a plot of the relation of loess thickness (an aggregate thickness of the "Roxana loess" and the "Peoria loess") to distance from the Mississippi River bluffs. This plot indicates a logarithmic relation between total loess thickness and distance from the bluffs. In the Dyer and Gibson counties area, Buntley and others recognized three loess units (from oldest to youngest): the "Loveland loess," the "Roxana loess," and the "Peoria loess."

In their detailed investigation of loess in Mississippi, Snowden and Priddy (1968) measured natural gamma-ray emission as one of many physical, chemical, and mineralogical characteristics they studied in search of criteria for subdividing the total loess section and for recognizing geosols

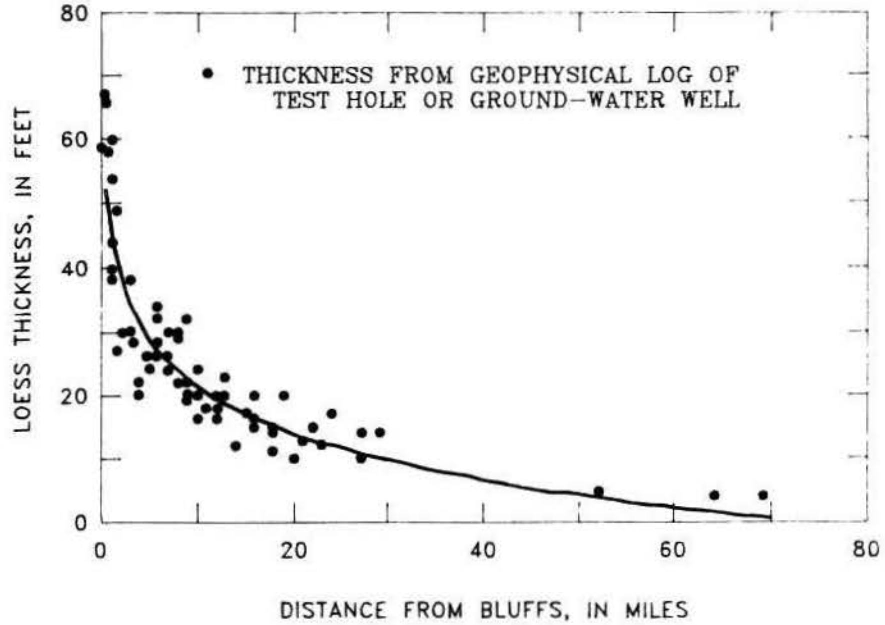


Figure 2. Relation of total loess thicknesses determined from geophysical logs to distances of test holes and wells from the Mississippi River bluffs in the Memphis, Tennessee - northern Mississippi area.

(paleosols in their report). Gamma-ray logs were made in several test holes drilled through thick loess near the Mississippi River bluffs at Vicksburg. Snowden and Priddy observed that the fresh loess, weathered loess, and geosols penetrated by the test holes had sufficiently different gamma-ray radioactivity to provide a lithologic record. However, they reported that the record of the gamma-ray logger was erratic and that most of the variations of gamma-ray emission occurred over short intervals. Comparisons between gamma-ray emission and the other characteristics measured apparently were not useful in distinguishing loess units for their study.

PURPOSE AND SCOPE

This paper presents information on total loess thicknesses determined from geophysical logs of test holes and ground-water wells in the Memphis, Tennessee - northern Mississippi area. It also provides correlations of loesses and geosols on gamma-ray logs made in several ground-water observation wells in western Tennessee.

This study is an extension of work conducted from 1971 to 1978 by the U. S. Geological Survey (USGS), in cooperation with the Tennessee Division of Geology, to map the seven 7 1/2-minute geologic quadrangles (scale 1:24,000) that include most of the Memphis urban area. Two of these geologic quadrangles have been published (Parks 1978, 1987).

TOTAL LOESS THICKNESSES FROM GEOPHYSICAL LOGS

Geophysical logs made in 72 test holes and ground-water wells were used to determine total loess thicknesses for this study. The 52 gamma-ray logs and 38 electric logs made in these wells were selected from a file of more than 600 geophysical logs available for the Memphis, Tennessee - northern Mississippi area. Most of the test holes and ground-water wells for which logs were used for this study were located in Shelby County, Tennessee, and DeSoto County, Mississippi (Figure 1).

Selection of geophysical logs was based on (1) topographic positions of wells for which logs were available, (2) areal distribution of log control, and (3) completeness of the near-surface part of geophysical logs that show the loess. Most logs selected were made in wells drilled at or near ridge tops or on hills in topographically high areas so as to presumably measure in-place loess and to avoid including reworked or colluviated loess. The logs were selected to include areas as far east of the Mississippi River bluffs as the loess could be identified on geophysical logs. This distance was about 70 miles.

Although many electric logs were correlated, natural gamma-ray logs proved to be more useful for the determination of loess thicknesses. The gamma-ray logs were made in uncased test holes or cased ground-water wells, and the near-surface parts of the logs that showed the loess generally were recorded. The electric logs were made only in uncased test holes drilled by hydraulic-rotary methods.

Making electric logs of the near-surface parts of test holes drilled by hydraulic-rotary methods required that the drilling fluid be maintained in the upper part of the bore hole. Unless a special effort was made, this generally was not achieved because the fluid level commonly fell in the bore hole as a result of water loss to deeper sand formations after circulation was stopped for geophysical logging. Therefore, the near-surface parts of the logs that would have shown the loess commonly were not recorded. In addition, recognition of the contact between the loess and fluvial deposits generally

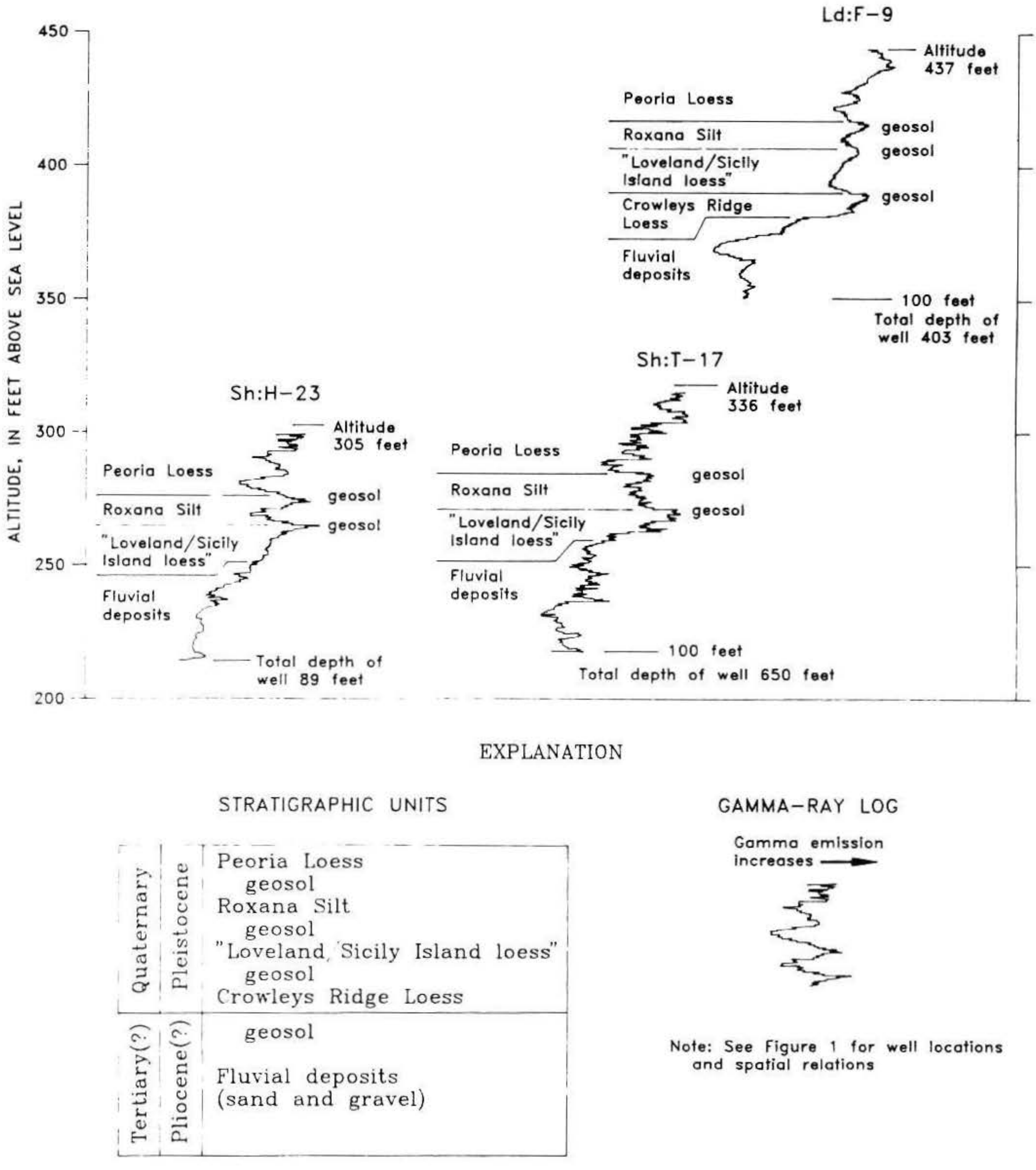


Figure 3. Correlations of loesses and geosols on gamma-ray logs made in U. S. Geological Survey ground-water observation wells Sh:H-23, Sh:T-17, and Ld:F-9.

was not as clear on electric logs as it was on gamma-ray logs.

The contact between the loess (silt or clayey silt) and the underlying fluvial deposits (sand or sand and gravel) was determined from the geophysical logs. Because the upper 5 to 10 feet (or more) of many wells were not logged, land surface datum at the well was assumed to be the top of the loess. Total loess thicknesses were calculated from these data. Distances of the wells from the Mississippi River bluffs were measured to the nearest 1 mile on USGS 1:250,000-scale topographic maps, except for areas extending about 5 miles

Table 1. Thicknesses of loesses and geosols determined by previous investigations in eastern Arkansas and western Tennessee compared to thicknesses determined by correlation of gamma-ray logs made in wells Ld:F-9, Sh:T-17, and Sh:H-23

[Geosol thicknesses (in parentheses) are included in the thickness of the underlying loesses from which they were formed; --, indicates not recognized or not present. Loess and geosol thicknesses compiled from data given in Rutledge and others (1990) and Porter and Bishop (1990) for the Wittsburg quarry, Buntley and others (1977) for the Finley section, and Parks and Lounsbury (1975) for the Old River section, with additional measurements in 1993]

	Thickness, in feet					
Loess or geosol	Wittsburg quarry, Cross County, Arkansas	Finley section, Dyer County, Tennessee	Old River section, Tipton County, Tennessee	Well Ld:F-9, Lauderdale County, Tennessee	Well Sh:T-17, Shelby County, Tennessee	Well Sh:H-23, Shelby County, Tennessee
Peoria Loess	20	45	35	28.5	33	27.5
geosol	(2.5)	(5)	(5)	(4.5)	(4)	(2.5)
Roxana Silt	5	9	7	10.5	14	10
geosol	(4)	(6)	(2)	(3.5)	(5)	(1.5)
"Loveland/ Sicily Island loess"	28	9.5	6.5	18.5	13	21.5
geosol	(2.5)	--	(3)	(3.0)	--	--
Crowleys Ridge Loess	8	--	4.5	9.5	--	--
Total loess thickness	61	63.5	53	67	60	59

east of the bluffs, where distances were measured to the nearest 0.1 mile on USGS 1:24,000-scale topographic maps. The thickness and distance data were entered into a computer plotting program and a best-fit curve was computed to match the data points (Figure 2).

CORRELATION OF LOESSES AND GEOSOLS ON GAMMA-RAY LOGS

As the geophysical logs for this study were being examined, it was recognized that gamma-ray logs of several ground-water observation wells located just east of the bluffs in western Tennessee had sufficient definition to show relatively thick silt layers alternating with thin, clayey silt interbeds. The thick silt layers were interpreted to be loesses of different ages, and the thin, clayey silt interbeds to be geosols.

Because of the complexity and wide geographical distribution of loess in the Lower Mississippi Valley, stratigraphic nomenclature and correlation of the loesses over great distances is still in a state of flux. The present status of loess stratigraphy was discussed in a recent report on the Quaternary geology of the Lower Mississippi Valley (Autin and others, 1991).

The nearest stratigraphic sequence for which recently published data were available for comparison with the loesses in western Tennessee and northern Mississippi is at the Wittsburg quarry on Crowleys Ridge, north of Forrest City, Arkansas (Figure 1). At the quarry, about 40 miles west of Memphis, the loess section consists of four units (from oldest to youngest): the Crowleys Ridge Loess (Porter and Bishop, 1990), the "Loveland/Sicily Island loess," the Roxana Silt, and the Peoria Loess (Rutledge and others, 1990). Correlations of these loesses in western Tennessee are shown on the gamma-ray logs made in USGS ground-water observation wells Sh:H-23, Sh:T-17, and Ld:F-9 (Figure 3).

The thicknesses of the loesses and geosols correlated on these gamma-ray logs compare favorably with the thicknesses to be expected for these units based on recent work at the Wittsburg quarry (Rutledge and others, 1990; Porter and Bishop, 1990) in eastern Arkansas and earlier work at the Finley section (Buntley and others, 1977) and Old River sections (Parks and Lounsbury, 1975) in western Tennessee

(Table 1). Additional measurements of the loesses and geosols at the Old River section were made in 1993.

CONCLUSIONS

Total thicknesses of loess of Pleistocene age in the Memphis, Tennessee - northern Mississippi area are logarithmically related to distance from the Mississippi River bluffs. The loess thins rapidly in the first several miles east of the bluffs, but the rate of thinning decreases thereafter. Maximum loess thickness measured in the bluffs area was about 70 feet, and minimum loess thickness measured at a distance of about 70 miles east of the bluffs was 4 feet.

Correlations of the natural gamma-ray logs made in three ground-water observation wells located near the Mississippi River bluffs in western Tennessee indicate the presence of (from oldest to youngest): the Crowleys Ridge Loess, the "Loveland/Sicily Island loess," the Roxana Silt, and the Peoria Loess. These loesses have been identified at the Wittsburg quarry on Crowleys Ridge in eastern Arkansas. Increases in gamma-ray emission observed on the gamma-ray logs at the tops of the Crowleys Ridge Loess, the "Loveland/Sicily Island loess," and the Roxana Silt indicate the presence of geosols in the upper parts of these loesses.

This study shows that geophysical logs (electric and gamma-ray logs) of test holes and ground-water wells can be used for determining total loess thicknesses in areas where sufficient logs are available. It also shows that natural gamma-ray logs of test holes and ground-water wells provide a method for correlating loesses and geosols, specifically in the Mississippi River bluff area where the loess is thickest.

REFERENCES CITED

Autin, W. J., S. F. Burns, B. J. Miller, R. T. Saucier, and J. I. Snead, 1991, Quaternary geology of the Lower Mississippi Valley, *in* R. B. Morrison, ed., Quaternary nonglacial geology; Conterminous U. S.: Boulder, Colorado, Geological Society of America, The Geology of North America, v. K-2, p. 547-582.

Buntley, G. J., R. B. Daniels, E. E. Gamble, and W. T. Brown, 1977, Fragipan horizons in soils of the Memphis-Loring-Grenada sequence in west Tennessee: Soil Science Society of America Journal, v. 41, p. 400-407.

Parks, W. S., 1978, Geologic map of the Tennessee portion of the Fletcher Lake quadrangle, Tennessee (including portions of adjacent quadrangles to the north, west, and south): Tennessee Division of Geology, GM 404-SW, scale 1:24,000.

Parks, W. S., 1987, Geologic map of the Southeast Memphis quadrangle, Tennessee (including the Tennessee part of the Pleasant Hill quadrangle Tennessee-Mississippi): Tennessee Division of Geology, GM 409-SW, scale 1:24,000.

Parks, W. S., and R. W. Lounsbury, 1975, Field Trip 2, Environmental Geology of Memphis, Tennessee, *in* Field Trips in West Tennessee: Tennessee Division of Geology, Report of Investigations no. 36, p. 35-63.

Porter, Donna, and Sam Bishop, 1990, Soil and lithostratigraphy below the Loveland/Sicily Island Silt, Crowley's Ridge, Arkansas: Proceedings Arkansas Academy of Science, v. 44, p. 86-90.

Rutledge, E. M., L. T. West, and M. J. Guccione, 1990, Loess deposits of northeast Arkansas, *in* M. J. Guccione and E. M. Rutledge, eds., Field guide to the Mississippi Alluvial Valley, northeast Arkansas and southeast Missouri: Friends of the Pleistocene South Central Cell Field Trip Guide, p. 57-98.

Snowden, J. O., Jr., and R. R. Priddy, 1968, Geology of Mississippi loess, *in* Loess Investigations in Mississippi: Mississippi Geological, Economic and Topographical Survey, Bulletin 111, p. 13-203.

Wascher, H. L., R. P. Humbert, and J. G. Cady, 1948, Loess in the southern Mississippi Valley: Identification and distribution of the loess sheets: Soil Science Society of America Proceedings, v. 12, p. 389-399.

MISSISSIPPI'S SHALLOW SALT DOMES

Stan Thieling
Mississippi Office of Geology

Mississippi is not known as a state having a great amount of mineral wealth. The primary mineral extraction has historically been oil and gas production. Mississippi does have an abundant, valuable and under-utilized natural resource in its fifty-three known shallow salt domes. This paper provides current data on the location and depth of these domes so that they may become an economically productive part of the state's mineral inventory.

About 150 million years ago, in the late Jurassic period, or in the middle of the age of the dinosaurs, southern Mississippi's climate and appearance were very different than today. An arm of a much smaller Gulf of Mexico covered much of the future Mississippi as far north as Issaquena, Madison, and Clarke counties. Most of Pearl River, Stone, and George counties, as well as the coastal counties, was above water, either as a peninsula or a series of islands. The climate was that of a hot, dry desert and the Gulf of Mexico was hypersaline, a consequence of being cut off for long periods from oceanic circulation. The sediments deposited under these unusual conditions consisted of nearly pure halite, or salt, mixed with a minor percent of other evaporite minerals. Salt was deposited in a more or less continuous band from the Yucatan of Mexico to Texas, Louisiana, Mississippi, Alabama and offshore Florida. This nearly pure salt bed, named the Louann, varies in thickness from a landward feather edge to many thousands of feet toward the center of the salt basin.

As the climate slowly changed more typical sedimentary sandstones, shales, and limestones were deposited on top of the salt layer. The weight of these overlying rocks combined with increasing temperature, as the salt was buried to greater depths, gave the salt plastic properties and the ability to slowly flow. Because salt is less dense than the overlying rock, it flows upward, forcing its way through fault zones or other areas of weakness until it reaches equilibrium with the surrounding and overlying sediments and fresh-water zone. Very briefly, this is how the fifty-three known shallow (those with crests less than 6,000 feet below sea level) salt domes of the Mississippi Interior Salt Basin were formed.

The salt was pressured into a continuum of shapes, dependent on depth of burial, temperature, amount of available salt, and, perhaps, movement of the earth's crust underlying the salt. This series of shapes, beginning with the least volume of salt and least relief, are salt monoclines or ridges, pillows, anticlines, walls, and domes. All of these features exist in the subsurface of Mississippi, but detailed knowledge of their location and shape is limited, coming mostly from the petroleum industry. Numerous wells drilled for oil and gas have penetrated the Louann Salt, and other information has come from gravity and seismic surveys used in petroleum exploration.

Salt domes are known to have a wide range of sizes and shapes with those in Mississippi being toward the smaller end of the size scale compared to many other locations around the world. Mississippi's shallow salt domes are typically one to two miles in diameter and frequently have varying, but generally small, amounts of overhang at the top giving them an elongated mushroom appearance, if they could be viewed from the side. The largest dome in Mississippi is nearly six miles long and two miles wide at its crest. Salt domes may become so elongated and stretched that they are separated from the salt source bed and migrate upward, with an inverted teardrop shape, having no remaining connection to their source. There are no definitive data to determine whether or not this has happened in Mississippi.

Across the crest of most salt domes is a layer of associated material up to several hundred feet thick called cap rock. Cap rock is composed largely of anhydrite, which may be the only constituent locally. Other components of cap rock may include gypsum (an anhydrite and water alteration product) and limestone. Associated accessory minerals frequently include pyrite, barite and sulfur. Numerous salt domes in the Texas and Louisiana gulf coast have commercial deposits of sulfur. Although much of the early, and some recent, salt dome exploration drilling in Mississippi was for sulfur, none has been found in commercial quantities.

Caverns in salt may be used to store any material that does not dissolve the salt; this currently means primarily petroleum products. Two of Mississippi's shallow salt domes, Petal and Eminence, are currently being used by several companies for the storage of natural gas and liquified petroleum gas. The gas is stored in caverns dissolved in the salt. For liquified petroleum gas storage there are twenty-one of these caverns currently in use with a combined capacity of 25.4 million barrels (1,066 million gallons). The largest of these caverns has a volume of 2.44 million barrels or 102 million gallons. There are also three caverns with a combined capacity of 6,012 billion cubic feet for natural gas storage. These are the only salt dome storage facilities east of the Mississippi River. The best known salt dome storage facilities in the United States are the caverns comprising the national Strategic Petroleum Reserve or SPR. The SPR is located in Texas and Louisiana and has a current capacity of 750 million barrels or 31.5 billion gallons. Worldwide there are nearly one thousand storage facilities in salt caverns. Germany alone has 174 active storage caverns with another 106 planned or under construction.

There are presently fifty-three known shallow salt domes in Mississippi. Geophysical evidence from gravity and seismic surveys puts several undrilled domes in the known category. As our knowledge of these features continues to increase, the list of known salt domes will very likely increase. With only twenty- four caverns in use in two domes, Petal and Eminence, there is not only room for expansion in the number of storage caverns at these two domes, but vast potential remains totally unused at the other fifty-one shallow Mississippi salt domes.

SELECTED REFERENCES

Gomm, Hartmut, and Lutz Peters, 1993, Steerable BHAs drill storage wells with difficult trajectories: Oil and Gas Journal, v. 91, no. 29, p. 44-50.

Halbouty, Michel T., 1979, Salt Domes, Gulf Region, United States and Mexico, Second Edition: Houston, Gulf Publishing Co., 561 p.

Hughes, Dudley J., 1960, Faulting associated with deep-seated salt domes in the northeast portion of the Mississippi Salt Basin: Gulf Coast Association of Geological Societies, Transactions, v. 10, p. 154-173.

Mississippi State Oil and Gas Board, August, 1993, Form #14-A, Monthly Report on Fluids Injected for Underground Storage Facilities.

Neal, James T., Thomas R. Magorian, Robert L. Thoms, Whitney J. Autin, Richard P. McCulloh, Steven Denzler, and Kathleen O. Byrne, 1993, Anomalous zones in Gulf Coast salt domes with special reference to Big Hill, TX and Weeks Island, LA: Sandia Report SAND92-2283, for the United States Department of Energy under contract DE-AC04-76DP00789, 65 p.

MISSISSIPPI OFFICE OF GEOLOGY

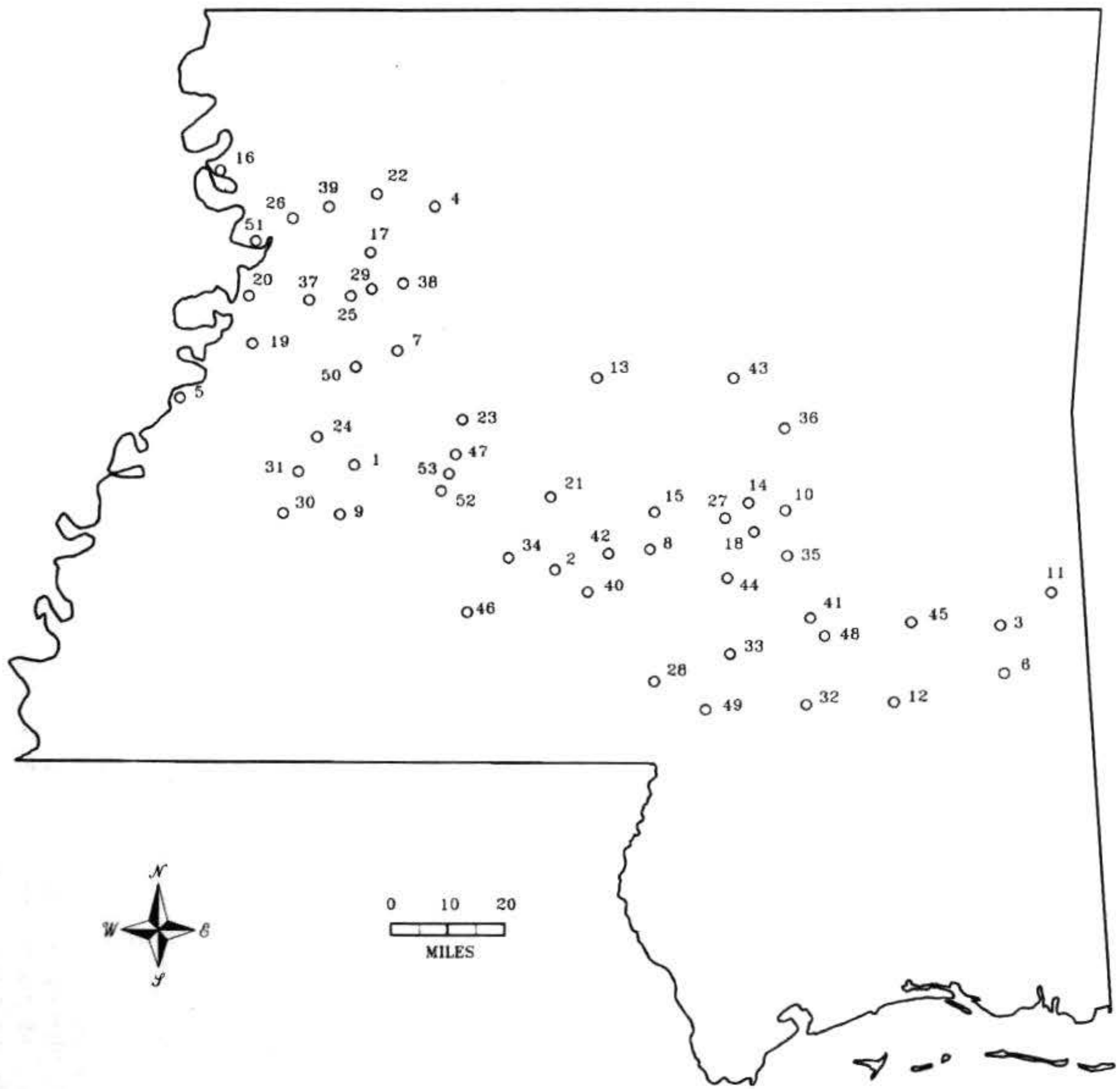
MISSISSIPPI SHALLOW PIERCEMENT SALT DOMES

Stan Thieling, August, 1993

County	Salt Dome	Location	Depth of shallowest: Caprock	Salt
Claiborne	Bruinsburg	13,15-11N-1E 1-11N-1W	1648	2016
	Galloway	24,25-13N-2E 30,43-13N-3E	3990	4432
	Hervey	7,8-10N-5E	3326	3547
Copiah	Allen	5-9N-6E	2447	2780
	Hazelhurst	28-1N-1W	1460	NR
	Sardis Church	29-10N-9E	1448	NR
	Utica	8-2N-4W	2630	3135
	Wesson	35-9N-8E	3394	NR
	Zion Hill	18-9N-9E	undrilled	
Covington	Dont	6,7-8N-14W	2034	NR
	Dry Creek	21,22,28-8N-17W	1986	NR
	Eminence	5,8-7N-14W	1937	2442
	Kola	27,28-8N-15W	2228	3041
	Richmond	17,20-6N-15W	1609	1954
Forrest	McLaurin	10-2N-13W	1701	1932
	Petal	23,24,25,26- 5N-13W	1198	1626

County	Salt Dome	Location	Depth of shallowest: Caprock	Salt
	Sunrise	8,9,16,17-4N-12W	5610	5940
Greene	Bothwell	33-5N-7W 4-4N-7W	undrilled	
	Byrd	16,17-3N-7W	1505	2058
	County Line	1,12-5N-6W	1239	2169
Hinds	Brownsville	10-7N-2W	4726	4697
	Carmichael	27-3N-3W	2685	2966
	Edwards	26,35-6N-4W	2775	3026
	Halifax	1,2-7N-4W	3907	3995
	Hubbard	6-4N-4W	4282	NR
	Learned	25,26,35,36-5N-4W	4429	4437
	Oakley	27,34-5N-3W	2484	NR on crest 11,196 flank
Jefferson	Leedo	18,19,20-8N-4E	1440	2060
	McBride	10-9N-4E	2010	2168
Jefferson Davis	Carson	18,19-7N-17W 13-7N-18W	2318	3083
	Oakvale	32,33-6N-19W	1839	2696
	Prentiss	25,26-7N-19W	2548	NR on crest 8905 on flank
Jones	Centerville	18-8N-13W	2032	NR
	Moselle	30,31-7N-13W	2120	NR
Lamar	Midway	27,28,33-4N-15W	1626	2522
	Tatum	11,12,13,14-2N-16W	872	1484
Lawrence	Arm	8,17-6N-20W	1281	1931

County	Salt Dome	Location	Depth of shallowest: Caprock	Salt
	Monticello	25,26,35,36- 7N-10E	2256	2751
	Grange	32-9N-20W 5-8N-20W	undrilled 3000 est.	
Lincoln	Caseyville	14,15,22,23- 8N-5E	2509	3035
	Ruth	15,16,21,22- 5N-9E	2212	NR on crest 10,468 flank
Marion	Lampton	16,17,20,21,22, 28-3N-17W	1305	1647
Perry	Cypress Creek (Agnes, New Augusta, Camp Shelby)	8,9,10,15,16, 17,21-2N-10W	1182	1298
	Richton	22,26,27,28,34, 35,36-5N-10W 1,2,3-4N-10W	497	722
Simpson	D'Lo	8,9,16,17- 2N-4E	2060	NR on crest 11,012 flank
Smith	New Home	5,8-10N-13W	1520	2578
	Raleigh	17,20-2N-8E	1490	2140
Warren	Eagle Bend	16-18N-2E	4241	4505
	Glass	33-15N-3E 6-14N-3E	3938	4030
	Kings	26,27,39,40- 17N-4E	3591	3845
	Newman	12-14N-4E	5086	5108
	Oak Ridge	9,10,15,16- 17N-5E	5060+/-	5078
	Vicksburg	15-6N-3E	4356	4386



SHALLOW SALT DOMES IN MISSISSIPPI

1	Allen	28	Lampton
2	Arm	29	Learned
3	Bothwell	30	Leedo
4	Brownsville	31	McBride
5	Bruinsburg	32	McLaurin
6	Byrd	33	Midway
7	Carmichael	34	Monticello
8	Carson	35	Moselle
9	Caseyville	36	New Home
10	Centerville	37	Newman
11	County Line	38	Oakley
12	Cypress Creek	39	Oak Ridge
13	D'Lo	40	Oakvale
14	Dont	41	Petal
15	Dry Creek	42	Prentiss
16	Eagle Bend	43	Raleigh
17	Edwards	44	Richmond
18	Eminence	45	Richton
19	Galloway	46	Ruth
20	Glass	47	Sardis Church
21	Grange	48	Sunrise
22	Halifax	49	Tatum
23	Hazelhurst	50	Utica
24	Hervey	51	Vicksburg
25	Hubbard	52	Wesson
26	Kings	53	Zion Hill
27	Kola		

S. Thieling 9/93

THE MISSISSIPPI MINERAL RESOURCES INSTITUTE - TWENTY YEARS OF SERVICE TO MISSISSIPPI (1972-1992)

Charles T. Swann
Mississippi Mineral Resources Institute
220 Old Chemistry Building
University, Mississippi 38677

INTRODUCTION

The Mississippi Mineral Resources Institute (MMRI), is headquartered on the University of Mississippi campus. Since its inception in 1972, the Institute has supported mineral resources related research in Mississippi, conducted primarily at state universities. In 1992, the Institute celebrated its twentieth year of continuous operation.

During these two decades, there have been many changes in the character of mineral resources research as well as advances in how research has been conducted. At the time of the Institute's inception, the oil and gas industry was very strong in the state, and much of MMRI's research (primarily remote sensing studies) was directed toward aiding this industry. Although oil and gas resources were of primary importance, the scope of investigations also included other Mississippi mineral resources such as clay, sand, gravel, heavy minerals, and lignite.

Environmental issues, such as waste disposal, have long been areas of concern for the Institute. The MMRI has taken an active role in aiding the state in various investigations and projects. For example, MMRI aided the state in monitoring the activities at the Tatum Dome nuclear test site, as well as the high-level nuclear waste disposal studies conducted at the Cypress Creek and Richton salt domes. More recently, MMRI participated in the State's efforts to develop selection criteria for a hazardous waste facility and to subsequently identify potential sites for such a facility.

In the 1990s, the Institute will continue to aid industry by expanding research in the environmental area. Studies will be directed toward compiling mineral resources data, and making these data available to Mississippi's small, mineral-related businesses, municipalities, as well as to other state agencies. To obtain this goal, additional cooperative projects with other state agencies will be initiated.

HISTORY OF THE MINING AND MINERAL RESOURCES INSTITUTE PROGRAM

The driving force behind the creation of the Mineral Resources Institute Program at the federal level was a report released in 1969 by the National Academy of Sciences Committee on Mineral Science and Technology. This report noted the decline in domestic mineral industries and a corresponding increase in mineral imports. The Committee recommended that more support be provided for mineral engineering and research programs and that mineral resources research be better coordinated. This report lead the U. S. Congress to develop legislation to address the Committee's recommendations.

A program to support mineral resources institutes was authorized by Congress in 1972 under the jurisdiction of the U. S. Department of the Interior. The original 1972 legislation, though never funded, became the basis for the Surface Mining Control and Reclamation Act of 1977 (Public Law 95-87). This act set up a one-to-one matching requirement for federal allotment monies and established institutes to be housed at universities providing instruction and research in mining or minerals extraction. The U. S. Department of the Interior assigned administration of the program to the Office of Surface Mining, Reclamation, and Enforcement. The program began in 1978 with awards to 20 of the 37 institutes which applied for Mineral Institute status.

In 1982, Congress transferred the program from the Office of Surface Mining to the U. S. Bureau of Mines. At Congressional urging, a consolidation was undertaken and resulted in the establishment of "Centers of Generic Mineral Technology" to coordinate and conduct research in specific areas.

In 1984, the program was reauthorized by passage of the State Mining and Mineral Resources Research Institute Program Act of 1984. Changes from the original legislation were considered minor. Required nonfederal matching monies were revised upward in 1985 to one and one-half-to-one matching and were again revised in 1986 to a two-to-one match. The program was reauthorized in 1988 with essentially no changes.

HISTORY OF THE MISSISSIPPI MINERAL RESOURCES INSTITUTE

The idea of a Mineral Resources Institute for Mississippi was first conceived by a group of geologists and engineers at the University of Mississippi. Dr. Velon H. Minshew, then Associate Professor of Geology, lead the group in writing the proposal to establish an institute and worked to push the idea forward at the state and federal levels of government. The original concept was to establish an institute which would focus on all the mineral resources of the state, from hydrocarbons to sand and gravel resources (personal communications, W. R. Reynolds). In a meeting held on December 7, 1972, a number of representatives urged the Board of Trustees of the Institutions of Higher Learning (IHL) to establish a mineral resources institute for Mississippi. Supporting the establishment were representatives from the U. S. Bureau of Mines, Mississippi Geological Survey, Mississippi State University, University of Southern Mississippi, University of Mississippi, IHL, and the Mississippi Test Facility. Mr. William H. Moore, director of the Mississippi Geological Survey, gave his support by indicating that there was room for other people to work on utilization and marketing of our state's mineral resources.

The Mississippi Mineral Resources Institute was officially formed in December of 1972 by action of Mississippi's Institutions of Higher Learning (Minutes of the Board of Trustees of State Institutions of Higher Learning, December 21, 1972). The December 21 action by the IHL board required that the Institute's main office be on the University of Mississippi campus and made requirements for quarterly meetings, designated representatives who would serve on the MMRI board, set procedures for starting new programs, and established reporting criteria. The fields of responsibilities remained as originally conceived, i.e. wide ranging.

Initially, the Institute was considered part of the Department of Geology and Geological Engineering, sharing personnel as well as space. Beginning in January of 1973, Dr. Velon H. Minshew served in the dual role of chairman of the Department of Geology and Geological Engineering and as the first director of MMRI. In this dual capacity, he taught classes as well as tended to the affairs of the Institute. In 1975, Dr. Minshew also became an Associate Professor of Urban and Regional Planning. In 1977, he relinquished his duties as chairman of the Department of Geology and Geological Engineering and devoted more time to Institute affairs. He remained MMRI director, an Associate Professor in Geology, and an Associate Professor in Urban and Regional Planning until May of 1982, when he resigned to accept a position in private industry.

Dr. J. Robert Woolsey, a former Navy pilot and engineering officer, who worked as a mining geologist and engineer with the United Nations and industry throughout the world, became MMRI's second director in July of 1982. Dr. Woolsey was hired as a Research Associate Professor serving under Dr. Minshew in 1980, and in 1981 he assumed the position of Associate Director. He served briefly as Acting Director following Dr. Minshew's resignation, and a month later became the Institute's second Director.

Shortly after Dr. Woolsey became the Institute director, the Universities Research Institutes Act of 1983 was passed, which established MMRI as a state agency. The act specified MMRI duties more specifically:

> "It shall be the function and duties of the MMRI to: (a) conduct basic and applied research for the development and conservation of mineral resources, including but not limited to mining, land reclamation and disposal of waste material; (b) Assist and support mining and mineral related research programs...; (c) Assist and consult with state and local agencies in planning the development and conservation of mineral resources; (d) Maintain liaison with private industry and appropriate state and local agencies to promote industrial development and conservation of mineral resources...; (e) Disseminate new information and facilitate transfer and application of new technologies....".

The Marine Minerals Technology Center (MMTC) was established as a U. S. Bureau of Mines Generic Center at the MMRI through the efforts of Dr. Woolsey in July of 1988, and he became director of MMTC as well as MMRI. In July of 1990, Dr. Woolsey was advanced to Research Professor in the Department of Geology and Geological Engineering.

OTHER PERSONNEL

Two people have held the position of MMRI Assistant Director and three, including Dr. Woolsey, have held the position of Associate Director. Mr. Conrad Gazzier became associated with MMRI in 1978 when he was hired as a Research Associate and Assistant to the Director. In 1979, he was promoted to Assistant Director for Operations, serving under Dr. Minshew. He resigned in 1980 to enter private industry and later served as State Geologist from 1987 to 1990. The next person to assume the position of Assistant Director was Dr. Walter C. Zacharias. Dr. Zacharias was hired in 1982 as Administrative Coordinator, and in 1983 he became the Institute's second Assistant Director, serving under Dr. Woolsey. In June of 1984, he resigned his position to assume new duties as Sponsored Programs Coordinator at the University of Mississippi.

Mr. Tracy W. Lusk was the first to serve as Associate Director for the Institute under Dr. Woolsey. Mr. Lusk, a University of Mississippi geological engineer, former State Geologist (1958-1962), and gravel producer (1964-1980), was hired as a Research Associate in 1983 and worked closely with the newly formed Minerals Commercialization Center, a special unit of MMRI. In 1984, he was promoted to the position of Associate Director, which he held until his retirement in December 1992.

In January of 1993, Dr. James L. Harding became the third person to serve as Associate Director of the Institute. Dr. Harding holds degrees in both geology and oceanography. He has international experience in offshore and onshore mineral resources evaluation.

Typically, the Director and Associate Directors hold one or more degrees from a Mississippi university. For example, Dr. Woolsey holds a baccalaureate degree from Mississippi State University. Mr. Lusk and Mr. Gazzier hold degrees from the University of Mississippi, and Dr. Harding holds a degree from the University of Southern Mississippi.

PHYSICAL PLANT

During its 20 year history, the Institute has been housed in three buildings on the University of Mississippi campus. Until 1977, it was housed in Temporary Building E, a wooden structure no longer in existence, located adjacent to the Engineering Science Building, and behind Hume Hall. From Temporary Building E, the Institute moved to 108 LaBauve Hall, which is adjacent to Conner Hall. In the summer of 1982, the Institute moved its main office to Room 202 in the Old Chemistry Building and again in January of 1991 moved its main office to Room 220. Additional shop and maintenance areas are located at the University of Mississippi Biological Field Station, and at Biloxi, Mississippi, home port for the two research vessels. These facilities are designed to support the marine activities of the Marine Minerals Technology Center.

WORK OF THE INSTITUTE

Until his resignation in 1982, Dr. Minshew was instrumental in involving MMRI in using remote sensing for ground water and hydrocarbon exploration. Other areas of work included sand and gravel characterization, lignite exploration and characterization, and environmental geology. Perhaps some of the most notable environmental studies during Dr. Minshew's term as Director were the result of the detonation of two nuclear devices in the Tatum Salt Dome in Lamar County, Mississippi. These nuclear detonations and several experiments involving explosions of gases in the resulting cavity have remained an environmental concern. The MMRI acted as an adviser to the State of Mississippi during post-closure monitoring of the site and advised state government during the initial stages to site a nuclear waste storage facility in a Mississippi salt dome. Dr. Minshew also lead the Institute in conducting several investigations characterizing Mississippi's coastal region.

The Institute, under the leadership of Dr. Woolsey, aggressively sought to expand its in-house research capabilities and expand work into the offshore. The MMRI supported several investigations to characterize the heavy minerals off the Mississippi coast. Working through the United Nations, MMRI also evaluated offshore mineral resources in Africa and South America. Continuing in its role as an adviser to state government, the Institute worked as a technical adviser during the U. S. Department of Energy's efforts to site a high-level nuclear waste repository in Mississippi. The MMRI continued in this advisory capacity for several years, until the decision was made to site the first repository in Nevada. When the Marine Minerals Technology Center (MMTC) was established under MMRI, offshore work became national in scope and the Institute obtained the two research vessels to carry this work forward.

Members of the MMRI staff participated in Mississippi's efforts to site a state-owned hazardous waste disposal site. The Institute also became the technical adviser to the Mississippi Research Consortium, an organization to coordinate research among Mississippi's universities.

The use of remote sensing techniques to aid in hydrocarbon exploration has continued with more sophisticated computer hardware and software. The Institute has worked with the clay and gravel industry in Mississippi to more efficiently use these natural resources. The evaluation of the engineering properties of Mississippi's clays and their potential use in the environmental field has been supported. Research efforts have involved the characteristics of Mississippi's salt domes and their genesis. A cooperative effort with other state agencies is pursuing the transfer of hydrofracing technology from private industry in the northeastern U. S. to applications in Mississippi. This technology is designed to be used by Mississippi's water well drilling industry. Funded through the Municipal Gas Authority of Mississippi and the Mississippi Department of Economic and Community Development, a new state-wide natural gas pipeline map was constructed in 1992, using a geographic information system format.

PUBLICATIONS AND DATA TRANSFER

All work completed by the Institute is available for public use. Traditionally, open-file reports and publications in professional journals have been the means of transferring data. From 1979 to the present, in-house research and grants issued by MMRI have produced a total of 182 open-file reports in addition to reports of investigation and student reports of investigation. These reports are the result of research projects conducted by qualified personnel in the appropriate departments at each of the comprehensive universities as well as the Gulf Coast Research Laboratory (GCRL) and the Mississippi Office of Geology. Table 1 illustrates the distribution of these reports among the universities.

TABLE 1 - DISTRIBUTION OF MMRI REPORTS AMONG UNIVERSITIES/AGENCIES

GULF COAST RESEARCH LABORATORY	10
JACKSON STATE UNIVERSITY	1
MISSISSIPPI STATE UNIVERSITY	39
OFFICE OF GEOLOGY	1
UNIVERSITY OF MISSISSIPPI	100
UNIVERSITY OF SOUTHERN MISSISSIPPI	31

A listing of these reports can be obtained from the Institute by calling (601) 232-7320 or by writing to MMRI, 220 Old Chemistry Building, University, MS 38677. The Mississippi Office of Geology also maintains a complete collection of MMRI open-file reports at their offices in the

Southport Center in Jackson, Mississippi.

A LOOK TO THE FUTURE

The Institute is committed to working with governmental entities as well as private industry. Recent projects have generated significant quantities of digital data in the form of data bases, as well as geographic information system coverage. The production of digital data will be an increasingly important product as computer applications increase. The areas of technology transfer and minerals related environmental issues are likely be given additional emphasis in the future.

ACKNOWLEDGMENTS

A number of people have been helpful in the completion of this paper. Nancy Roberts and Tracy Lusk provided information regarding the Institute in the early 1980s. Dr. William Reynolds of the University of Mississippi's Department of Geology and Geological Engineering freely provided information regarding the earlier years of the Institute.

"Daily it is forced home on the mind of the geologist, that nothing , not even the wind that blows, is so unstable as the level of the crust of this earth."

Charles Darwin, 1839
The Voyage of the Beagle

REVIEW OF *OIL IN THE DEEP SOUTH*

Michael B. E. Bograd
Mississippi Office of Geology

Oil in the Deep South: A History of the Oil Business in Mississippi, Alabama, and Florida, 1859-1945, by Dudley J. Hughes: published for the Mississippi Geological Society by the University Press of Mississippi, 1993, 267 p., $35.00 (see end of review for ordering instructions)

Dudley Hughes has written a book that will be fascinating to people involved in the oil and gas industry in the southeastern United States, to those interested in Mississippi history, and to those interested in the history of geology in the South. The history of exploration and development is chronicled in an easily readable manner, and the story is enlivened with tidbits about some of the very colorful individuals in the business. And many colorful characters reside in these pages, including geologists, developers, speculators, the mayor of Hattiesburg, drillers, and a charlatan or two. Sparky McGlothlin, Geoffrey Jeffreys, Army Dorchester, Fred Mellen, W. S. F. Tatum, Henry Toler, B. B. Jones, Robert Steffey...these are a small sampling of the names to be found in *Oil in the Deep South*. Governor Theodore Bilbo makes an appearance, as does Ella Rawls Reader Stokely, "the greatest businesswoman in the world." Read this book and learn about these interesting people.

The book's 42 chapters are divided into four sections: I. The Development of Petroleum in the Southeastern States to 1925; II. The 1926-1938 Era; III. The 1939-1941 Era; and IV. The Boom of the War Years, 1942-1945. The subtitle gives the scope of the book; it deals with the oil-producing areas of Mississippi, Alabama, and Florida, and the years from the beginning of the industry up to 1945. There are several good charts and location maps to augment the text, and two sections of historical photographs, mostly of people but a few of flowing wells.

My particular interest is in the history of geology in Mississippi, and I found plenty to satisfy my curiosity. There are mentions in a dozen places of structures being found with the aid of surface geologic mapping. These include E. W. Hilgard's 1860 report of the Jackson Uplift, where the important gas field would be discovered in 1930, and Fred Mellen's discovery of an outcrop of Moodys Branch marl structurally high at Tinsley, leading to the drilling and development of the giant oil field there. Surface geologic mapping was also instrumental in the first two salt dome discoveries in Mississippi as well as such important oil fields as Heidelberg. Not all was glory, however. Hughes on page 201, in describing activities during World War II, reports that "Sixteen years of intensive exploration effort, beginning with the surface-mapping crews in 1928, had been a failure for Gulf." But then they found Eucutta.

I especially enjoyed reading Chapter 13, The Jackson Gas Field. It begins with the geologic history of the volcano and its surrounding reef in a sea of late Cretaceous time. Figure 4 is an intriguing map of the volcano, island, surrounding sea, and reef that became the Gas Rock, superimposed on a map of today's geography with counties, towns, and the Tinsley and Flora oil fields. I spent some time staring at this map and trying to envision what the Jackson volcano would have looked like those millions of years ago when it jutted above the surface of the sea. Was the island clothed in lush, tropical vegetation? Were there mosasaurs in the sea and pterosaurs soaring overhead? The book brought me back to the twentieth century as I read the equally exciting story of the drilling for oil or gas on the Jackson structure and the development of the Jackson Gas Field. Hughes tells the stories of several of the wells that were drilled, and brings the story home by pointing out where those wells are with respect to today's streets.

Hydrogeologist Ernest Boswell, U. S. Geological Survey retired, recently asked me if I knew anything about the first well in Mississippi to have a geophysical log run. I did not know then, but I do now. Hughes tells the story on page 102 of his book. In 1934 E. B. Germany hired the brand-new Schlumberger Well Surveying Corporation of Houston to measure the depth and electrical readings of the formations in the J. J. Newman Lumber Company No. 1 well in Lamar County near Hattiesburg. Incidentally, the "A. F. Crider, geologist from Shreveport," involved with this project had been the State Geologist of Mississippi from 1906 to 1909 and with the U. S. Geological Survey before that.

Also to be found in the pages of this book are the stories of many oil companies large and small, the Dixie Geological Service, the establishment of the Mississippi State Oil and Gas Board, the development of gas pipeline companies, the organization of the oil scouts association, the drilling of gushers and dry holes, and many oil and gas field discoveries.

The book is well written, except for a few run-on sentences, and makes enjoyable reading. Throughout the text Hughes manages to capture the excitement of the geologists, investors, and drillers when a well comes in and in a community when an oil boom hits. Where technical terms and industry jargon are used in the text, they are succinctly explained for the benefit of any reader not familiar with them. For example, the concepts of electric logging and piercement salt domes are nicely explained with a few well-chosen words. As usual, the University Press of Mississippi has done an excellent job of printing and binding.

I have made good use of the book's index to the people and places mentioned. It includes thorough lists of oil/gas companies, oil/gas fields, and even specific oil/gas wells.

I heartily recommend this book to a wide range of people. You do not have to be an "old-timer" in the oil business to enjoy *Oil in the Deep South*.

Copies of *Oil in the Deep South* are available for $35.00 each from

Mississippi Geological Society
P. O. Box 422
Jackson, MS 39205-0422

Enclose a check or money order payable to the Mississippi Geological Society. Include $3.00 shipping and handling for the first book ordered and $1.00 for each additional book ordered. Mississippi residents must include 7% state sales tax. All orders must be prepaid. Orders will be shipped UPS, so include a street address (P. O. boxes are not acceptable). This book is available as a hardback only. The ISBN is 0-87805-615-7.

The proceeds to the Mississippi Geological Society from the sale of this book will go into a scholarship fund that will be matched dollar for dollar by the Gulf Coast Association of Geological Societies.

DAVID DOCKERY RECEIVES MAJOR AWARD

Dockery and the late PRI director Dr. Katherine V. W. Palmer at the entrance to the institution. This photograph was taken in the summer of 1972 as Dockery was studying types for his first Bulletin on the mollusks of the Moodys Branch Formation (Late Eocene). Dr. Palmer and Dr. Gilbert Harris had published on this fauna in 1946 and 1947 (PRI Bulletin 30), and their collections are housed at PRI.

Dr. David T. Dockery III, director of the Office of Geology's Surface Geology Division, has been given a prestigious award by the Paleontological Research Institution. He became the first ever recipient of the Gilbert Harris Award on August 14, 1993, at the institution's sixty-first anniversary reunion for members and friends in Ithaca, New York.

The Gilbert Harris Award, named for the institution's founder, is given in recognition of excellence in contributions to systematic paleontology. Systematic paleontology is that area of paleontology concerned with description of the diversity of fossil species and investigation of their interrelationships. The award is given to a scientist who, through outstanding research and commitment to the centrality of systematics in paleontology, has made a significant contribution to the science. Dr. Dockery is widely noted for his careful investigations of fossil mollusks from the Gulf Coastal Plain of the United States and the detailed and extensive publications resulting from these studies published by the Office of Geology.

According to Dr. Warren Allmon, director of the Paleontological Research Institution, Dockery was selected to be the first recipient of the Harris Award because of his outstanding work and because his work is along the lines of that of Harris.

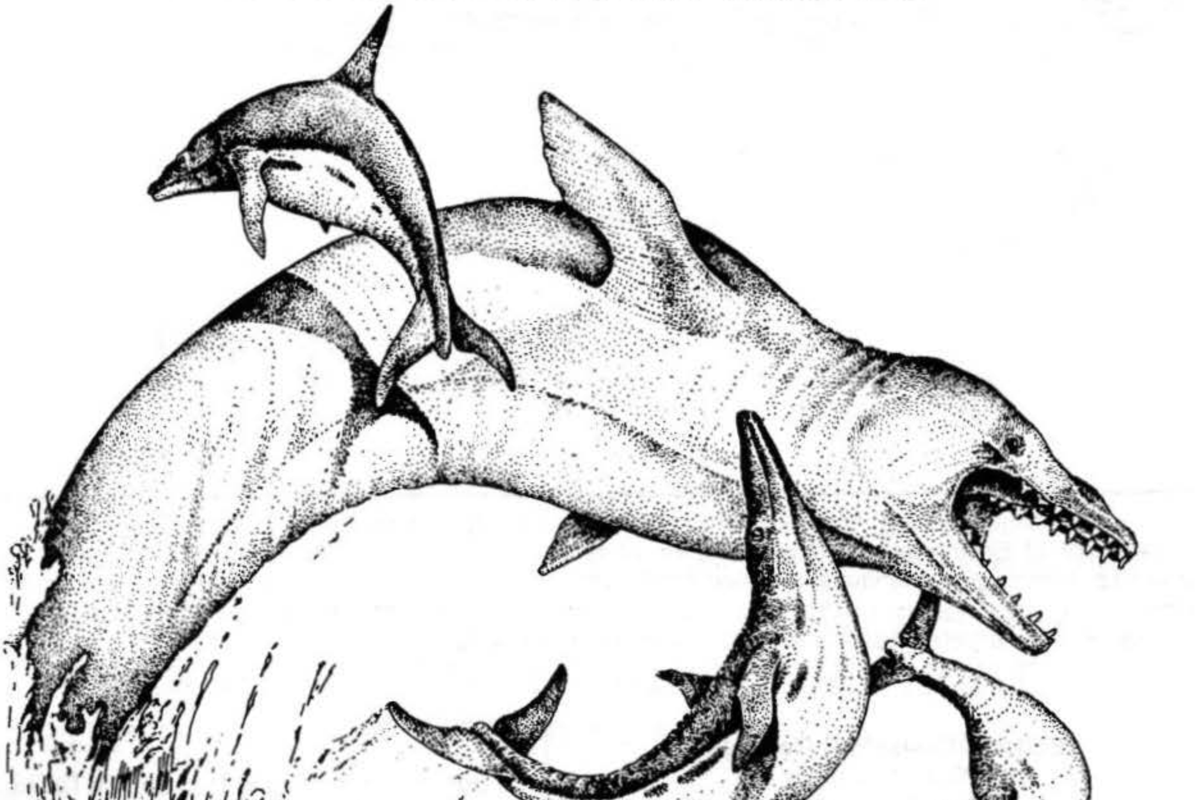
Dockery has worked for the Office of Geology (then the Mississippi Geological Survey) as a geologist since 1978, and before that for many years part-time as a college and high school student. He has published many technical papers on paleontology in outside journals and in our quarterly *Mississippi Geology*. He has published four major reports on Mississippi's invertebrate fossils in the Office of Geology's bulletin series, and a fifth is in press. This is the work that gained him recognition by PRI. At the same time he has directed the activities and reports of the Surface Geology Division in its work to map the surface geology of the state, where his paleontological expertise has been invaluable in resolving difficult mapping problems. Geologic maps provide vital background information for nearly every environmental and water management issue. In addition, he stays busy with professional organizations, giving talks about geology to schools and civic groups, and identifying rocks and fossils for scores of visitors. Further recognition of Dockery's service to the profession is shown by his being named as the recipient of the 1993 Distinguished Service Award of the Gulf Coast Section of the Society for Stratigraphic Geology (SEPM).

The Paleontological Research Institution was founded in 1932 by Cornell University professor Gilbert Harris to house his extensive library and fossil collections and to continue to publish his two journals, *Bulletins of American Paleontology* (begun in 1895) and *Palaeontographica Americana* (begun in 1916). PRI today houses one of the largest collections of invertebrate fossils in North America and *Bulletins of American Paleontology* is one of the oldest continuously published paleontological periodicals in the world.

- from PRI news release and DEQ newsletter, expanded by Michael B. E. Bograd

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 ($2.50 by mail) from the Office of Geology, P. O. Box 20307, Jackson, MS 39289.

MISSISSIPPI'S ANCIENT WHALES



Action-filled scene of a long-bodied, behemoth (60-foot) *Basilosaurus* scattering a group of smaller (16-foot), porpoise-like *Zygorhiza* as drawn by Robert T. Bakker in his book *The Dinosaur Heresies* (1986, page 433). Dr. Bakker was the Forum speaker at the University of Southern Mississippi on September 21, 1993. The following day at a Geology Department reception Dr. Bakker gave permission to reprint this figure. Mississippi's state fossil is the "fossil whale," but the Senate Concurrent Resolution does not specify whether it is *Basilosaurus cetoides* or *Zygorhiza kochii*. These archaeocete whales lived in a sea that covered Jackson, Mississippi, in the late Eocene Epoch 40-34 million years ago. Their remains are found in the Yazoo Formation. Bakker clearly favored the larger *Basilosaurus* as a state fossil. He said that he first heard of Mississippi while reading about basilosaurs as a fourth grader (now his favorite grade to lecture).

MISSISSIPPI GEOLOGY
Department of Environmental Quality
Office of Geology
Post Office Box 20307
Jackson, Mississippi 39289-1307

Mississippi Geology is published quarterly in March, June, September and December by the Mississippi Department of Environmental Quality, Office of Geology. Contents include research articles pertaining to Mississippi geology, news items, reviews, and listings of recent geologic literature. Readers are urged to submit letters to the editor and research articles to be considered for publication; format specifications will be forwarded on request. For a free subscription or to submit an article, write to:

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

Editors: Michael B. E. Bograd and David Dockery