1986

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Open-File Report 86-7F

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The Mississippi Mineral Resources Institute
University, Mississippi 38677

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IN THE

NATCHEZ AND CITRONELLE FORMATIONS,

ADAMS COUNTY, MISSISSIPPI

by

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1986

Prepared for

Mississippi Mineral Resources Institute
University, Mississippi 38677
Research Grant No. 86-7F

ABSTRACT

Twenty samples of coarse clastic sediments were collected from deep borings and outcrops in the Adams County, Mississippi area. These samples represented the Natchez and Citronelle Formations of Plio-Pleistocene Age. Textural and petrographic studies were conducted on these samples to determine whether there were any significant textural or mineralogical differences between them. Textural data revealed that the Natchez Formation (Pleistocene) as described by Vestal (1942) was significantly coarser than the Citronelle (Pliocene) at the Bluff Line at Natchez. However, there were no significant mineralogical differences between these two sediments in this area; both were classified as subarkose. The comparison of Vestal's Citronelle at the Bluff Line to Citronelle from outlying areas of Adams County and in Forrest and Lamar Counties in southcentral Mississippi revealed significant differences in terms of mineralogy. At the Bluff Line, the sediments contained appreciable feldspar and igneous rock fragment, whereas those from the other areas named above contained minor feldspar and chert rather than igneous rock fragments and were classified as quartzarenite to sublitharenite.

ACKNOWLEDGMENTS

The writers are pleased to acknowledge the financial support and assistance provided by the Mississippi Mineral Resources Research Institute who funded this project. We are indebted to Mr. George Hunt of the U. S. Army Engineer District, Vicksburg who kindly provided samples. Dr. Lawson M. Smith, U. S. Army Engineer Waterways Experiment Station, Vicksburg, provided useful insights to the geology at Natchez. Also, we acknowledge the able assistance of Ms. Barbara Bowles who conducted the textural analyses.

CONTENTS

INTRODUCTION

Purpose and Scope

This report describes the current results and conclusions of our investigations of the stratigraphy, petrology, and economic geology of Adams and Wilkinson Counties, Mississippi. The purpose of the project is to characterize the mineralogy, texture, and overall petrology of the pre-loessial, Miocene and younger (post-Vicksburg) clastic sediments in these counties in order to improve our understanding of the stratigraphic framework of their deposition and their economic significance. The loess deposits are not a part of these studies; however, we have included the gravels, sands, and lutites which underlie the loess and which are similar in appearance to materials which occur to the east, in southcentral Mississippi, beyond the present loess outcrop area and where we have conducted similar investigations. This report addresses a specific portion of these investigations - the comparative petrology of the coarse clastics in the Natchez and Citronelle Formations in Adams County.

Location, Natural Resources, and General Geology

Adams and Wilkinson Counties lie in southwest Mississippi and form the border with Louisiana to the west (Adams and Wilkinson) and to the south (Wilkinson). Adams County has an area of 1,181 sq.km. and a population of 38,035; the area and population of Wilkinson County are, respectively, 1, 756 and 10,021. The major source of income in Adams County is manufacturing whereas that of Wilkinson County is transfer payments. The natural resources of both counties include forest products (over 50 percent of the land in both counties is in commercial forests), hydrocarbons (mainly Adams County), and sand and gravel (mainly Adams County). The youngest, surficial sediments in both counties and best exposed in Adams County is loess, a brownish, wind-blown silt which has been derived from the flood plain of the Mississippi River to the west and carried by westerly winds to the eastern valley wall where it was deposited during the Pleistocene. The loess deposits exhibit thicknesses of upwards of 50 meters and extend, in measurable thickness, several tens of kilometers to the east. Underlying the loess in both counties are Miocene - Pleistocene(?) age clastic sediments, the subject of this report, which consist of the economically important sands and gravels of the Citronelle Formation (Plio-Pleistocene) and the older, Neogene sediments. These sediments are post-Vicksburg (Oligocene) in age and consist of as much as 2,000 feet of fine-to coarse-grained, non-marine clastics representing primarily fluvial and, to a lessor extent, deltaic facies. Formational names such as the Catahoula, Hattiesburg, Paqscagoula, Citronelle, and Natchez have been applied to these clastics on the basis of lithology. For example, the oldest unit, the Catahoula Formation consists primarily of sands in outcrop whereas the overlying Hattiesburg is fine grained. The Citronelle has been considered more gravelliferous than the orther units and this lithology has been the primarily means of recognition in outcrop.

Problem Statement

The absence of fossils and well-defined marker beds as well as extensive vegetative cover and extreme weathering have made stratigraphic correlation difficult. With the exception of the Catahoula, none of these formations have definable stratigraphic tops and bottoms. The base of the Catahoula is defined in the subsurface by the zone of Heterostegina; however, there is no defined top of the Catahoula. Thus, the overlying Hattiesburg Formation is undefined with respect to its base; the top of the Hattiesburg is similarly poorly defined and the Hattiesburg may be gradational with the overlying Pascagoula Formation. Although the Citronelle Formation is mapped separately, both the Catahoula and Hattiesburg Formations possess well-defined gravel strata exposed at the surface and identifiable in the subsurface which are similar in appearance to those of the Citronelle.

At Natchez, along the Mississippi River bluffs (Bluff Line), an anomalous sand and gravel unit having a thickness of approximately 30 meters occurs between the overlying loess and the underlying Citronelle. This unit is named the Natchez Formation and is considered to be early Pleistocene in age and to represent a Mississippi River terrace deposit. The gravel component of this unit has been reported to contain igneous rock fragments derived by glacial action from northern parts of the continent and which were deposited by the Mississippi River at a time when it was a glacial sluiceway (Chamberlin, 1896; Vestal, 1942; and Saucier,1974).

Generalized stratigraphic sections at the Bluff Line at Natchez are shown below (Vestal, 1942; Church and Hunt, 1984).

After Vestal	Elev. (MSL)	After Church and Hunt
Loess		Loess
	175 ft	---------------------------*
Natchez Formation-----------		-----------------------»
	105 ft	Natchez Formation *
Citronelle Formation-----------		-----------------------*
____________________	30 ft	-----------------------»
Hattiesburg Formation		Hattiesburg Formation
-----------------------	23 ft**	-----------------------

* Sampled interval ** Mean low water

As seen above, Church and Hunt (1984), on the basis of visual examination of cores and outcrops, found no evidence for the presence of the Citronelle Formation at the Bluff Line. The identification of the Citronelle Formation by Vestal (1942) was based upon coarse grain size, presence of chert, and ferruginous cements in the Citronelle. The textural and petrographic studies described herein were conducted to determine whether specific petrologic differences between these two units exist.

PETROLOGY

Classification and Texture

Grain sizes were determined from standard sieving techniques (0.5 phi intervals) and cumulative percent distribution (gradation) curves were prepared for each sample (Folk, 1974). Textural names (after Willman, 1942) were determined and each sample was also classified according to the Unified Soil Classification System (USCS); these data are given in Table 1. Note that Atterberg limits were not determined; thus, those samples which exhibited fines in amounts greater than five percent are classified as SM/SC or GM/GC, for example. Also, the percent gravel, sand, and fines given in Table 1 are based upon Wentworth size classes where gravel is material greater than 2.0 mm (-1.0 phi) and silt and clay (fines) are material finer than 0.0625 mm (4.0 phi). In the USCS, gravel is material greater than 5.0 mm (-2.32 phi) and silt and clay are material finer than 0.074 mm (3.75 phi).

Of the twenty coarse-grained samples examined, 12 were classed as sands, 5 as sandy gravels, and 3 as pebbly sands; no samples contained sufficient particles greater than 2 or 5 mm to be classed as gravels according to Willman although 4 samples (all sandy gravel) were classed as gravel in the USCS. The amount of fines was variable; however, 6 samples exhibited as much as 5 percent or greater fines and would require the determination of Atterberg limits to completely classify them. The sorting of these materials , based upon the coefficients of uniformity and sorting. was also variable; 12 samples were classed as poorly graded (well sorted), 6 samples were classed as well graded (poorly sorted), and 2 samples (both sands) were classed as SM/SC due to the presence of greater than 12 percent fines although they would, otherwise, be classed as poorly graded if they possessed lessor amounts of fines. On average and collectively, these materials would be classed as pebbly sands having approximately 21, 74.7, and 4.1 percent gravel, sand, and fines respectively.

The examination of gradation data indicated that 10 samples (4 sandy gravels and 6 sands) exhibited bimodal gradations (shown on the right hand side of Table 1 by a "B"). The secondary modes consisted of gravel and coarse sand size fractions which are typical of many rudites and coarse sands. The two samples having fines in excess of 12 percent and otherwise unimodal, may be bimodal in terms of either silt and/or clay; the clarification of this question awaits the completion of hydrometer analyses of these samples. The samples exhibiting bimodality were also skewed in the direction of the secondary mode; thus, the 10 sandy gravels and sands were negatively skewed whereas the 2 silt- and clay-rich samples were, most likely, positively skewed.

Petrography

Thin sections and/or grain mounts (depending upon degree of lithification) were prepared by a commercial vendor for all samples. These sections were examined with a polarizing petrographic microscope and approximately 200 . grains were identified using standard point-counting techniques. Petrographic data obtained from point-counting are given in Appendix B. Quartz types were classified according to Folk (1974) except that types of inclusions were not considered. Feldspars were classified as K-feldspar, plagioclase, or undifferentiated since many grains were highly altered. Mica was identified in only a few samples. Rock fragments included igneous (plutonic or volcanic), metamorphic (undifferentiated), and sedimentary (chert or undifferentiated). Samples were classified using Folk's (1974) sandstone classification system and the classification results are shown in Table 2. Note that: 1) Chert is included with rock fragments and 2) Plutonic igneous rock fragments are included with feldspar.

Miocene (Undifferentiated). The Miocene sample was classified as a quartzarenite; compositionally, this sample was similar to Citronelle samples except that the Miocene sample contained appreciably less composite quartz and no chert rock fragments. However, the lack of composite quartz and chert may be due, in part, to its fine grain size.

Citronelle Formation. Of the 6 samples, 3 classed as quartzarenites and 3 as sublitharenites. Feldspar, if present, occurred in trace amounts and chert was the most common rock fragment. Most of the grains examined exhibited limonitic cements and occasional grains, not cemented by limonite, were partially cemented by silica. Many feldspar grains have been weathered to a greenish alteration product.

Natchez Formation. The 13 samples collected from the Natchez Formation were all classed as subarkose. Feldspar was common and the presence of igneous rock fragments among the gravel-size grains was readily detectable. These igneous rock fragments represent intermediate plutonic compositions since quartz was accompanied by both K-feldspar and plagioclase. Also, two thin sections from hole NB-9 contained clasts of basaltic composition.

Table 1. Classification and texture of coarse-grained sediments.

Sample No.	Classification* Willman/USCS	Weight Percent Gravel	Sand	Fines**
Natchez Formation (Church and Hunt, 1984)				
NB-1-81	Sand/SP-SM/SC	-	94. 5	5. 5
NB-1-95	Sand/SP-SM/SC	1.9	93. 6	4. 5
NB-1-120	Sand/SP-SM/SC	14. 1	80. 9	5. 0 B
NB-1-149	Sand/SM/SC	0. 4	86. 0	13. 6
	Mean Values	4. 1	88. 8	7. 1
NB-1-170**	Pebbly Sand/SP	25. 3	70. 4	4. 3 B
NB-1-171**	Sand/SP	4. 8	93. 4	1.8
NB-1-195**	Sand/SP	2. 1	96. 7	1.2
NB-8-34**	Sand/SM-SC	0. 3	81.6	18. 1
NB-Θ-41**	Sandy Gravel/SW	51. 1	47. 2	1.7 B
NB-9-125**	Sand/SW-SM/SC	11.5	79. 6	8. 9
NB-9-140**	Sandy Gravel/GW	54. 2	42. 8	3. 0 B
NB-9-149**	Pebbly Sand/SP	24. 8	73. 7	1.5 B
A-l-a	Sand/SP	-	99. 6	0. 4
** Citronelle of Vestal (1942)				
	Mean Values	19. 3	76. 2	4. 5
	Overall Mean Values	14. 8	SO. 0	5. 2
Citronelle Formation				
A-2-a	Sand/SP	11. 9	86. 7	1.4 B
A-2-b	Sandy Gravel/GW	56. 3	42. 7	1.0 B
A-4-a	Sandy Gravel/GW-GM/GC	58. 8	41. 0	0. 2 B
A-4-C	Sand/SP	-	99. 0	1. 0
A-4-f	Pebbly Sand/SP	41. 3	58. 7	- B
A-5-b	Sandy Gravel/GW	65. 0	34. 5	- B
	Mean Values	38. 9	60. 4	0. 7
Miocene (Undifferentiated)				
A-7-a	Sand/SP-SM/SC	—	91. 0	9. 0
	Mean Values (all samples)	21. 2	74. 7	4. 1

* Textural name after Willman (1942)/Unified Soil Classification System; Atterberg limits not determined.

** Silt and clay; particles finer than 4.0 phi.

B - Bimodal distribution.

Table 2. Sample classification and summary of petrographic data.

Sample No.	Classification	Percent Quartz	Percent Feldspar	Percent Rock Fragments
Natchez Formation i (Church and Hunt, 1984)				
NB-1-81	Subarkose	76	20	4
NB-1-95	Subarkose	77	13	7
NB-1-120	Subarkose	77	17	6
NB-1-149	Subarkose	64	7	9
NB-1-170**	Subarkose	85	11	4
NB-1-171**	Subarkose	83	11	6
NB-1-195**	Subarkose	84	13	3
NB-8-34**	Subarkose	89	9	2
NB-8-41**	Subarkose	83	15	2
NB-9-125**	Subarkose	90	7	3
NB-9-140**	Subarkose	79	15	6
NB-9-149**	Subarkose	81	14	5
A-l-a	Subarkose	73	20	7
* * Citronelle of Vestal (1942)				
	Mean Values	82	13	5
Citronelle Formation				
A-2-a	Quartzarenite	95	1	4
A-2-b	Quartzarenite	95	-	5
A- 4-a	Sublitharenite	90	-	10
A-4-C	Sublitharenite	90	3	7
A-4-f	Quartzarenite	99	-	1
A-5-b	Sublitharenite	91	4	5
	Mean Values	93	1	6
Miocene (Undifferntiated)				
A-7-a	Quartzarenite	95	2	3

CONCLUSIONS AND DISCUSSION

On the basis of the textural data given in Table 1, the Natchez and Citronelle Formations at the Bluff Line as described by Vestal are significantly different, particularly in terms of percent gravel, having mean values of 4.1 percent (Natchez) versus 19.3 percent (Citronelle). However, the textures of samples of Citronelle collected from other areas in the county have appreciably higher gravel contents (mean value of 38.9 percent) than both the Natchez and Citronelle at the Bluff Line. Also, the Citronelle at the Bluff Line contains more silt and clay than samples from other areas, having 4.5 versus 0.7 percent.

In terms of mineral composition, the data given in Table 2 demonstrate that there is no significant mineralogical difference between the Natchez and Citronelle of Vestal. Furthermore, the data indicate a rather substantial mineralogical difference between the Citronelle of Vestal versus the Citronelle of outlying areas. Generally, these mineralogical differences pertain to the amount of feldspar present; those units at the Bluff Line contain appreciably more of this mineral.

The comparison of these Adams County sediments with those of similar designation and age in Forrest and Lamar Counties to the east reveals that the outlying Citronelle sediments are similar to those of Forrest and Lamar Counties in terms of texture, feldspar content, and chert rock fragments (Kirby, 1985).

Our evidence supports the contention of Church and Hunt (19Ö4) that the sediments underlying the loess and overlying the Miocene clay at Natchez cannot be differentiated and must be a part of the same stratigraphic and depositional unit and are, therefore, unrelated to the Citronelle. Regionally, those sediments underlying the loess along the Bluff Line have the appearance and character of the Citronelle Formation and are mapped as such. The Natchez Formation has not been identified at other localities beyond the Bluff Line at Natchez; we speculate that other areas along the Bluff Line, currently mapped as Citronelle, may, upon detailed petrographic examination, be found to be similar to the Natchez Formation in Adams County.

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APPENDIX A - SAMPLE LOCATIONS

Natchez Bluff Borings

Samples were obtained from three Vicksburg District Corps of Engineers bore holes (NB-1, NB-8, and NB-9) which had been drilled as a part of an investigation of bluff failure at Natchez. NB-1-81 signifies boring number 1; depth, 81 feet below surface.

NB-1: SW 1/4 of NW 1/4, Section 16, Township 7 North, Range 3 West; 100 feet west of Cemetery Road and 200 feet southeast of Weymouth Hall. Elevation of top of hole, 251.3 feet (MSL).

NB-8: NE 1/4 of SE 1/4, Section 15, Township 7 North, Range 3 West; at base of bluff adjacent to Magnolia Street (Learned Road). Elevation of top of hole, 84.5 feet (MSL).

NB-9: NE 1/4 of SE 1/4, Section 15, Township 7 North, Range 3 West; at base of bluff approximately 300 feet northwest of NB-8. Elevation of top of hole, 75.5 feet (MSL).

Surface Samples

A-1: NW 1/4 of NW 1/4, Section 24, Township 7 North, Range 3 West; at base of bluff along pathway at Natchez Under the Hill.

A-2: NE 1/4 of NW 1/4, Section 27, Township 6 North, Range 2 West; outcrop along Liberty Road

A-4: SE 1/4 of NE 1/4, Section 47*, Township 7 North, Range 2 West; Dale Polk and Son Sand and Gravel Company pit.

A-5: NE 1/4 of NE 1/4, Section 33, Township 6 North, Range 1 West; off Crawford Road at Natchez Sand and Gravel Company pit.

A-7: NW 1/4 of NE 1/4 Section 2, Township 5 North, Range 1 West; outcrop on Liberty Road mapped as Miocene (Hattiesburg-Pascagoula Undifferentiated).

♦Non-standard sections in this region.

APPENDIX B - PETROGRAPHIC DATA SHEETS

Mineralogy	NB-1-81	NB-1-95	NB-1-120	NB-1-149
Quartz				
Single Grain				
Straight Extinction	5. 9	1.0	-	-
Slightly Undulóse	25. 1	27. 7	27. 8	22. 1
Strongly Undulóse	24. 6	30. 2	33. 8	45. 9
Composite Grain				
Slightly Undulóse	5. 9	-	2. 5	tr
Strongly Undulóse	14. 3	18. 3	13. 1	15. 6
Feldspar				
K-feldspar	7. 9	1. 0	4. 5	-
Plagioclase	3. 9	3. 0	2. 5	1. 0
Undiff.	3. 7	8. 9	6. 6	4. 5
Mica	-	-	tr	tr
Rock Fragments				
Igneous				
Plutonic	-	1. 9	3. 5	tr
Volcanic	-	—	-	-
Metamorphic	-	1.5	1. 5	2. 0
Sedimentary				
Chert	3. 9	4. 9	2. 0	4. 0
Undiff.	-	1. 0	2. 0	2. 5

	NB-1-170	NB-1-171	NB-1-195	NB-8-34
Quartz				
Single Grain				
Straight Extinction	1. 7	-	-	2. 0
Slightly Undulóse	27. 1	26. 5	22. 2	29. o
Strongly Undulóse	48. 0	43. 5	51. 1	30. 0
Composite Grain				
Slightly Undulóse	tr	1. 5	tr	11. 0
Strongly Undulóse	7. 5	11.0	9. 9	15. 0
Feldspar				
K-feldspar	-	tr	1. 8	tr
Plagioclase	2. 2	2. 0	1. 8	4. 0
Undiff.	8. 0	7. 0	9. 0	4. 0
Mica	-	-	-	3. 0
Rock Fragments				
Igneous				
Plutonic	tr	1. 5	1.0	-
Volcanic	-	tr	-	-
Metamorphic	-	tr	tr	1. 0
Sedimentary				
Chert	2. 6	3. 0	-	2. 0
Undiff.	1. 7	2. 5	2. 3	-

Mineralogy	NB-8-41	NB-9-125	NB-9-140	NB-9-149
Quartz				
Single Grain				
Straight Extinction	-	-	-	-
Slightly Undulóse	36. 0	20. 0	20. 0	20. 0
Extremely Undulóse	39. 0	46. 0	45. 0	50. 0
Composite Grain				
Straight Extinction	-	1. 0	-	-
Slightly Undulóse	-	1. 0	1. 0	-
Extremely Undulóse	9. 0	16. 0	13. 0	14. 0
Feldspar				
K-feldspar	-	-	-	-
Plagioclase	3. 0	2. 0	tr	2. 0
Undiff.	9. 0	5. 0	12. 0	7. 0
Mica	-	-	-	-
Rock Fragments				
Igneous				
Plutonic	1. 0	2. 0	2. 0	4. 0
Volcanic	1. 0	-	-	-
Metamorphic	tr	tr	tr	1. 0
Sedimentary				
Chert	1. 0	3. 0	4. 0	3. 0
Undiff.	1. 0	2. 0	2. 0	1. 0

	A-1-a	A-2-a	A-2-b	A-4-a
Quartz				
Single Grain				
Straight Extinction	-	-	-	-
Slightly Undulóse	17. 0	15. 0	15. 0	25. 0
Extremely Undulóse	45. 0	67. 0	63. 0	47. 0
Composite Grain				
Slightly Undulóse	tr	1. 0	-	-
Extremely Undulóse	10. 0	13. 0	13. 0	16. 0
Feldspar				
K-feldspar	-	-	-	-
Plagioclase	2. 0	tr	-	-
Undiff.	12. 0	-	-	-
Mica	-	-	-	-
Rock Fragments				
Igneous				
Plutonic	4. 0	-	-	-
Volcanic	1. 0	-	-	-
Metamorphic	-	tr	-	-
Sedimentary				
Chert	3. 0	3. 0	7. 0	10. 0
Undiff.	4. 0	1. 0	-	-

Mineralogy-	A-4-C	A-4-f	A-5-b	A-7-a
Quartz				
Single Grain				
Straight Extinction	-	-	-	-
Slightly Undulóse	8. 0	27. 0	22. 0	16. 0
Extremely Undulóse	66. 0	58. 0	54. 0	78. 0
Composite Grain				
Slightly Undulóse	-	-	1. 0	-
Extremely Undulóse	15. 0	15. 0	15. 0	2. 0
Feldspar				
K-feldspar	-	-	-	-
Plagioclase	-	-	-	-
Undiff.	3. 0	tr	4. 0	2. 0
Mica	-	-	-	-
Rock Fragments				
Igneous				
Plutonic	-	-	-	-
Volcanic	-	-	-	-
Metamorphic	1. 0	-	tr	2. 0
Sedimentary				
Chert	4. 0	-	3. 0	-
Undiff.	3. 0	-	2. 0	-