Red River Waterway Project
Shreveport, LA, to Daingerfield, TX, Reach
Reevaluation Study In-Progress Review

GEOMORPHIC INVESTIGATIONS

PREFACE

1. In October 1988 (Fiscal Year 1989), the U.S. Army Corps of Engineers, Vicksburg District, was directed by Congress to initiate a reevaluation of the feasibility of the Shreveport, LA, to Daingerfield, TX, reach of the Red River Waterway Project. Subsequent funding was provided by Congress in Fiscal Years 1990-1993.

2. In December 1992, an in-progress review of the feasibility of extending navigation on the Shreveport to Daingerfield reach was completed. The review was a preliminary assessment of project costs, benefits, and environmental impacts. The review revealed that construction of this reach of the project was not economically feasible. The project was also found to result in significant environmental impacts for which mitigation was not considered to be practicable. The reevaluation studies were terminated as a result of the in-progress review.

3. Various documents are available so that the public can better understand the results of the reevaluation study. The documents are:

a. In-Progress Review Documentation prepared in December 1992 for headquarters review.

b. Environmental Summary.

c. Regional Economic Development.

d. Public Involvement.

e. Recreation.

f. Mussel Survey.

g. Historic Watercraft Survey.

h. Geotechnical Investigations.

i. Geomorphic Investigations.

Copies of all these documents have been placed in the local depositories listed in the Public Involvement documentation. Copies can be obtained from the Vicksburg District for the cost of reproduction.

4. The geomorphic investigations were conducted by the U.S. Army Engineer Waterways Experiment Station in Vicksburg, MS. The purpose of the investigations was to define the evolution of the geologic features in the project area. The results of the investigations have also been published in CEWES Technical Report GL-93-31.

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1 Introduction

Background and Study Area

The U.S. Army Engineer District, Vicksburg (CELMK), is currently evaluating the opening of the Shreveport, LA, to Daingerfield, TX, segment of the Red River Waterway for navigation to Daingerfield (Figure 1). The proposed project, authorized by U.S. House of Representatives Document NO. 304 (dated 2 May 1968), would provide for a 9-e (2.74-m) deep and 200-B (60.96m)-wide channel from the Red River to Lake 0' the Pines. The proposed project requires 75 miles (120.7 km) of channel dredging and the construction of three locks and dams. It will traverse Twelvemile Bayou, Caddo Lake, and Big Cypress Bayou, and it will extend into the upper reach of Lake 0' the Pines. The study area contains approximately 450 square miles (1,165 square km) and is identified in Figure 1.

Purpose and Scope

The purpose of this investigation is to provide a geomorphic framework for the cultural resources research of the Shreveport to Daingerfield project area. Specific objectives of this investigation are as follows: identify and map the geomorphic features or landforms in the study area on appropriate scale base maps, define the geomorphic processes that are active in the study area, reconstruct to the extent possible the geomorphic development of the study area, and determine the significance of the geomorphic features in terms of locating previously unknown archaeological sites and the potential for discovering buried sites.

The major focus of this investigation is the Big Cypress Bayou Drainage Basin, since this area either has no documented information or contains only limited geomorphic and cultural resources data. The absence of any detailed geomorphic and cultural resources data for this reach of the study area is in sharp contrast to the amount of detailed information that is available for the Red River Valley near Shreveport, LA. Because of the disparity between the levels of data between the upper and lower study reaches, this investigation will concentrate primarily on the Big Cypress Bayou portion of the study area. The Red River Valley segment will be evaluated in general terms as geomorphic influences on the Red River affected the upper study area.

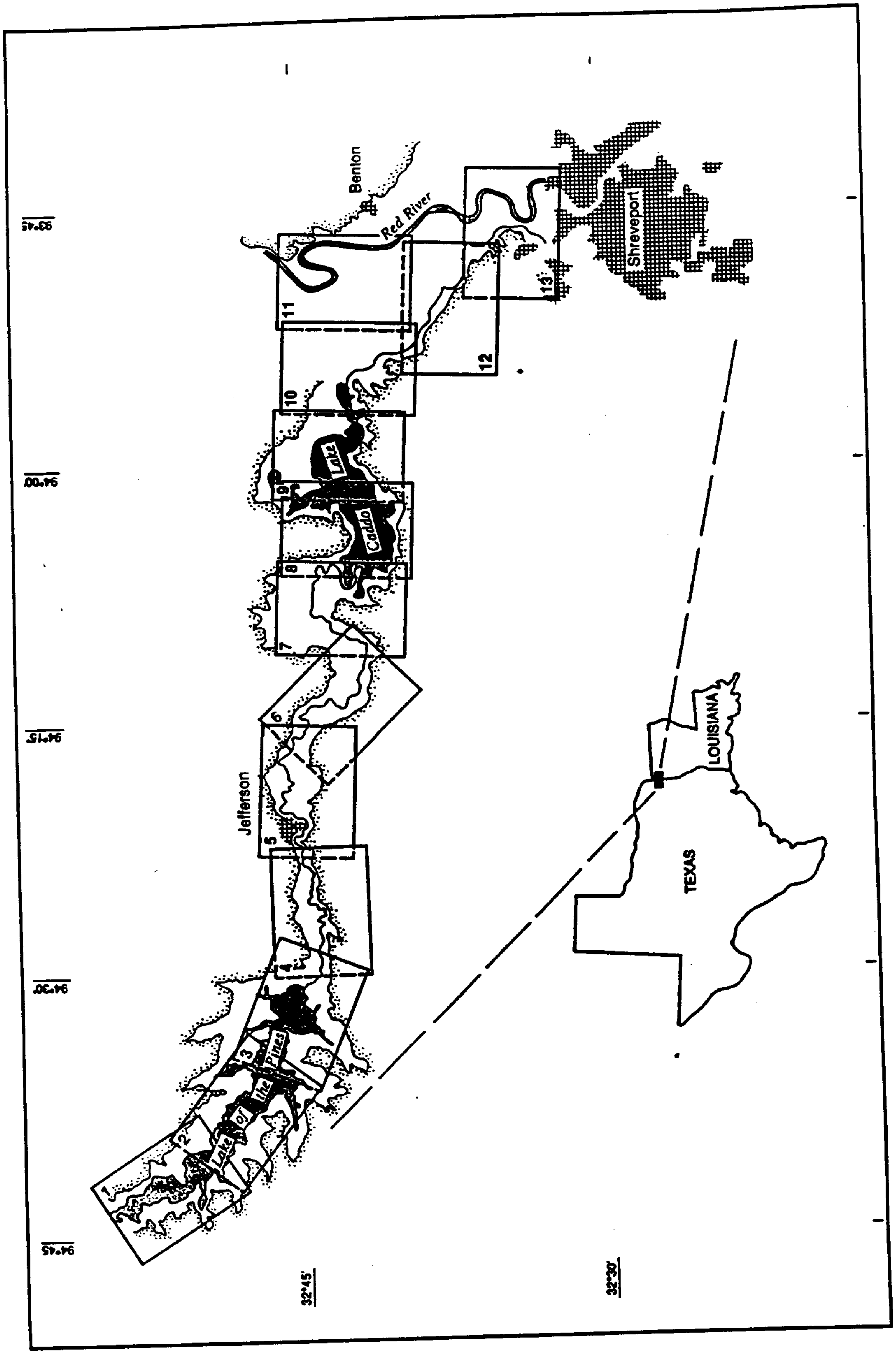

Figure 1. Location and index map to study area

The following study has been conducted in two separate phases. Phase 1 was a preliminary investigation involving geomorphic mapping and a field reconnaissance of the project area, of which this report is an account. Phase 2 built upon the first study by finalizing the geomorphic maps with a detailed field investigation to determine site specific stratigraphic and chronologic characteristics about the different depositional environments within the study area. This investigation involves the following major tasks: data collection and literature review, geomorphic mapping from aerial photography, a field reconnaissance of the project area, soil sampling of selected geomorphic environments, laboratory soil testing, data analysis and reduction, and report preparation.

Previous Investigations

Several studies relate either directly or indirectly to the Shreveport to Daingerfield project area. Geological reconnaissance of the upper Cypress Creek Basins was conducted by Saucier (1967). A regional overview of the chronology and dynamics of the Mississippi and Arkansas Rivers is described by Saucier (1974). Harvey et al. (1987) conducted a geomorphic and hydraulic analysis of the Red River above Shreveport. Both of these reports describe the changes in base level which affected Caddo Lake and Big Cypress Bayou. Changes in base level are attributed to climate changes during the Pleistocene (2 million to 10,000 years) and Holocene (10,000 years to present). Climatic variations in the region are discussed by Delcourt and Delcourt (1985), Hall (1990), and Ferring (1986). Their results indicate the drainage systems in this region experienced significant climatic and geomorphic changes at approximately 14,000, 11,000, 7,500, 5,000, 2,000, and 1,090 years before present (BP).

Site specific studies include work by Klimas (1987) and Albertson (1992). Klimas (1987) evaluates the relationship between Baldcypress and lake level fluctuations caused by construction of Caddo Dam in 1914. Albertson (1992) conducted engineering geology mapping of the project area for sources of construction material and to provide foundation data for engineering structures associated with the proposed navigation project.

An overview of the archaeology of the area is presented by Gibson (1969) and Thurmond (1990). These two reports identify the known cultural resources in the study area. Early historic documents about this area include U.S. Army Corps of Engineers (USACE) reports (1873, 1893, and 1968), Darby's (1816) account of his travels in Louisiana, and Watch's (1906) report about the geology and groundwater resources of northern Louisiana and southern Arkansas.

2 Procedure

Geomorphic Mapping

The first objective of this study was to map the geomorphic features within the study area. Mapping was done at a scale of 1:24,000 on 13 base maps developed by CELMK for the Shreveport to Daingerfield Map Atlas (USACE 1990). This map atlas was derived from portions of U.S. Geological Survey (USGS) 7-l/2-min topographic quadrangle maps.

The delineation and definition of the geomorphic features was accomplished primarily by analysis of topographic data and aerial photography (i.e. 1:24,000-scale black and white photography flown in 1989, and 1:62,500- and 1:24,000-scale color infrared (IR) photography flown in 1990). In addition to this data, the geomorphic mapping was based upon and guided by previous U.S. Army Engineer Waterways Experiment Station (WES) studies (Albertson 1992, Saucier 1967, Russ 1975, and Smith 1982). These studies served as the foundation for the aerial photographic interpretation and provided detailed information about the subsurface geology. The results of the geomorphic mapping are presented on Plates 1 through 13 (see Figure 1 for index to plates).

Field Studies

Objectives and approach

The purpose of the field studies was to evaluate the results of the geomorphic mapping and conduct soil sampling of selected geomorphic environments. Soil samples were analyzed and tested in the laboratory to determine specific stratigraphic and chronologic properties about the study area. Two separate visits were made to the project area as part of the field work. Site visits consisted of a general reconnaissance and a detailed field investigation.

A general reconnaissance was conducted during the first phase to evaluate the results of the geomorphic mapping and identify locations for later soil borings. During the detailed field investigation, soil sampling was conducted of selected geomorphic environments to obtain sediments for radiocarbon dating and to determine general soil properties about the various geomorphic environments. Radiocarbon dating was used to reconstruct the general chronology of the study area by dating selected stratigraphic horizons and their associated geomorphic features. Pollen analysis of selected sediment samples provided further evidence of the paleoenvironmental record. In addition, soils data were used to define the sedimentological characteristics of the different geomorphic environments to aid in reconstructing the evolution of the study area.

Soils information was obtained from boring data and published literature. Boring data included existing CELMK borings and borings drilled during this study. Published data consisted of county soil survey bulletins from the Soils Conservation Service (1980, 1990, and in preparation). Soil surveys were available for approximately 60 percent of the project area. Soils data were not available for Marion County. Limited soils data for this county were obtained from a field reconnaissance with the Soil Conservation Service (SCS) near Jefferson, TX (SCS unpublished data).

Soil sampling

Soil samples were obtained with a vibracore or a Giddings drilling rig. Twelve borings were drilled in the project area as part of this study. The vibracore sampler works on the principle of soil liquefaction by the sampling equipment in unconsolidated and saturated sediments. Sampling is best in fine-grained sediments (sand, silt, and clay) where the displacement of soil particles allows penetration of the core barrel. The vibracore sampler does not work well in stiff clays. For this type of soil, the Giddings drill rig was used to obtain samples.

Vibracore equipment consists of a 5 horsepower gasoline engine and a 20-a (6.1-m) flexible hydraulic cable attached to a hydraulic vibrator head. The vibrator head is connected to a 30-e (9.1-m)-long, 3-in. (7.62-cm)diam aluminum sampling pipe by an adjustable clamp. A 45-deg cutting edge was added to the sample pipe by sawing the base of the aluminum pipe. This cutting edge was sharpened by filing the aluminum edge to a smooth surface.

Soil sampling by vibracoring consisted of hoisting the sample pipe and the attached vibrator head to a vertical position and vibrating the sample tube to its maximum penetration. A 3-m (7.62-cm) sample packer was inserted into the upper end of the sample pipe and tightened to prevent sample loss by creating an air-tight seal at the top of the aluminum pipe. The air-tight seal prevents the sample from falling out when hoisting the sample pipe from the ground. Samples were recovered from the ground with a winch and pulley attached to the tripod mast. Sample tubes were cut into 3.28-e (1.0-m) lengths and sealed for transportation to WES for later laboratory testing and analysis.

In addition to the vibracore borings, three borings were drilled with a trailer-mounted Giddings drill rig. These borings were drilled in stiff floodplain sediments where the vibracore sampler would not penetrate. Three-inch (7.62-cm)diam standard Shelby tube samples were pushed into the ground by hydraulic pressure. Boring advance and cleanout between sample intervals were with a S-in. (12.7-cm)diam auger rotated to the desired sample depth. Generally, soil samples were visually inspected and logged onsite. Soil samples were extruded from the Shelby tubes in the field by a hydraulic ram attached to the drill rig. Only selected soil samples were sealed in the Shelby tubes for later laboratory classification and analysis.

Laboratory Analyses

Sample preparation and testing

Vibracore soil samples were cut into 3.28-ft (1.0-m) lengths and split in half along the longitudinal axis. Sample cores were photographed, one half was sealed in plastic for future reference, and the other half was used for laboratory testing and analysis. Laboratory testing and analyses consisted of preparing detailed boring logs of the soils and sedimentary structure and performing radiometric, radiographic, and biostratigraphic testing of selected samples. These tests were used to characterize important soil and stratigraphic properties about the different geomorphic environments and to aid in the paleoreconstruction of the project area.

Boring logs

Logs of borings drilled during this study are presented in Appendix A. Boring logs in Appendix A contain descriptions of soil type, color(Munsell), texture, soil structure, consistency, and stratigraphic thickness. In addition, locations of samples submitted for radiocarbon dating and pollen analysis are shown on the boring log. Boring locations are identified on the boring logs in Appendix A and are shown on the geomorphic maps in Plates 6, 7, 10, 12, and 13.

Radiocarbon dating

Radiocarbon dating of selected stratigraphic horizons was used to determine the general chronology of the Shreveport to Daingerfield project area. Samples submitted for carbon dating were primarily organic clays from abandoned channels. By dating selected abandoned channels in the study area, it is possible to determine the minimum age of the respective meander belts and estimate the rate of channel migration and abandonment. In addition to dating abandoned channels, lacustrine-backswamp/pointbar sediments from the Twelvemile Bayou area in the Red River Valley were dated to establish the time frame for Soda Lake.

Ten soil samples were sent to Beta Analytic Inc., Coral Gables, FL, for radiocarbon dating. Three of the samples submitted had insufficient carbon for analysis. Test results from the submitted samples are presented in Appendix B. Included in Appendix B is a general description of test procedures and definition of terms. Sample locations are identified on the boring logs in Appendix A and boring locations are identified on geomorphic maps in Plates 1 through 13. A full summary of test results is presented in Table Bl in Appendix B.

Biostratigraphy

A pollen analysis of selected soil samples from the study area was conducted to determine the effects and significance of changing paleoenviromnental conditions during the Pleistocene and Holocene and to assist with the reconstruction of the general chronology for this area. Fourteen sediment samples from five cores were submitted to Dr. Vaughn M. Bryant, Palynology Laboratory, Texas A & M University, College Station, TX, for a general pollen analysis. The pollen report by Dr. Eri Weinstein and Dr. Bryant, Palynology Laboratory, Texas A & M University, is presented in Appendix C. Their report provides an overview of the laboratory procedures, the pollen analyses, and test results.

Radiography

Radiographic techniques permit the inspection of subtle depositional and structural details not evident by ordinary visual examination and logging of soil cores. Nine soil samples were X-rayed to identify important stratigraphic and sedimentological characteristics from various depositional environments which are present in the project area. X-ray techniques are ideally suited for distinguishing sedimentary stratigraphy in lacustrine and backswamp soils that appear to be homogenous.

The main objective of using this technique was to determine the thickness of shallow lacustrine sediments beneath historic Soda Lake in the Red River Valley. X-rays made from lacustrine environments are distinguished from backswamp sediments by the presence of thin sedimentary layering. Organic bioturbation in the backswamp environment generally destroys this layering.

Sample preparation involves placing a 0.4-m. (l-cm)-thick by10.0 in. 25 cm)-long soil sample onto X-ray film and exposing the sample to radiation. X-rays are absorbed differentially by the soil sample because of variations in sample density, composition, and soil structure. Absorption patterns are registered onto the X-ray film as an image. These images were then examined for structural and sedimentological characteristics.

3 Geology and Geomorphology

Geologic Setting

Geomorphic development of the Big Cypress Bayou drainage basin is the result of geologic processes operating during the last 65 million years. The study area is composed of Tertiary (65 to 2 million years) to Quaternary (2 million years to present) age sediments. Tertiary sediments were deposited by fluvialdeltaic processes similar to processes presently active in Louisiana. During the Quaternary, these Tertiary sediments were uplifted and incised by numerous Pleistocene and younger fluvial systems such as Big Cypress Bayou. This drainage basin reflects the geomorphic processes that have been active during the past 2 million years. These processes are controlled by climatic fluctuations and previous tectonism (i.e. Sabine uplift) .

Geomorphic Surfaces and Environments

Introduction

Geomorphic mapping has identified three major geomorphic surfaces within the study area. These surfaces are differentiated according to their physical characteristics, their apparent age, and by the types of processes that are active on each of these surfaces. These surfaces are identified in Table 1 as the floodplain, terraces, and valley slopes. These three surfaces are further subdivided into depositional environments and/or geologic formations as shown by Table 1 and Figure 2. The approximate age of each surface and the types of geomorphic processes that are active are identified in Table 1.

Valley dopes and tertiary sediments

Surface outcrops of Tertiary sediments in the study area are restricted to the valley slopes and hill slope summits. Tertiary sediments forming the valley slopes were defined by a sharp break in the topography between the nearly flat terraces and floodplain surfaces which border the valley slopes.