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THE CHEMISTRY AND MINERALOGY OF THE UPPER YAZOO FORMATION (UPPER EOCENE) AT THE CYNTHIA PIT, HINDS COUNTY, MISSISSIPPI

Daniel K. Reeves and Otto C. Kopp
Department of Geological Sciences, University of Tennessee
Knoxville, Tennessee 37916

INTRODUCTION

The Yazoo Formation is the uppermost of two formations of the Jackson Group in the central Gulf Coast physiographic province. It is composed predominantly of argillaceous sediment which was deposited in the Mississippi Embayment during the Upper Eocene marine transgression and regression (Murray, 1961). In western Mississippi, at the type locality in Yazoo City, the formation is approximately 450 feet thick (Toulmin, 1977), representing deposition near the north-south axis of the embayment. The Yazoo Formation thins toward the east, and is divided into four members in eastern Mississippi and Alabama. They are, in ascending order: (1) the North Twistwood Creek Clay, (2) the Cocoa Sand, (3) Pachuta Marl, and (4) the Shubuta Clay. The Yazoo Formation is correlative to the Ocala Limestone to the east, and to the arenaceous Fayette Group to the west (Murray, 1961, and Stuckey, 1960).

The chemistry and mineralogy of the Yazoo Formation have not been well documented, although the semi-quantitative mineralogy of the $< 2 \mu\text{m}$ size fraction of a single sample was reported by Buck (1956). That sample was composed of approximately 45% kaolinite, 30% smectite, 15% illite, and 10%

quartz + carbonate + feldspar. In this paper we report the chemical composition and semi-quantitative mineralogy of the upper Yazoo Formation exposed in west-central Mississippi at the Cynthia Pit in Hinds County.

SAMPLE COLLECTION AND DESCRIPTION

Although the Yazoo Formation at the Cynthia Pit is undifferentiated, it is considered by Dockery and Siesser (1984) to be equivalent to the Shubuta Clay member on the basis of its calcareous nannoplankton assemblage. They divided the exposure at the Cynthia Pit into four units on the basis of physical characteristics, with unit 1 at the base of the pit.

Fifteen samples were collected, beginning at the base of the pit, and one sample about every ten feet of section thereafter. Samples were collected at closer intervals near the contacts of Dockery and Siesser's (1984) units. Samples were numbered sequentially from the base of the pit. Samples designated CP1 through CP8 were collected in unit 1, CP9 is from unit 2, and CP10 through CP15 are from unit 3. Unit 4 is unique in that it contains large selenite crystals; however, the unit is badly weathered and will not be discussed in this paper.

Unit 1 consists of 44 feet of dusky yellow-green to grayish olive green, blocky, plastic, and generally silty clay. Shell fragments are abundant. Most samples are lignitic and a few contain a small amount (<1%) of framboidal pyrite. Unit 2, which overlies unit 1, is a distinctive marker horizon in the pit. It is a 4 foot thick layer of greenish-gray, calcareous, partially indurated clay. Unit 2 is lignitic, contains some very fine-grained muscovite, and is less silty than unit 1. Unit 3 is a 27 foot thick layer of olive green, plastic, lignitic, and fossiliferous clay. It appears to be more fossiliferous (and calcareous) and less lignitic than unit 1. Samples from unit 3 contain rare pods and stringers of pyrite. (Measured thicknesses are from Dockery and Siesser, 1984.)

ANALYTICAL METHODS

Chemical Composition

The chemical composition of each bulk sample and that of selected < 2 μm samples (separated by centrifuge) was determined by X-ray fluorescence (XRF) with an EG&G ORTEC TEFA III X-ray fluorescence analyzer. The accuracy of the instrument was checked by analyzing clay mineral standards as unknowns. The samples were prepared for analysis as follows: each sample was dried for 1 hour at 105° C, then ground in a swing mill for six minutes. The powdered sample was transferred to a high-pressure die and pressed for 1 minute at 30,000 psi into pellet form with a boric acid backing.

Mineralogy

The bulk mineralogy of each sample, and of the selected < 2 μm samples, was determined by X-ray diffraction (XRD) using a Phillips powder diffractometer using CuK-alpha radiation ($\lambda = 1.5418 \text{ \AA}$). Bulk samples were prepared for semi-quantitative XRD analysis as follows: each sample was dried for 1 hour at 105° C, then ground in a swing mill for six minutes. 3.00 grams of powdered sample were mixed with 1.00 gram of an aluminum oxide internal standard. The mixture was then ground in the swing mill for an additional twelve minutes and pressed into pellet form under the same conditions used for XRF pellets.

The < 2 μm size fractions of samples CP1, CP2, CP8, CP9, and CP10 were separated by centrifuge in order to determine the mineralogy of the clay-size fraction. Elutriated slides and smear mounts of these were prepared to accentuate the basal reflections of the clay minerals. The clay minerals were identified using the procedures described by Starkey et al. (1984). No attempt was made to identify clay minerals beyond the group level.

Semi-quantitative Mineralogy

The abundance of each mineral in the bulk samples was

estimated by two independent methods: 1. quantitative X-ray diffraction (QXRD) using the Relative Intensity Method (RIM) of Chung (1975), as modified by Mulligan (1987), and 2. calculated mineralogy from XRF data (CMXRF) in a manner analogous to the calculation of C.I.P.W. norms (Cross et al., 1902).

The underlying concept of QXRD is that a direct correlation exists between the concentration of a mineral and the intensity of its diffraction peaks. The RIM compares the intensity (or area) of specific diffraction peaks of each mineral in the sample with that of an internal standard, the concentration of which in the sample is known.

A diffractogram was obtained for each sample, and the peak area of a prominent reflection for each phase measured with an electronic digitizer. Mineral concentrations were then calculated by the formula: (Chung, 1975)

$$(1) \quad X_i = \frac{1}{\frac{1 + k_i}{I_i} \sum_{i=1}^n \frac{I_{1 \dots n}}{k_{1 \dots n}}}$$

where X_i = mineral concentration
 k_i = mineral relative intensity constant
 I_i = mineral peak area
 n = other phases present

Note that equation (1) normalizes the sum of each sample to 100%. The concentration of the internal standard can be calculated as an unknown, and compared against its known concentration as a partial check of the accuracy of QXRD.

The term k_i relates the areas of specific peaks of mineral standards to that of the aluminum oxide internal standard. Values for k_i were taken from Mulligan (1987), and were calculated from the formula: (Chung, 1975)

$$(2) \quad k = \frac{C}{X} \cdot \frac{I_x}{I_c}$$

k = relative intensity constant
 X = concentration of mineral
 C = concentration of internal standard
 I_x = mineral peak intensity (or area)
 I_c = internal standard peak intensity

The accuracy of QXRD is largely dependent on the choice of the constant k_i for each mineral in the sample. The value of k_i is governed by factors such as the grain size and the degree of crystallinity of the mineral standards. Samples which differ in composition, grain size and/or degree of crystallinity from the mineral standard may yield higher, or lower, apparent concentrations of that mineral.

Preferred orientation of mineral grains may also cause spurious results (Brindley, 1980) affecting the precision of QXRD. To minimize this effect, sample preparation should be as uniform as possible between samples. Mulligan (1987) reported that the use of pressed pellets yields relatively uniform degrees of preferred orientation.

Quantitative mineralogy was also estimated by calculating the mineralogy from XRF data (CMXRF). In order to calculate quantitative mineralogy from chemical data, all phases present in the samples must be identified, and their compositions must be known or assumed. Ideally, each mineral should contain an element which is unique to that mineral. For example, the weight percent of calcite in a sample may be calculated from the wt. % CaO, if it is assumed that calcite is a pure CaCO_3 , and that no other phase contains calcium.

Clay minerals are difficult to characterize chemically, due to their common deviation from "ideal" compositions by the substitution of cations in both the tetrahedral and octahedral layers, as well as in the interlayer site. Of particular concern is the substitution of aluminum for silica in illite and smectite, and of iron and magnesium for aluminum in illite. The following idealized chemical formulas (modified from Deer et al., 1966) were used to calculate quantitative clay mineral abundances:

Illite: $\text{KA}l_4(\text{Si}_7\text{Al})\text{O}_{20}(\text{OH})_4$

Smectite: $\text{Na}_{0.7}(\text{Al})(\text{Mg}, \text{Fe})_3(\text{Si}_{7.33}\text{Al}_{0.67})\text{O}_{20}(\text{OH})_4 \cdot n\text{H}_2\text{O}$

Kaolinite: $\text{Al}_4(\text{Si}_4\text{O}_{10})(\text{OH})_8$

The calculations were carried out in a manner analogous to the calculation of C.I.P.W. norms (Cross et al., 1902), except that the oxides were assigned only to minerals known to exist in the sample. Calcite, illite and smectite were assumed to be directly proportional to the concentrations of calcium, potassium, and iron + magnesium, respectively. Kaolinite, which was the only other common aluminum-bearing mineral detected by XRD, is assumed to be proportional to the aluminum in excess of that required to satisfy the calculated amounts of illite and smectite. Finally, quartz is equal to the SiO_2 in excess of that required for illite, smectite, and kaolinite.

In this study, CMXRF is considered more reliable than QXRD for the following reasons:

1. The illite peak on the XRD diffractograms was often obscured by the smectite peak, hence its area could not be accurately measured.
2. Because CMXRF does not require mineral standards, it is not affected by differences in diffraction characteristics between the sample and mineral standards. For example, QXRD calculations in this study indicated the presence of more calcite than is possible based on the amount of calcium present in the samples. This suggests that the crystallinity of the calcite standard used does not match

that of the calcite in the study samples, and that the value of k_i used for the calculation of calcite was too low.

3. The calculations used to determine concentrations by QXRD normalize the total concentration to 100%. Conversely, CMXRF calculates the concentration of each mineral phase independently; hence, the totals need not sum to 100%. In this study, CMXRF yielded totals between 87 and 97 weight percent.

On the other hand, the difficulty of specifying the compositions of clay minerals limits the accuracy which may be obtained by CMXRF. The technique becomes less practical as the number of phases in the mineral assemblage increases. For example, QXRD calculations yielded a value of 2-6% feldspar in samples CP1 and CP6; however, since the composition of the feldspar was unknown, it could not be quantified by CMXRF.

RESULTS

Chemical Composition

The results of XRF analysis for SiO_2 , Al_2O_3 , Fe_2O_3 , K_2O , CaO , MgO , Na_2O , TiO_2 , and S are given in Table 1. In addition to the elements reported in Table 1, the samples were also analyzed for Cr, MnO, Ba, Rb, and Zr. Each unit appears to have a distinctive bulk chemistry; the most prominent differences are shown in Figure 1. Samples from unit 1 show little variation in composition. They are characterized by relatively high SiO_2 and Al_2O_3 , and are enriched in Fe_2O_3 and TiO_2 , relative to units 2 and 3. Unit 2 (a single sample) is characterized by its high CaO and Na_2O contents. (The correlation between high calcium and high sodium is also seen in zone 3.) The sample from unit 2 contains less SiO_2 , Al_2O_3 , Fe_2O_3 , TiO_2 , and K_2O than any other sample in the suite. All samples from unit 3 contain more CaO and Na_2O than those of unit 1. Two samples from unit 3 (CP11 and 14) are particularly calcareous and approach the composition of the sample from unit 2, while samples CP10, 12, 13, and 15 more closely resemble unit 1 samples in composition.

In each sample the concentrations of SiO_2 , Al_2O_3 , TiO_2 , S, and to a lesser extent K_2O , vary inversely with CaO, while Na_2O varies directly with CaO. The MgO content does not appear to vary significantly within the sample suite.

The compositions of the $< 2 \mu\text{m}$ size fractions of the samples spanning the contact between units 1, 2, and 3 (CP8, CP9, and CP10) are compared with the chemistry of the corresponding bulk samples in Table 2. Size separation removed the sand and silt-sized shell fragments from the clay-size fractions, resulting in less calcium in each $< 2 \mu\text{m}$ sample than in its corresponding bulk sample. In general there is a concomitant decrease in Na_2O and MgO, and an increase in Al_2O_3 , SiO_2 , K_2O , and Fe_2O_3 contents for samples CP9 and CP10.

Table 1. Bulk chemistry of the Yazoo Clay exposed at the Cynthia Pit (weight percent)

	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	K ₂ O	CaO	Fe ₂ O ₃	TiO ₂	S	
CP15	1.3	2.2	17.7	42.8	1.6	12.0	4.0	0.6	0.6	
CP14	2.9	2.4	12.5	29.4	1.0	23.5	2.3	0.4	0.3	
CP13	1.2	2.2	17.9	43.0	1.7	11.6	4.6	0.6	0.6	unit 3
CP12	1.3	2.3	18.0	43.3	1.7	11.2	4.7	0.5	0.6	
CP11	3.7	2.3	10.1	24.0	0.8	27.4	2.0	0.3	0.3	
CP10	1.6	2.2	16.7	40.4	1.5	13.5	4.1	0.6	0.5	
CP9	4.7	2.3	6.6	18.1	0.4	33.6	1.3	0.1	0.2	unit 2
CP8	0.8	2.3	21.0	50.5	2.0	4.3	6.6	0.8	0.7	
CP7	0.7	2.0	19.8	47.6	1.8	7.3	5.7	0.8	0.6	
CP6	0.7	2.2	21.0	52.7	2.0	3.4	5.8	0.9	0.6	
CP5	0.7	2.2	21.0	53.5	2.0	2.7	6.0	0.9	0.7	unit 1
CP4	0.7	2.1	19.6	48.0	1.9	5.2	6.0	0.8	0.4	
CP3	0.9	2.3	19.9	49.0	1.8	4.8	6.3	0.8	0.8	
CP2	0.9	2.0	17.6	47.3	1.7	7.3	5.2	0.7	1.0	
CP1	0.8	2.2	18.9	47.6	1.8	6.0	6.2	0.8	0.6	

Mineralogy

Each bulk sample consists primarily of illite, smectite, kaolinite, quartz, and calcite. A small amount of feldspar was detected in samples CP1 and CP6. Pyrite, which was visible in some hand specimens, is apparently present in quantities below the detection limits of XRD (generally 1 wt. %). Due to structural (and chemical) similarities, the 10Å diffraction peaks of illite and muscovite overlap. Although a small amount of muscovite was seen in many samples, the broad, diffuse peaks suggest poorly crystallized particles and support the interpretation of illite as the predominant mica. The minerals recognized in the < 2 µm size fraction were calcite, quartz, illite, smectite and kaolinite.

Semi-quantitative mineral concentrations obtained by CMXRF are given in Table 3 and are compared with values obtained by QXRD in Figure 2. QXRD appears to overestimate the abundance of calcite, quartz and smectite, and to underestimate illite and kaolinite, compared to CMXRF. It should be noted that although QXRD and CMXRF yield different estimates of mineral concentrations, both methods show a similar trend of increasing calcite at the expense of detrital minerals in unit 2, and to a lesser extent in unit 3 (see Figure 2).

The mineralogy of unit 1 (samples CP1-8) is dominated by illite and smectite, which make up about 30 wt. % each, followed by kaolinite, calcite and quartz (about 17, 9, 8 wt. % respectively). The mineralogy of unit 2 (CP9) is dominated by calcite, with subordinate smectite, illite, kaolinite and quartz, in decreasing order of abundance. Unit 3 shows a much greater variability of composition than does unit 1. The samples of unit 3 can be divided into two groups on the basis of calcite

content. One group (represented by samples CP10, 12, 13, and 15) contains about 21 wt. % calcite, 25 wt. % each illite and smectite, and 7 wt. % quartz. A second group, represented by samples CP11 and 14, contains > 40 wt. % calcite, 15 wt. % illite, 18 wt. % smectite, and 3 wt. % quartz. Within unit 3 kaolinite varies from 10-16 wt. %, and does not appear to be related to the calcite content.

SUMMARY AND CONCLUSIONS

The division of the Yazoo Formation at the Cynthia Pit into units by Dockery and Siesser (1984) is justified on the basis of bulk chemistry and semi-quantitative mineralogy. Unit 1 is a relatively homogeneous unit, characterized by subequal amounts of illite and smectite (about 30 wt. % each) with subordinate amounts of kaolinite, calcite and quartz (about 17, 9, 8 wt. % respectively). Sediment homogeneity decreases upward as the calcite content increases to 20-60 wt. % in units 2 and 3. The abundance of detrital minerals, in general, shows a negative correlation to calcite content. Illite and smectite show the greatest variations in abundance, while kaolinite shows the least.

The primary source of error for QXRD arises from selecting mineral standards with diffraction characteristics dissimilar to those of the field samples. The major shortcoming of CMXRF is that the compositions of clay minerals are poorly constrained. In the future it may be possible to use both methods together to obtain the best possible concentration values. CMXRF could be used to select values of k_f from a "library" of values. The improved QXRD values could then be used to better constrain clay mineral compositions.

ACKNOWLEDGMENTS

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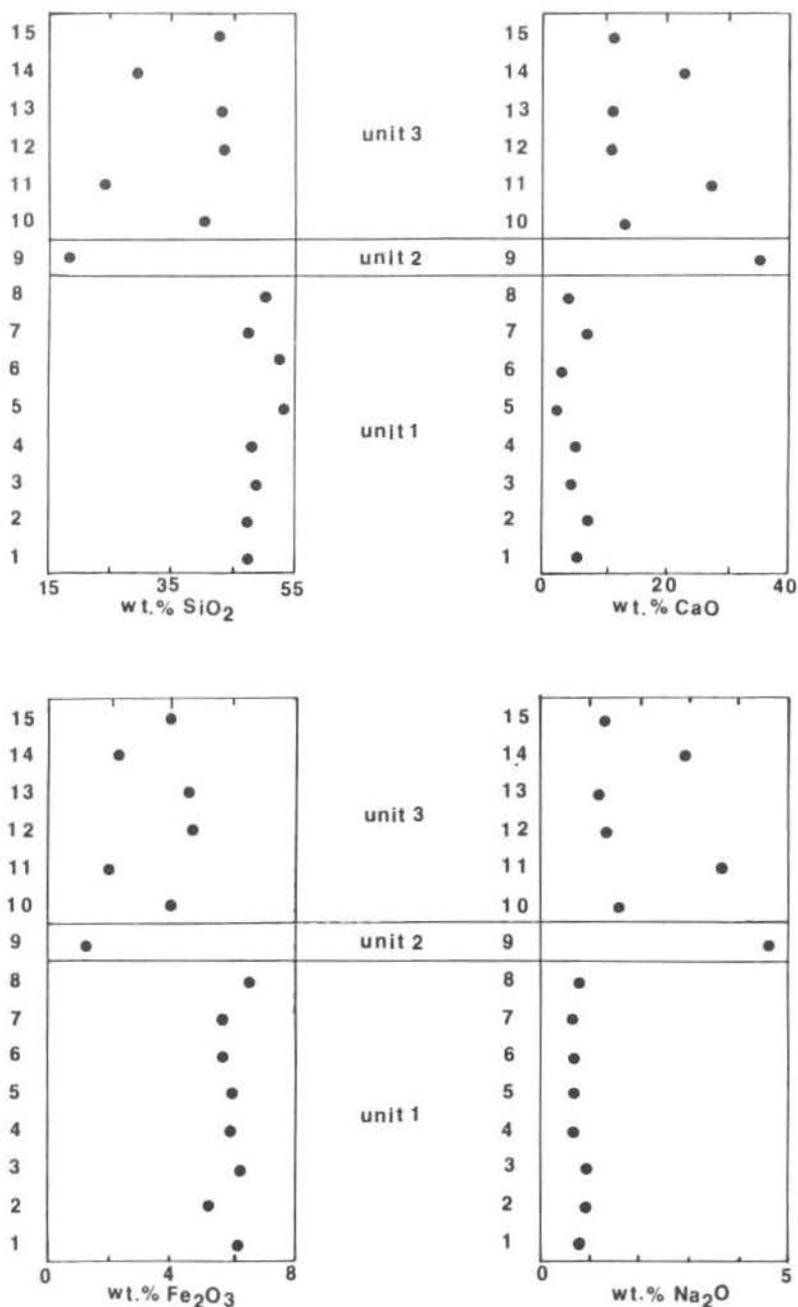


Figure 1. Variation of SiO₂, CaO, Fe₂O₃, and Na₂O in bulk samples of the Yazoo Formation at the Cynthia Pit. Note the positive correlation of CaO and Na₂O, and the inverse relation of CaO, with SiO₂ and Fe₂O₃.

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Table 2. Comparison of bulk chemistry of Yazoo Clay samples with chemistry of <2 μ m size fraction.

	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	K ₂ O	CaO	Fe ₂ O ₃	TiO ₂	S
CP10	1.6	2.2	16.7	40.4	1.5	13.5	4.1	0.6	0.5
CP10 (<2 μ m)	1.0	2.0	19.6	45.9	1.7	8.0	4.3	0.6	0.2 unit 3
CP9	4.7	2.3	6.6	18.1	0.4	33.6	1.3	0.1	0.2
CP9 (<2 μ m)	2.0	2.3	13.0	35.4	0.9	19.2	2.0	0.3	0.1 unit 2
CP8	0.8	2.3	21.0	50.5	2.0	4.3	6.6	0.8	0.7
CP8 (<2 μ m)	0.5	2.0	20.9	49.1	1.9	2.4	4.9	0.7	0.3 unit 1

Table 3. Semiquantitative bulk mineralogy of Cynthia Pit samples, determined by CMXRF, in weight %.

	Calcite	Quartz	Illite	Smectite	Kaolinite	Sum
CP15	21	8	26	24	16	95
CP14	42	4	16	19	13	94
CP13	21	7	27	26	15	96 unit 3
CP12	20	6	27	27	15	95
CP11	49	2	13	18	10	92
CP10	24	7	24	24	10	89
CP9	60	2	6	16	3	87 unit 2
CP8	8	7	32	33	17	97
CP7	13	7	29	29	18	96
CP6 ^a	6	10	32	30	18	96
CP5	5	11	32	31	17	96 unit 1
CP4	9	7	31	30	16	93
CP3	9	7	29	32	17	94
CP2	13	11	27	27	14	92
CP1 ^a	11	7	29	31	15	93

^a Calculations ignore the presence of a small amount of feldspar detected by XRD.

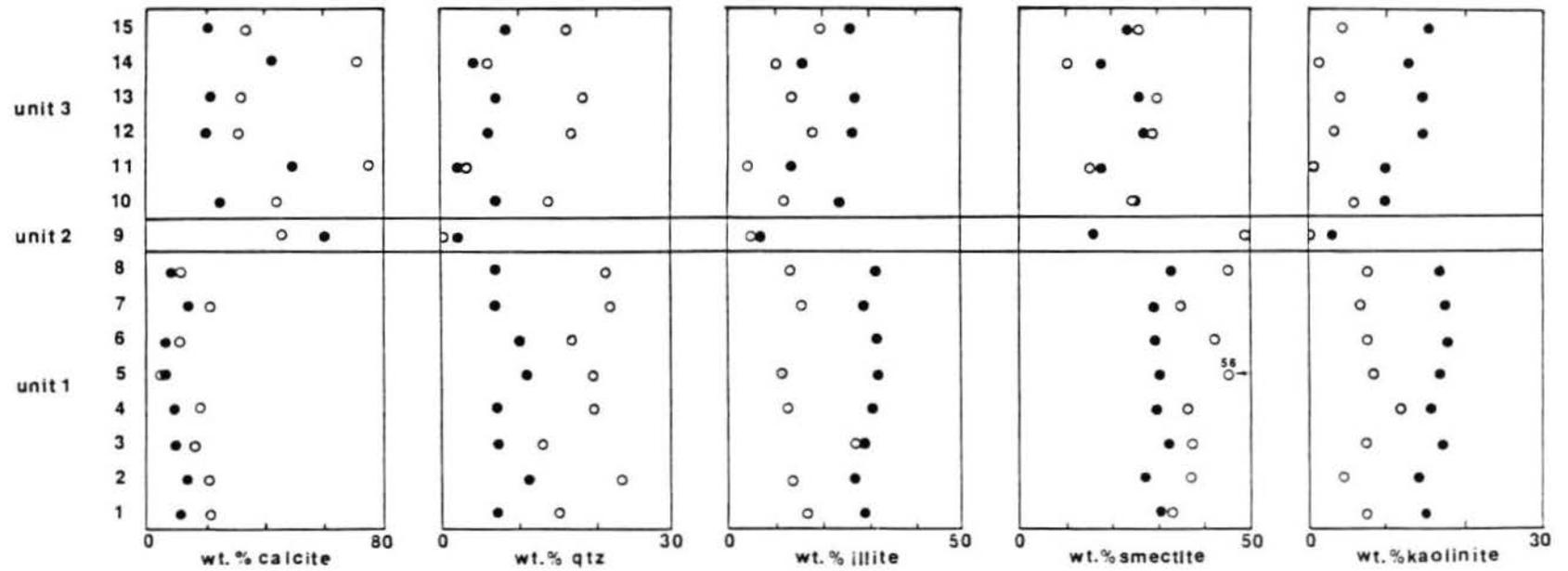


Figure 2. Comparison of semi-quantitative mineralogy of the Yazoo Formation at the Cynthia Pit by QXRD (open circles) and CMXRF (solid circles).

MMRI RESEARCH GRANTS

The Mississippi Mineral Resources Institute is pleased to announce the recipients of research grants awarded by the Institute for 1989-1990. These projects will be conducted by researchers and student assistants at the Gulf Coast Research Laboratory (GCRL), the University of Southern Mississippi (USM), Mississippi State University (MSU), and the University of Mississippi (UM). Principal investigators, their affiliation, and project titles are listed below:

Establishing a Stratigraphic Framework and Mapping of Ground Water- and Aggregate-Rich Deposits, Coastal Mississippi and Adjacent Areas; Dr. Ervin Otvos; GCRL.

Authigenic Clay Mineral Distribution, Lower Tuscaloosa Formation, Southwest Mississippi: Impact on Sandstone Reservoir Quality; Dr. Christopher Cameron, Dr. Maurice Meylan, and Dr. David Patrick; USM.

Determination of Type and Distribution of Boron Minerals Associated with the Subsurface Evaporite Formations of East-Central Mississippi; Dr. Daniel Sundeen; USM.

Ash Removal from Lignite by Density Separation; Dr. Charles Bouchillon and Dr. Glen Steele; MSU.

Crude Oil Production Data Base and Decline Curve Analysis for Predicting Future Mississippi Tax Revenues; Dr. Rudy Rogers; MSU.

Mineral Resource Potential of the Jackson Dome; Dr. James Saunders; UM.

Geographic/Geotechnical Engineering Data Base and Information System for the Mississippi Gulf Coast; Dr. Al VanBesien; UM.

Clay Composition of Mississippi-Commercial Clay Deposits; Dr. Nolan Aughenbaugh; UM.

Natural Resources Law Program; Dr. Al Sage; UM.

LIST OF PUBLICATIONS

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The primary importance of science and the characteristic that distinguishes it from other philosophies and arts is its usefulness.

Cecil J. Schneer
1960

ESTUARINE MARSH LOSS IN MISSISSIPPI, 1956-1985

Klaus J. Meyer-Arendt
Assistant Professor of Geography
Department of Geology and Geography
Mississippi State University,
Mississippi State, MS 39762

ABSTRACT

A mapping project was conducted in 1988 to closely examine ongoing habitat changes in Mississippi's wetlands and to update an earlier U.S. Fish and Wildlife Service study. As a pilot project for an expanded coastal mapping project, nine topographic quadrangles encompassing the estuarine marshes of St. Louis Bay, Back Bay of Biloxi, and their tributary streams were selected for detailed analysis. Habitat interpretations of 1956 black-and-white photographs were compared with similar interpretations of 1985 U.S.G.S. color infrared imagery. Computer digitization of the habitat interpretations produced the measurements of habitat changes as well as the final cartographic images. Comparison of the 1955 and 1985 data reveals that the estuarine wetlands have been reduced by 15.6% since the late 1950's -- from 15,300 acres to 12,900 acres. Of the 2,400 acres of wetland lost, 1,400 acres (58.7%) were directly converted to development (largely recreational subdivisions), 620 acres (25.8%) became open water (both via shore or bank erosion as well as canalization), and 370 acres were subjected to spoil deposition.

INTRODUCTION

The loss of wetlands, by both human and natural processes, has been receiving much attention in recent years (Kearney et al., 1988; Titus, 1988; Walker et al., 1987). These productive land-water ecotones are recognized for their value as wildlife habitat and nursery grounds for commercial and recreational fish and shellfish species. Human interference with wetland ecosystems is now augmented by accelerating rates of sea level rise (Titus, 1988). Both human-induced and natural processes have placed much stress on the nation's wetlands in recent decades, and an overall trend of marsh loss has been documented for the United States (Mitsch and Gosselink, 1986).

The extent of coastal wetland losses along the central Gulf Coast first became apparent in a summary report of a 2-year U.S. Fish and Wildlife Service habitat (i.e. land cover) mapping project (Wicker, 1980). This report documented the extent of habitat changes between 1955 and 1978 in the official Coastal Zones of southeast Louisiana and Mississippi. The resultant data, which showed a reduction in land area of 413,000 acres (11.3% of an original 3,646,000 acres) in

southeast Louisiana alone, not only documented the severity of land loss along the lower Mississippi River but also led to heightened national awareness of rapid losses of wetland resources. South Louisiana, containing over 40% of the nation's coastal wetlands, quickly became the focus of much public and legislative attention (Alexander et al., 1986).

In comparison to southeast Louisiana's loss of about 650 square miles of land between 1955 and 1978, the overall land loss calculated for coastal Mississippi -- 9 square miles over approximately the same period -- seemed trivial. The proportion of coastal zone land lost also appeared to be much lower than in Louisiana, in part because the official Mississippi Coastal Zone extends up to the 15-foot contour and contains much non-wetland habitat -- chiefly pine flatwoods -- between the 5-foot and 15-foot contours.

Closer inspection of the habitat data reveals that, exclusive of the offshore barrier islands, Mississippi's tidal marsh acreage of 69,130 acres in the 1950's (photography varied from the early 1950's to the late 1950's) had dwindled to 64,089 acres by 1978 (Figure 1). This loss of 5,041 acres (nearly 8 square miles) represents a 7.3% loss, a rate approximately 65% that of the deltaic plain of Louisiana. A 1973 estimate of 64,805 acres of mainland marshes (based on 1968 planimetry of the latest available topographic quads) would imply that most of the loss took place prior to implementation of the Mississippi Wetland Law in 1973 (Eleuterius, 1973).

Perhaps because of the small amount of wetland loss and implementation of a state Wetlands Protection Law of 1973

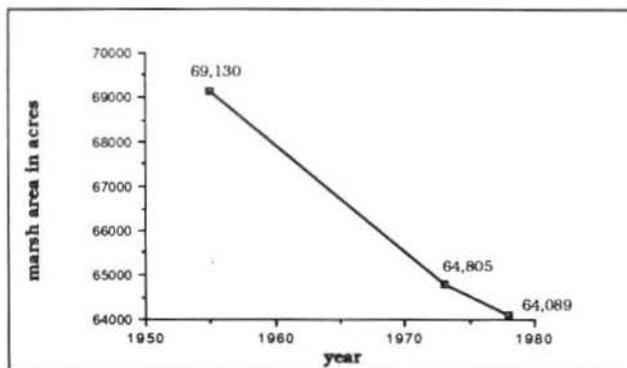


Figure 1. Change in Acreage of Tidal Wetlands in Mississippi, 1955-1978, (Data from Eleuterius, 1973, and Wicker, 1980).

(which was perceived as generally effective), concerns with wetland losses in Mississippi were minimal throughout the latter 1970's and 1980's. Not only were the U.S. Fish and Wildlife Service data for Mississippi generally disregarded, but a 1987 status report on wetlands in Mississippi suggested that the acreage of tidal wetlands was actually increasing (Eleuterius, 1987).

PURPOSE OF STUDY

In view of the paucity of knowledge of processes and patterns of wetland changes in coastal Mississippi, a pilot project -- funded by the Mississippi State University Office of Research -- was conducted in 1988. The purposes of the study were: 1) to verify the accuracy of the U.S. Fish and Wildlife Service habitat data, 2) to update the habitat measurements to the 1980's, 3) to document the relative role of each of the major identifiable processes of wetland change, including urbanization, within the 1950's-1980's period, 4) to assess the impact of the 1973 Wetlands Protection Law upon both the major agents of change as well as upon rates of wetland change, 5) to make the wetland change information available to the public and the scientific community, and 6) to evaluate the need for expanding such a geographic analysis to the remainder of Mississippi's marshes.

The tidal marshes of Mississippi can be grouped into three broad categories: fluvial marshes, estuarine marshes, and coastal marshes. Fluvial marshes are found almost exclusively within the lower Pearl and Pascagoula River systems. Estuarine marshes are found along the shores of the two major bay systems of Mississippi -- St. Louis Bay and Back Bay of Biloxi -- as well as at the mouths of numerous streams that empty into the bays. Coastal marshes comprise expanses of marsh between the Pleistocene uplands and the shore of Mississippi Sound, mostly associated with Holocene fluviodeltaic deposits. The estuarine marshes were selected for the pilot study because of their proximity to the major urban areas of coastal Mississippi and the perceived recreational attributes of the bays -- for boating and second home construction. A greater range of prevailing processes of wetland impacts was inferred.

METHODOLOGY

To conduct the study, the most recent U.S. Geological Survey topographic quadrangles covering the two estuaries were used to prepare stable base maps. Longitude/latitude, the 15-foot contour, and various control points such as highway intersections were mapped onto the overlays. In addition, a wetland/non-wetland boundary was delineated from a combination of topographic maps, the 1950's U.S. Fish and Wildlife Service data, and 1942 black-and-white aerial photography on file at MSU. This "wetlands boundary" was intended not to identify pre-existing, natural conditions but to present a

1950's baseline within which habitat changes could be more accurately documented. The then-newest color infrared aerial photography -- mostly 1985 and 1986 NHAP imagery from the U.S. Geological Survey -- was ordered at a scale of 1:24,000 and used to interpret the various landuse categories. The classification system used was a condensed version of the standard alpha-numeric system employed by the U.S. Fish and Wildlife Service (Cowardin et al., 1979; Meyer-Arendt and Wicker, 1981). By using the control points derived from the topographic maps, the 1985 map interpretations were formatted (i.e. distortions manually smoothed) to the stable base overlays. The U.S. Fish and Wildlife Service 1950's map interpretations were then checked for accuracy against the stable base map, and habitat changes were recorded.

The habitat change maps were then digitized at the MSU Remote Sensing Center using a Numonics 2200 Digitizer. By use of the software GRED (G**R**aphics **E**ditor), the cartographic interpretations were entered into an IBM AT microcomputer as separate layers of information in standard Geographic Information Systems format. Boundary data included map limits, the coastal zone, the wetland/non-wetland line, and shorelines. The remaining layers represented the various identified changes, and areal symbolization was manually added to easily distinguish the geographic patterns of change. Areal measurements were calculated and recorded on copies of the final digitally plotted maps.

RESULTS

The data derived from the pilot study yielded results that both confirmed existing knowledge and also identified problems with existing studies. Of the U.S. Fish and Wildlife Service habitat maps, the 1950's interpretations varied most in accuracy, in part because of poor quality black-and-white aerial photography. As a result, marsh acreages for the 1950's may have been overestimated by 2 to 2½%.

Of an overall recalculated 1950's marsh area of 15,317 acres within the study area, a total of 2390 acres were "lost", i.e. converted to another non-wetland habitat, by 1985 (Figure 2). Over 1400 acres of this loss (almost 60% of the total) occurred as a direct result of urbanization, mostly via dredge-and-fill activity associated with recreational subdivisions. Although the Bay St. Louis area was the primary locus of this activity, urban infringement upon wetlands was found throughout the study area. About 620 acres (over 25% of the loss) were converted into open water. Much of this was associated with the dredging of fill for the foundations of Interstate 10, but marina construction and residential canal dredging were also significant agents of land-to-water conversion. Natural land loss processes such as shoreline erosion or interior ponding, widespread throughout coastal Louisiana, were relatively insignificant. Also, over 370 acres of marsh wetlands became sites of spoil disposal. Because of the retention dikes and continued elevational increases due to periodic spoil disposal,

most of these spoil disposal sites eventually became functional uplands in terms of vegetation and wildlife habitat. Some of the disposal sites are partially colonized by marsh vegetation, however.

In contrast to the loss, a total of 55 acres of marsh wetlands were gained during this 1956-1985 period, chiefly as a result of rivermouth sedimentation, as at the Wolf River north of Pass Christian. Accounting for the gain, the net marsh loss in 30 years was 2335 acres -- or 15.2% of the 1950's total wetland area, a rate higher than southeast Louisiana and perhaps double the average for the total wetland area of Mississippi.

In contrast to the 1950's interpretations, the 1978 data exhibited a higher degree of interpretative accuracy that was most likely a reflection of the higher quality aerial photography. The U.S. Fish and Wildlife Service study listed a total of 13,142 acres of marsh within the study area in 1978, and the present study generated a figure of 12,982 acres. Assuming a relative accuracy for the 1978 data, wetland losses between 1978 and 1985 amounted to only 160 acres at the very most, or slightly over 1% loss over a period of 7 years. That percent loss may well be buried within the estimated margin of error, because of the difficulty of accurately mapping the minute habitats, even at the 1:24,000 scale.

With minor exceptions, the Wetlands Law of 1973 has been successful in sharply curtailing rates of human-induced wetland losses in the vicinity of St. Louis Bay and Back Bay of Biloxi. Examples of marsh losses since 1978 include a) the wave erosion of abandoned fingerfill lots near the junction of Bayou la Croix and the Jourdan River, b) erosion of dredge-and-fill sites along Bernard Bayou, and c) several isolated cases of canal-dredging and spoil disposal. Recent highway construction across the lower Wolf River also appears to be impacting wetlands by means of hydrologic modification and water impoundment.

SUMMARY

In summary, wetland losses in coastal Mississippi resulting from rampant construction and urbanization activities appear to have been significantly minimized by passage of the 1973 Wetlands Law. However, suggestions that 3600 acres of marsh have been added to Mississippi's wetlands by natural processes of marsh accretion since 1968 appear unfounded. And to predict a further gain of 3600 acres of marsh in the next 20 years also appears premature (Eleuterius, 1987). Recent studies in the coastal marshes east of the Pascagoula River, where both the U.S. Navy and the Ingalls shipyard have proposed extensive dredging and spoil disposal projects, indicate that marsh loss is indeed occurring.

To more accurately delineate past changes in tidal wetlands and to continue monitoring ongoing habitat changes in this valuable resource base, the Mississippi Bureau of Geology is embarking on an ambitious program to map and computerize -- in G.I.S. format -- the historic and present changes in wetland habitats.

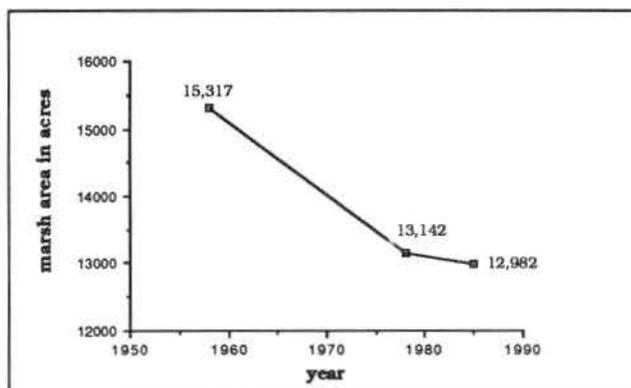


Figure 2. Change in acreage of Estuarine Wetlands of St. Louis Bay and Back Bay of Biloxi, Mississippi, 1956-1985.

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Bureau of Geology
P. O. Box 5348
Jackson, Mississippi 39296-5348

Editors: Michael B. E. Bograd and David Dockery