U.S. Army Corps of Engineers
New Orleans District

CULTURAL RESOURCES INVESTIGATION OF PUBLIC ACCESS LANDS IN THE ATCHAFALAYA BASIN FLOODWAY, INDIAN BAYOU NORTH PROJECT AREA, ST. LANDRY PARISH, LOUISIANA

Draft Report

September 2004

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The results of cultural resources investigations conducted by Coastal Environments, Inc., (CEI) in the Indian Bayou North Area of the Atchafalaya Basin Floodway of south-central Louisiana are presented. The research was carried out under contract to the U.S. Army Corps of Engineers (USACE), New Orleans District in order to evaluate the cultural resources of recently acquired public lands. The study area encompassed about 2,700 acres (1093.5 ha) and was conducted in southern St. Landry Parish. Using a research design developed by Earth Search, Inc., and subsequently modified by CEI, the area was examined for buried channels and associated natural levees that could have supported prehistoric sites using a program of hand augering and machine coring. These investigations were augmented by an experimental shallow seismic survey and a preliminary examination of old growth cypress trees and stumps for dendrochronological information. In addition, a shovel test survey was conducted in an attempt to find recent historic deposits along the major crevasse channels.

The results were largely negative; no new archaeological sites were located within the Indian Bayou North study area. The auger, coring, and seismic surveys could not locate any suitably ancient surfaces near the current surface of the area, and shovel tests only uncovered a few pieces of recent trash. The experimental seismic study, however, was successful in proving that the methods could be used to find shallow (<4 m deep) geological facies. In addition, the cypress tree survey showed that these methods of dating could also be of considerable value in providing dates for surface and near-surface landforms.

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ABSTRACT

The results of cultural resources investigations conducted by Coastal Environments, Inc., (CEI) in the Indian Bayou North Area of the Atchafalaya Basin Floodway of south-central Louisiana are presented. The research was carried out under contract to the U.S. Army Corps of Engineers (USACE), New Orleans District in order to evaluate the cultural resources of recently acquired public lands. The study area encompassed about 2,700 acres (1093.5 ha) and was conducted in southern St. Landry Parish. The area of concern was bounded by the Atchafalaya River levee to the east, Bayou Courtableau to the north, and to the south and west by Bayou Fordoche and the Lake Fordoche swamp. This is an area that has seen heavy accumulations of sediment from the Atchafalaya and related streams within the last two centuries. Using a research design developed by Earth Search, Inc., and subsequently modified by CEI, the area was examined for buried channels and associated natural levees that could have supported prehistoric sites using a program of hand augering and machine coring. These investigations were augmented by an experimental shallow seismic survey and a preliminary examination of old growth cypress trees and stumps for dendrochronological information. In addition, a shovel test survey was conducted in an attempt to find recent historic deposits along the major crevasse channels.

The results were largely negative; no new archaeological sites were located within the Indian Bayou North study area. The auger, coring, and seismic surveys could not locate any suitably ancient surfaces near the current surface of the area, and shovel tests only uncovered a few pieces of recent trash. The experimental seismic study, however, was successful in proving that the methods could be used to find shallow (<4 m deep) geological facies. In addition, the cypress tree survey showed that these methods of dating could also be of considerable value in providing dates for surface and near-surface landforms.

Given the negative results of the study, CEI recommends that the USACE utilize the remainder of the funds in the present Work Order to investigate the Bayou Fordoche Mounds

(16SL34), an aboriginal site on Bayou Fordoche within the newly acquired public lands. The site consists of two small mounds on the west bank of Bayou Fordoche, and has not been adequately investigated since it was first noted by personnel from Louisiana State University in 1974. It has received only one recorded visit by professional archaeologists since it was first discovered, and the size, age, and cultural content of the site has never been assessed. The authors argue that the USACE should attempt to understand these issues in order to develop a management plan for the site and its surroundings. A plan for testing the site and dating its associated landform is presented as part of the recommendations in this report.

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PREFACE AND ACKNOWLEDGEMENTS

This report presents the results of a cultural resources survey conducted within the Indian Bayou North project area, St. Landry Parish, Louisiana. This area consists of ca. 2,700 ac of land newly acquired by the U.S. Army Corps of Engineers (USACE) and open to the public at certain times of the year for hunting, fishing, hiking, and other similar outdoor recreational activities. The survey was conducted by Coastal Environments, Inc., (CEI) under contract with the New Orleans District, USACE (Contract No. DACW29-01-D-0016, Delivery Order No. 0004), and was performed as a means to identify any existing cultural resources that might occur on the property and to assess the potential for the area to yield buried, near-surface cultural resources. Such resources could be affected by the future construction of any hunting and/or hiking trails, boat launches, etc., that would allow the property to be more accessible to the public.

Fieldwork for the project began in late August 2003, and lasted, on and off, until May 2004, although most had been completed by October 2003. Several field crews were involved, each with a different task to perform. The initial augering program was conducted by Richard A. Weinstein and April Lemoine, both of CEI, with subsequent help from Jeramé J. Cramer, Brian P. Tyler, and Josh C. Whiting, also of CEI. This was followed by a coring program that included Glen H. Doran and David Thulman, of the Department of Anthropology, Florida State University, Tallahassee, Florida, plus Richard Weinstein and April Lemoine. Paul V. Heinrich, of the Louisiana Geological Survey, Louisiana State University (LSU), Baton Rouge, Louisiana, also joined the coring crew for two days of work.

The shovel testing program was led by Jeramé Cramer, and included Brian Tyler and Josh Whiting of CEI. Initial investigations of the region's cypress trees was directed by George J. Castille III, also of CEI. Josh Whiting and April Lemoine aided in this research at various times. Later in the project, Patricia (Joy) Young of the Department of Forestry at LSU joined the cypress tree investigations and retrieved the tree-ring cores for dendrochronological

dating. Lastly, Juan M. Lorenzo, of the Geology Department at LSU, plus several of his graduate students, conducted the two seismic surveys across portions of the project area.

In addition to the field crews, several other individuals should be acknowledged for their help. Michael L. Swanda, of the New Orleans District, USACE, oversaw the project for the Corps and served as liaison between the Corps' main office in New Orleans and its field office in Port Barre. Members of the Port Barre office also aided in the project. Included were Dee Goldman, park manager; Neil Lalonde, natural resources specialist; and Dave Fisher, park ranger. Fisher was particularly helpful, especially when he was called upon to pull stuck CEI vehicles out of the mud.

Several landowners of the region also aided in the project, mainly by allowing access to their property for some of the augering and coring that occurred north of the Corps-owned land. Of particular help were Bradley Grimmett and Toby Kimball, who owned most of the land in question. Grimmett also provided a tractor with a bushhog to clear some heavily overgrown sections of the project area and allow the shovel-testing crew easier access to the property.

Once the field investigations were completed, actual work on the report began. As can be seen in the remainder of the study, many of the individuals involved in the field research served as authors or co-authors of specific chapters. Weinstein authored the Introduction and Chapter 4 on the results of the auger borings. He also co-authored Chapters 2, 7, and 9 and prepared Appendix B on the radiocarbon dates. Paul Heinrich authored Chapters 3 and 5 on the background geology and geoarchaeological investigations, respectively, plus he prepared the core logs presented in Appendix A. Juan Lorenzo authored Chapter 6 on the seismic investigations, while Jeramé Cramer co-authored Chapter 7 on the shovel-testing survey. George Castille III and Joy Young co-authored Chapter 8 on the cypress tree investigations, while Castille helped co-author Chapter 9. In addition to these people, three members of CEI's professional staff aided in preparation of the report: Douglas C. Wells served as co-editor of the study and co-authored Chapters 2 and 9; Curtis Latiolais served as draftsman and was responsible for most of the illustrations and maps; and Cherie Schwab acted as editor and report layout specialist.

CHAPTER 1

INTRODUCTION

Richard A. Weinstein

This report provides detailed discussions relative to a varied suite of field investigations associated with a Phase I cultural resources survey of Public Access Lands in the "Indian Bayou North Area" of the Atchafalya Basin Floodway (Figure 1-1). The overall project area consists of ca. 2,700 acres of land that have an elevation above ca. 15 ft MSL.[1] It is located south of Bayou Cortableau, west of the Atchafalaya River's western levee, and east and north of the Bayou Fordoche and Lake Fordoche swamp, all within St. Landry Parish, Louisiana (see Figure 1-1). The project area is situated immediately north of another survey area, identified as the "Indian Bayou Area," that was being investigated simultaneously by personnel from Earth Search, Inc., (ESI) of New Orleans, Louisiana. The line dividing the two project areas lies along the boundary separating Sections 23 and 26 in the southeastern portion of the Indian Bayou North tract.

Prior Research Design

Previous to the field investigations, the New Orleans District had contracted with ESI to produce a research design that would provide necessary background information on the two project areas. This included a review of previous archaeological investigations, a synthesis of the region's prehistoric cultural history, and detailed summaries of the history and geology of the area (Earth Search, Inc. 2003). Due to the existence of this document, CEI was instructed by New Orleans District not to replicate the ESI effort, but, instead, only to provide a minimal amount of supporting background data in the current report. It was

[1] In fact, except for a small portion of the project boundary that occurs along the line separating Sections 23 and 26, the Corps set the southern edge of the project survey area at the 15-ft contour interval, as shown on modern U.S. Geological Survey (USGS) quadrangles of the area (USGS 1969, 1970).

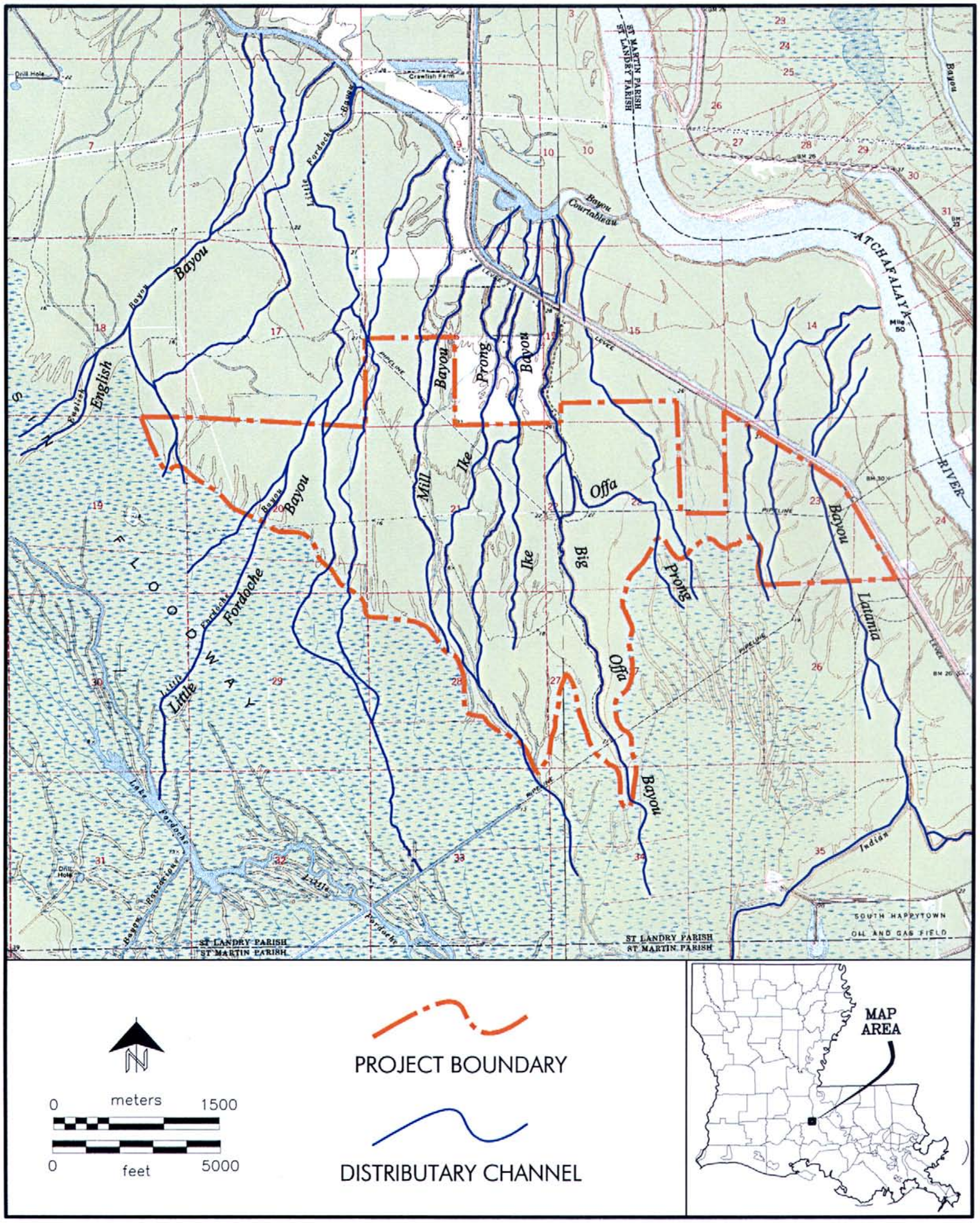

Figure 1-1. The Indian Bayou North project area on the west side of the Atchafalaya River in southern St. Landry Parish. Note the numerous distributary channels emanating from Bayou Courtableau and passing through the project area (USGS 1969, 1970).

reasoned that persons interested in reading the detailed background information could do so by consulting the ESI study.

The ESI (2003) research design also provided suggestions on additional research and field methods thought most appropriate for conducting cultural resources investigations in the region. These included: (1) An examination of foundation borings to help interpret the geology of the area. The research design specifically noted those borings acquired in conjunction with the construction of Interstate 10 (I-10) at the southern edge of the Indian Bayou Area, but the suggestion also pertains to foundation borings drilled prior to construction of the Atchafalaya River levees. (2) Collection of shallow seismic profiles along east-west lines in the project areas. It was envisioned that data from these lines might help identify buried distributary channels or other water bodies whose natural levees might have supported archaeological sites. If identified, such possible channels could be verified through a minimum program of "drillholes." (3) Revisits to two archaeological sites situated on the Corps-owned land in the Atchafalaya Basin (but located beyond the limits of the two current project areas): the Bayou Fordoche Mounds (16SL34) and the Henderson Lake site (16SM95). The former is located ca. 3.7 km west-northwest of the western tip of the Indian Bayou North survey area, while the latter is situated beyond the southern limits of the Indian Bayou Area. It was suggested that controlled site testing take place to determine the age and cultural affiliation of the Bayou Fordoche Mounds, as all that was known of the site was that it consisted of two low mounds. (4) Conduct systematic backhoe trenching at 50-m intervals across the project areas to locate buried archaeological sites. Trenches were to be relatively short (ca. 3 m in length) but of sufficient depth to locate buried surfaces that might contain sites. (5) Conduct systematic shovel tests at 30-m intervals in those areas where potential sites were not thought to be deeply buried. Although not stated in the research design, this would be particularly true of those areas with a potential for relatively recent historic sites.

As will be seen, most of the suggested field methods were carried out by CEI in the Indian Bayou North Area, with some minor modifications. Only the fourth method, systematic backhoe trenching, was not conducted during the CEI field investigations (although it was conducted by ESI in their survey area). It was reasoned that the historic crevasse channels in the current (Indian Bayou North) study area were fairly well-exposed, and that coring, shovel-testing, and augering would be more efficient means of gathering data on historic sites. In addition, CEI added another field technique not mentioned in the ESI research design. This entailed an examination of the area's cypress trees and cypress stumps in an effort to obtain dendrochronological cores from those trees and/or stumps believed to be of significant age. Coupled with a determination of the landform upon which the tree initially began to grow, these data could then be used to help date the age of that landform and to assess its potential for supporting prehistoric occupation.

Potential for Site Burial

As mentioned above, a major problem confronting the current investigations was the potential for site burial in the area. A brief review of that potential is offered here, to help "set the stage" for the field investigations discussed in the following chapters. Obviously, more information will be provided on this topic as the different field techniques are addressed throughout the report.

Accordingly, when work began on the study an unknown portion of the project area was known to have been covered by relatively recent sedimentation from the Atchafalaya River, with most having accumulated since the river was cleared of its last obstructing raft in 1861.[2] Although the exact age and depth of these deposits was unknown for the project area proper, a nearby location was examined by CEI for the New Orleans District over a decade ago (Castille et al. 1990). That location, identified as the "Old Atchafalaya Area," was one of several disjointed locales spread out along the Atchafalaya River. It was located at the junction of the Atchafalaya River and the Whiskey Bay Pilot Channel, just a few kilometers southeast of the current Indian Bayou North Area, and roughly on the line separating St. Landry and St. Martin parishes. By examining a series of elevation transects that had been run across the Atchafalaya Basin by the Corps during the period 1932 to 1963, it was found that the transect along Range Line 6 (R-6) crossed almost directly through the Old

[2] See the discussion in Chapter 3 for more details on clearing the raft.

Atchafalaya Area (Castille et al. 1990:Figure 6). It showed that the amount of sediment varied quite a bit according to the specific area along the range line. For instance, the land between the Atchafalaya River and the Pilot Channel had accumulated between 4 and 10 ft of sediment. East of the Pilot Channel, up to 15 ft of sediment had accumulated in some locations. Yet, the area west of the Atchafalaya River showed only 1 to 3 ft of sediment (Castille et al. 1990:Figure 7).

Given the information derived from Castille et al (1990), plus that offered by the ESI research design, which noted a similar accumulation of sediment on the west side of the Atchafalaya River, it was considered likely that land surfaces dating prior to the mid 1880s would be buried by at least 3 ft of sediment, if not more. However the exact depth was unknown.

However, at least two prominent crevasse channels emanating from Bayou Cortableau pass through the project area, and both may have considerable time depth. These are the channels associated with Little Fordoche Bayou (which passes through Section 20) and Big Offa Bayou, which flows through Sections 15, 22, 27, and 34 (see Figure 1-1). Both are shown on the original plat map for Township 7 South, Range 7 East of the Southwestern District (Figure 1-2). According to a note on the map, the boundaries and interior section lines were surveyed in 1807, while the meanders of Bayou Cortableau and the Atchafalaya River were surveyed in 1829. Thus, these two channels were present in the region in the early 1800s and it is likely that they had been present for an unknown period of time prior to that. Given the fact that Bayou Cortableau itself may be several thousand years old, then it reasoned that the natural levees associated with these crevasse channels could have supported a wide range of prehistoric archaeological sites.[3]

That being said, there remains the problem of relatively recent sedimentation covering the natural levees of these two channels plus the remainder of the project area.

[3] The exact age of Bayou Cortableau is unknown. Gagliano et al. (1979:Figure 5-1) identify it as a crevasse off the Teche-Mississippi, a Stage 3-4 Mississippi River course that was active between ca. 3800 and 1500 B.C. Saucier (1994:Plate 11) shows it as part of an undated relict Red River course that once flowed within the old Teche-Mississippi meander belt but broke through the Mississippi's natural levee and extended eastward into today's Atchafalaya Basin. This would imply a post-1500 B.C. age.

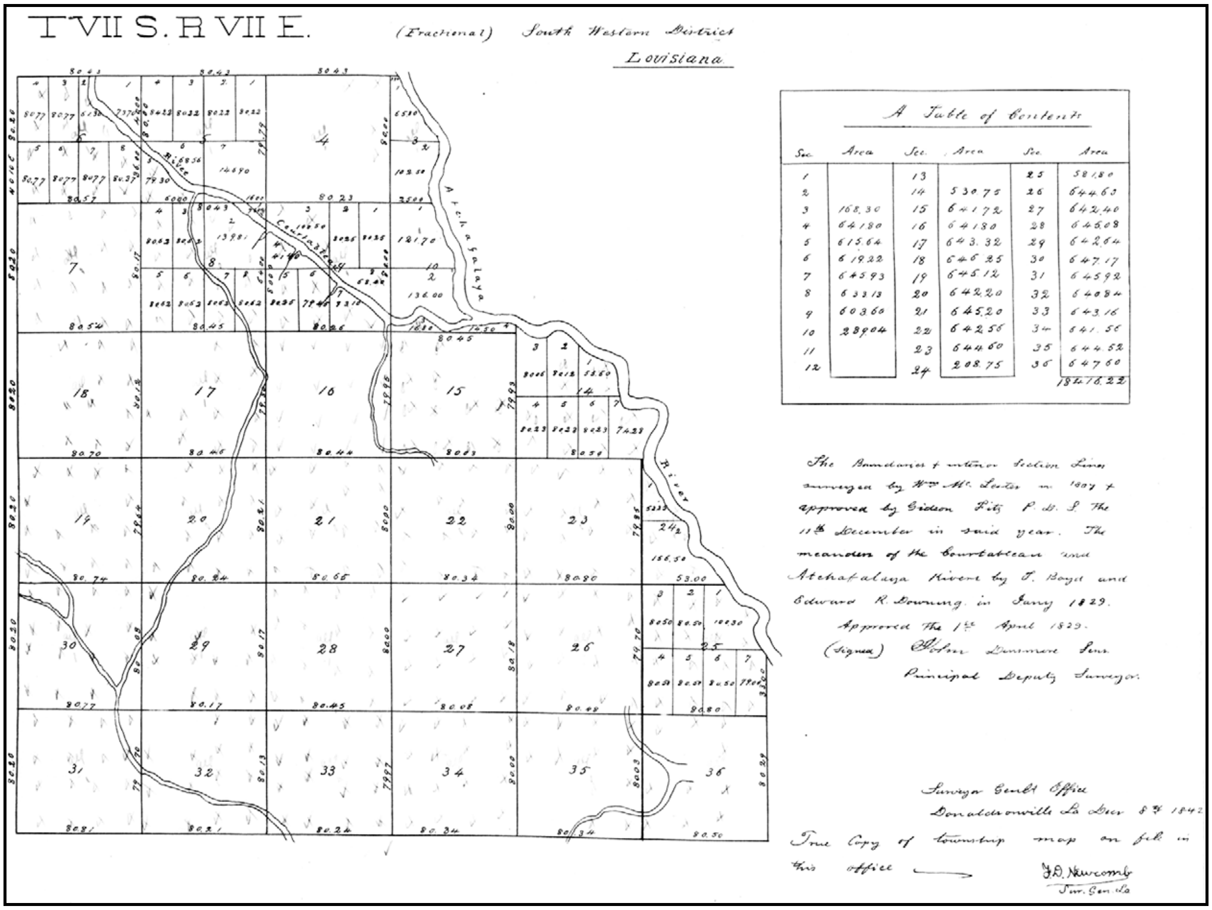

Figure 1-2. 1842 plat map of Township 7S, Range 7E, showing the courses of Little Fordoche Bayou and the upper part of Big Offa Bayou at that time. It is known from the survey notes upon which this plat is based that Big Offa continued southward into Sections 22 and 27 (Newcomb 1842).

According to a series of elevation ranges run across the area in the 1930s and '40s, about 1 to 2 ft of sediment had accumulated during those two decades. When several of these ranges were resurveyed in early 2003, it was found that somewhat less than a foot of additional sediment had built up since ca. 1950 (Earth Search, Inc. 2003). Thus, at least 2 to 3 ft of very recent sediment may overly much of the project area. These figures, however, do not take into account sediment that undoubtedly accumulated in the region between 1861 and 1932. Thus, well over 3 ft of post-1861 sediment (potentially on the order of 4 to 5 ft) probably covers much, if not all, of the project area. Furthermore, it has been assumed by Heinrich and Autin (2000) that many of the small crevasse channels currently present within the project area (not including the two possible Teche-Mississippi-age channels described above) are the result of very recent overbank flooding. Nevertheless, as with the two probable Teche-Mississippi channels, the exact ages of these waterways are unknown and it is possible that some may have reoccupied older courses related to channels of the ancient Teche-Mississippi.

Given the uncertainty of the ages of all of the channels within the project area, plus the fact that much of the region may be buried by 4 to 5 ft of recent alluvium, the following proposal deviates somewhat from the field methods suggested in the Scope of Work (SOW). Instead, it offers a two-step approach to the field investigations. As part of the first step, an attempt will be made to gain additional information about the ages of the identifiable channels within the project area, plus gather data on the depth of the recent deposits that most likely overlie them. This information then will be used to assess the potential for the natural levees of these channels to have supported prehistoric occupation. A survey research design based on this information then will be prepared and submitted to the Corps. It will offer survey methods believed most conducive to locating buried sites. The second step will involve a detailed search for these potentially buried resources, and will utilize the field methods advocated in the survey design.

These investigations were carried out by personnel from Coastal Environments, Inc., (CEI) under contract to the New Orleans District, U.S. Army Corps of Engineers (USACE), primarily from August through October 2003. As stipulated in the proposal prepared by CEI for the project, three subtasks were to be carried out during the initial field investigations: (1) conduct preliminary geological studies to help determine the age of the various distributary channels running through the project area, and to identify those channels that might be of sufficient age to have supported prehistoric and/or protohistoric aboriginal archaeological sites; (2) examine the depth of sedimentation overlying the root mats of selected cypress trees that, when coupled with estimates on the ages of the trees, could provide a rate of sedimentation for that particular location within the overall project area, and, thus, help determine the age of the landform; and (3) conduct a terrestrial survey of selected locales within the project area in an attempt to locate historic sites. It was envisioned that the results of these three subtasks would allow for recommendations to be made regarding the need for future field investigations in the project area. Such recommendations are provided in Chapter 9.

CHAPTER 2

PREVIOUS RESEARCH AT THE BAYOU FORDOCHE MOUNDS (16SL34) AND HENDERSON LAKE (16SM95) SITES

Richard Weinstein
Douglas Wells

Introduction

Due to sedimentation as well as a lack of previous survey, the Indian Bayou North project area has no previously recorded archaeological sites. However, two recorded sites within Corps of Engineers property are situated near the project area, and should provide some idea of the cultural resources that could potentially be found in the area. These are the Henderson Lake (16SM95) and Bayou Fordoche Mounds (16SL34) sites (Figure 2-1).

Bayou Fordoche Mounds (16SL34)

The Bayou Fordoche Mounds site is located on the west side of Bayou Fordoche, about 400 m south of a powerline ROW that crosses through the area. The site straddles the line separating Sections 11 and 14, Township 7S, Range 6E. This location is approximately 3.7 km west-northwest of the westernmost point of the present project area (which falls along the line separating Sections18 and 19, Township 7S, Range 7E).

The site was found in 1975 by personnel from Louisiana State University (LSU) during their survey of the Atchafalaya Basin for the New Orleans District (Neuman and Servello 1976). The original site form described two mounds spaced about 50 m apart, on a north-south line that followed the edge of the bayou. Mound A was the northernmost of the two, pyramidal in shape, 13 m north-south by 28 m east-west, and 2.5 m high. Mound B was

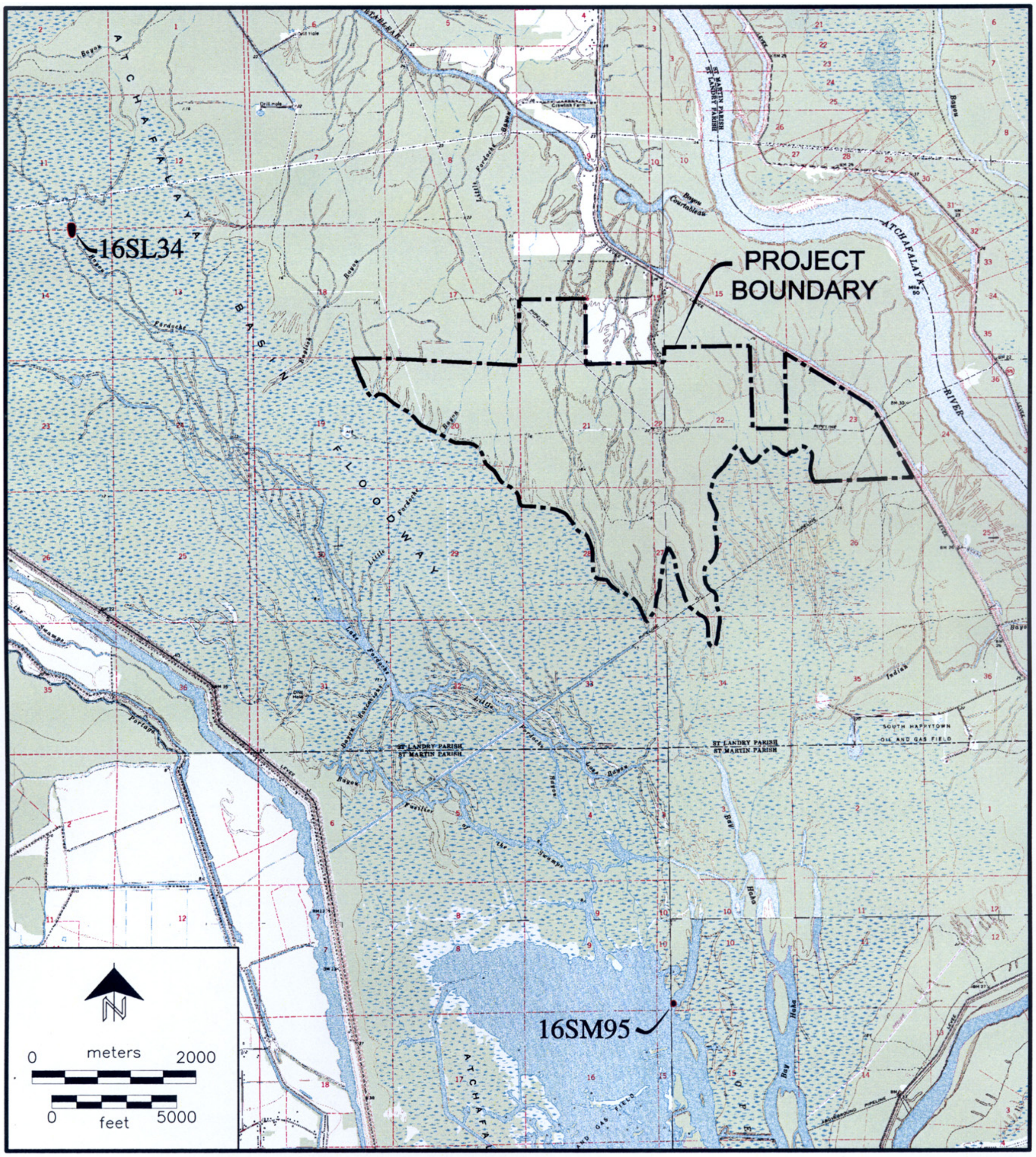

Figure 2-1. Map of the Indian Bayou project area, showing the Henderson Lake (16SM95) and Bayou Fordoche Mounds (16SL34) sites (USGS 1969, 1970).

conical, 50 m in diameter, and also 2.5 m high (LDA site form). The final report stemming from the project noted that a minimum of 2.5 m of sediment covered the site, but it is not known how this figure was obtained (Neuman and Servello 1976:48). No mention was made of any collected artifacts, so it can be assumed that none was found. Likewise, no estimate is provided on the possible age of the site. Nevertheless, the mounds reportedly were in good condition and the site was considered to have a medium to high potential for inclusion in the National Register of Historic Places (Neuman and Servello 1976:32, 48-49). Testing to determine the nature of the mounds and the extent of any associated midden was recommended.

The site was next visited by Dennis Jones and Malcolm Shuman in the spring of 1991 during the course of LSU's mound-mapping project in Acadia, Lafayette, and St. Landry parishes (Jones and Shuman 1991). Unfortunately, flood waters during that time of year were at least 2 ft deep over most of the site area, and only the tops of the mounds projected above the water. Nevertheless, data on the two mounds were collected, including a few photographs (Jones and Shuman 1991:139). A little over 4 ft of Mound A stood above the water. It was flat on top, as described by Neuman and Servello, but Jones and Shuman (1991:136) suggested that the mound probably had been built originally as a conical structure, and that it had been cut down and leveled to make room for the camp. Nothing remained of the camp, save for a few pieces of glass and whiteware, and it appeared as if the building had burned. The mound was described as measuring 40 ft east-west by 60 ft north-south, which is comparable to the dimensions noted by the LSU Atchafalaya Basin survey.

Mound B was described as somewhat smaller than Mound A, with a diameter of about 35 ft (Jones and Shuman 1991:136). About 4 ft of it also stood above the flood waters, but, since it had not been cut down to support a camp, it was reasoned that it originally had been shorter than Mound A. No prehistoric artifacts were found on the tops or flanks of either mound.

Jones and Shuman note that they placed a few soil probes through the mounds in an effort to determine their original height and the depth of the old premound A horizon. Although the probes first penetrated a sequence of basket-loaded mound fill, and then a probable A horizon, no depths are given for any of these strata, and no detailed soil descriptions are provided (Jones and Shuman 1991:137). Thus, it is not possible to determine the depth of the original ground surface, nor whether midden was encountered in any of the probes. Overall, Jones and Shuman (1991:137) speculated that the site might be Marksville in age (ca. A.D. 1 to 400) and that it probably once contained twin conical mounds.

Henderson Lake (16SM95)

The Henderson Lake site was exposed during a drawdown of Henderson Lake in 2000, and recorded by Charles McGimsey of the Southwest Regional Archaeologist's Office in Summer of 2001. The exposure of human bone prompted a local fisherman to report the site to the St. Martin Parish Sheriff's Department, who brought it to the attention of Mary Manheim of LSU (McGimsey and Heller 2001). Once it was determined that the site was not a crime scene, archaeologists from the Corps of Engineers and the Regional Archaeologist's office, as well as the Chitimacha tribe of Louisiana, were brought in to examine the site, and two burials were found to be eroding from the exposed shell at the site. Consultation between the State of Louisiana and the Chitimacha determined that the site was a prehistoric cemetery, and that the burials should be removed before further damage was done by erosion and/or looters. The emergency fieldwork was subsequently carried out in September of 2000 by the Southwest Regional Archaeologist's Office in consultation with the Chitimacha Tribe.

The site is located on the west side of Bayou Coquille, a cut-off, largely silted-in remnant of the Atchafalaya distributary system (McGimsey and Heller 2001:3), on a natural levee that has subsided and was largely inundated by the construction of Henderson Lake. The site is located in the southwest corner of Section 10, Township 8S Range 7E, about 3.0 mi (4.8 km) south of the current project area.

Henderson Lake is a shell midden measuring 20 by 10 m, having been severely truncated at the northern end by a canal cut east-west through the western natural levee of

Bayou Coquille. McGimsey (LDA site form) reports that the site is exposed along 35 m of modern bankline, and that the midden is at least one meter thick, although coring did not reach the base of the midden. A single one-by-one-meter unit exposed an A-horizon covering twenty cm of intact midden above the water table. Two radiocarbon dates on shell from these upper midden levels came back with 2-sigma ranges of cal AD 2,997 BP to 2,713 BP and 2,853 to 2,364 BP (McGimsey and Heller 2001:28).

A total of 14 burials, including one dog burial, were identified at the site. Eight of these were intact, and all but one exposed by wave erosion. No grave goods were found associated with the burials, although the majority of ceramic markers from the associated A-horizon suggest that the burials could be Marksville in age (McGimsey and Heller 2001:23-28). These markers include Marksville Incised, Marksville Stamped, Mabin Stamped, and Churupa Punctated, as well as earlier (Tchefuncte) examples of Tchefuncte Plain, Tchefuncte Stamped, and Tammany Punctated, and later (Baytown or Coles Creek periods) sherds of Pontchartrain Check Stamped and French Fork Incised. A sherd of shell-tempered Mississippi Plain probably denotes a Mississippi period component. A single stone point, probably a preform for an Alba or Perdiz point, was recovered, as well as bone tools.

The intact human burials include one primary burial, five secondary interments, and two whose methods of burial were uncertain (McGimsey 2001:30). The secondary burials appear to have been arranged in approximate anatomical position. Nearly all burials were flexed, and orientation, when determinable, was varied. McGimsey (2001:36) notes that the density of graves is exceptionally high, with approximately one grave to every five square meters. A detailed skeletal analysis was undertaken by R. Christopher Goodwin and Associates for the Chitimacha Tribe.

The Henderson Lake site has deep, intact shell midden deposits, as well as human burials. It is considered potentially eligible for the National Register of Historic Places, but the site limits could not be determined due the constraints of time and the rising waters of Henderson Lake. It was recommended that these limits be determined when the lake is drawn down again so that a definitive pronouncement of National Register eligibility can be made (LDA Site Form; McGimsey and Heller 2001:29).

CHAPTER 3

A BRIEF BACKGROUND TO THE GEOARCHAEOLOGY OF THE INDIAN BAYOU NORTH PROJECT AREA

Paul V. Heinrich

Introduction

As noted in Chapter 1, ESI has produced much of the background information on the two project areas for the current study, including a review of previous archaeological investigations, regional cultural history, and summaries of the history and geology of the region. The following section is not intended to duplicate this effort, but rather add information more specific to the geoarchaeological history of the region. Specifically, this section provides background relevant to the formation of ancient and modern channels and events that have effected sedimentation rates in the area.

Background

The northern part of the Indian Bayou project area consists largely of (1) the coalesced natural levees of the Atchafalaya River and crevasse splays of Bayou Courtableau and (2) the edges of adjacent backswamp. The highest part of the project area, over 7.6 m (25 ft) to more than 9 m (30 ft) in elevation (NGVD) in a few places, lies along the west bank of the Atchafalaya River. The natural levees drop in elevation over a distance of about 2.6 km (1.6 mi) to less than 4.6 m (15 ft) in elevation within the adjacent backswamp. The crevasse splays along Bayou Courtableau are highest adjacent to its southwest bank, with elevations over 7.6 km (25 ft). They drop in elevation southwestward into the adjacent backswamp over a distance of about 3.5 km (2.2 mi) to an elevation just below 4.6 m (15 ft). The most prominent crevasse splay, containing Big Offa Bayou as its main channel, extends about 5.6 km (3.5 mi) into adjacent backswamp.

The current project area lies within an elongated, shallow depression, known as the "Atchafalaya Basin," within the Mississippi Alluvial Valley. The basin is approximately 175 km (109 miles) long, north-northwest to southeast, and has a maximum width of 55 km (34 miles) at about the latitude of Baton Rouge. It is bounded on the west by the Teche Ridge, an alluvial rise created between 5,800 and 3,500 years ago by an abandoned course of the Mississippi River. The eastern edge of the Atchafalaya Basin consists of the natural levees and meander belt of the currently active course of the Mississippi River. This course has been present in the area for the past 3,500 years. Thus, for more than 5,800 years, that part of the Atchafalaya Basin in which the project area lies has been a flood basin, receiving floodwaters and sediments from Mississippi River meander belts situated to the west (the Teche course) and, later, to the east (the modern course) by way of several major distributaries.

The Atchafalaya River, until intersected by the meandering of the modern Mississippi River, was a minor river that internally drained floodwaters dumped into the upper Atchafalaya Basin, channeling the water southward into the lower Atchafalaya Basin. The first detailed geological accounts of the Atchafalaya River come from the nineteenth century. They describe a minor, internal backswamp drainage completely choked by a series of log rafts and utterly impossible to navigate. Collectively called the "Atchafalaya River Raft," these rafts consisted of log jams extending some 64 km (40 mi) southward along the river from a starting about 48 km (30 mi) downstream of the river's junction with Old River (located at the cutoff channel of Turnbull Bend of Mississippi River). The aggregate length of individual rafts within this stretch of river was reported to have been 16 km (10 mi), with the longest section extending about 5 km (3 mi) and shortest section about 274 m (900 ft). The rafts consisted of a jumbled, tangled mass of limbs, tree trunks, and other assorted debris. The trees, however, were relatively small, as the maximum reported diameter of the their trunks was only 15 cm (6 in). Most of the debris consisted of material transported into the channel of the Atchafalaya River by inflow from the Mississippi River (Fisk 1952; Ruess 1998).

The actual age of the Atchafalaya River Raft is unknown. Ruess (1998) suggested that it might have formed as early as the sixteenth century and noted that local nineteenth-century geographers and other natives of Louisiana indicated that it may have formed as late as the late eighteenth century. Unfortunately, Ruess (1998) does not discuss what evidence, if any, upon which these estimates were based.

In 1831, Shreve's Cutoff was excavated across the neck of the Turnbull Bend of the Mississippi River to form what is now known as "Old River." The Red River flowed into the upper cutbank of former Turnbull Bend about 3.2 to 9.6 km (92 to 3 mi) upstream of where the head of the Atchafalaya River joins it. As a result of this cutoff, the Red River flowed along a short stretch of the Old River and into the Atchafalaya River without merging with the active channel of the Mississippi River. In short time, Old River became choked with an extension of the Atchafalaya River Raft. This resulted in a further clogging of the Atchafalaya River and diminishment of flow down it (Fisk 1952; Ruess 1998).

It was in 1838 that the proposals and studies about removing the Atchafalaya River Raft were first made. Because of financial constraints and politics of the day, as discussed in detail by Ruess (1998), these plans were not funded and the clearing of the raft was left to the state government of Louisiana. However, in 1839, during a period of drought and resulting extreme low water within the Atchafalaya River, local residents set fire to the raft in an attempt to remove it. This fire burned off the portion of this raft lying above water level and reportedly roasted thousands of alligators. However, the vast bulk of the Atchafalaya River Raft lying below water level was left untouched (Fisk 1952; Ruess 1998).

By 1840, funding for removal of the Atchafalaya River Raft had been approved, and several attempts were made to clear the obstruction between 1840 and 1860. From 1840 until April 1842, steamers converted to snag boats created a narrow channel through the raft. This clearing failed to created a permanent channel, however, and by 1847 additional debris transported into the Atchafalaya River had blocked this channel from 3.2 km (2 mi) above Pigeon Bayou to within 11 km (7 mi) south of the river's junction with Old River. After 1847, the Atchafalaya River Raft again was broken up from year to year. Finally, in 1858 the snag boat *Atchafalaya* went to work clearing the raft, and by 1860 the obstruction had been completely removed. Of note is the fact that, even before complete removal of Atchafalaya

River Raft, the Atchafalaya River had become a significant distributary of the Mississippi River with increasing inflow. After 1851, rapid enlargement of the Atchafalaya River occurred within its upper reaches. This process involved the deepening of the river's bed and heavy caving along its bends and narrow reaches (Mississippi River Commission 1881; Fisk 1952; Ruess 1998).

As the width of the Atchafalaya River increased and sediment accumulated within the downstream portion of the Atchafalaya Basin, the frequency and height of flooding rapidly increased along the upper reaches of the Atchafalaya River. Land not previously susceptible to flooding became subject to annual floods of increasing severity and the region was abandoned by all save local hunters and raftsmen. As illustrated by Ruess (1998), the increasing frequency of flooding resulted in the construction of artificial levees, starting in 1881 along the east and west banks of the Atchafalaya River downstream from its junction with Old River. By 1927, the artificial levees had been built as far south as River Mile 51.1 along the east bank and River Mile 46.5 along the west bank. By 1952, the artificial levees had been extended as far south as River Mile 52 on the east bank and River Mile 68 on the west bank. It was during this time that Bayou Courtableau was cut off from the Atchafalaya River (Mississippi River Commission 1881; Fisk 1952; Ruess 1998).

The removal of the Atchafalaya River Raft and resulting enlargement of its channel also resulted in the increased diversion of the flow from the Red River down the Atchafalaya River. By 1883, because of channel enlargement due to Shreve's Cutoff on the Mississippi River (which resulted in an eastward migration of the Mississippi), the Red and Atchafalaya rivers existed almost as a separate river system. In fact, during low stages of the Mississippi River, most of the flow in the Atchafalaya River came from the Red River. In 1891, a sill was built across the mouth of the Atchafalaya River at its junction with Old River, with the intention of diverting the flow of the Red River into the Mississippi River during low-water stages on the Red. This sill was poorly maintained and abandoned in 1896. However, during major Mississippi River floods, substantial volumes of flow surged through the lower segment of the Old River and into the Atchafalaya River. Such floods posed the threat of washing out lower Old River and diverting the Mississippi River into the Atchafalaya River (Fisk 1952; Ruess 1998).

By 1891, the lower segment of Old River was the principle navigation route as the upper segment of Old River was filling with sediment; it became completely filled by 1896. The lower segment was annually dredged, as needed, until 1937. By 1940, dredging of the Old River was a practice of the past as increased diversion of water down the Atchafalaya River from the Mississippi River widened and deepened the Atchafalaya's channel. From 1882 to 1942, the inflow of water from the Old River into the Mississippi River occurred on an average of 50 days a year. Between 1942 and 1950, this occurred on the average of only nine days a year. Eventually, flow from the Mississippi River into the Atchafalaya River increased rapidly and consistently to the point that a low-sill control structure on Old River was constructed in 1960 to prevent the diversion of the Mississippi River down the Atchafalaya River (Ruess 1998).

CHAPTER 4

AUGER BORINGS

Richard A. Weinstein

One of the primary investigative methods employed during the first phase of fieldwork consisted of the retrieval of 19 auger borings from selected locations within the project area (Figure 4-1). Basically, the borings were placed adjacent to recognizable distributary channels in an effort to: (1) determine that location's potential for later use as a coring locale, (2) identify the thickness of natural-levee deposits in that area, (3) determine whether backswamp deposits were accessible below the natural-levee deposits, and (4) acquire organic samples suitable for radiocarbon dating. The latter would serve as supplements to similar samples collected later during the coring program, to be described in detail later.

The initial set of auger borings was placed along the main east-west road running through the project area, at points where the road crossed selected distributary channels. In most instances (Augers A1, A3 through A8, A10, and A12), the borings were positioned just beyond the edge of the channel, atop what was considered to be the highest point of the channel's associated natural levee (see Figure 4-1). In two cases (A2 and A8), borings also were placed slightly towards the backslope of the natural-levee deposit in the hope of locating underlying backswamp deposits at shallower depths. Finally, one additional boring (A11) was positioned roughly midway between Augers A10 and A12 to acquire data that could be used to develop a full-length cross section through the project area.

A second set of auger borings was positioned adjacent to several of the same distributary channels on private property to the north of the project area. These were designed to provide information on associated natural-levee deposits at the proximal ends of the channels, near the points where they emanated from Bayou Courtableau, and this

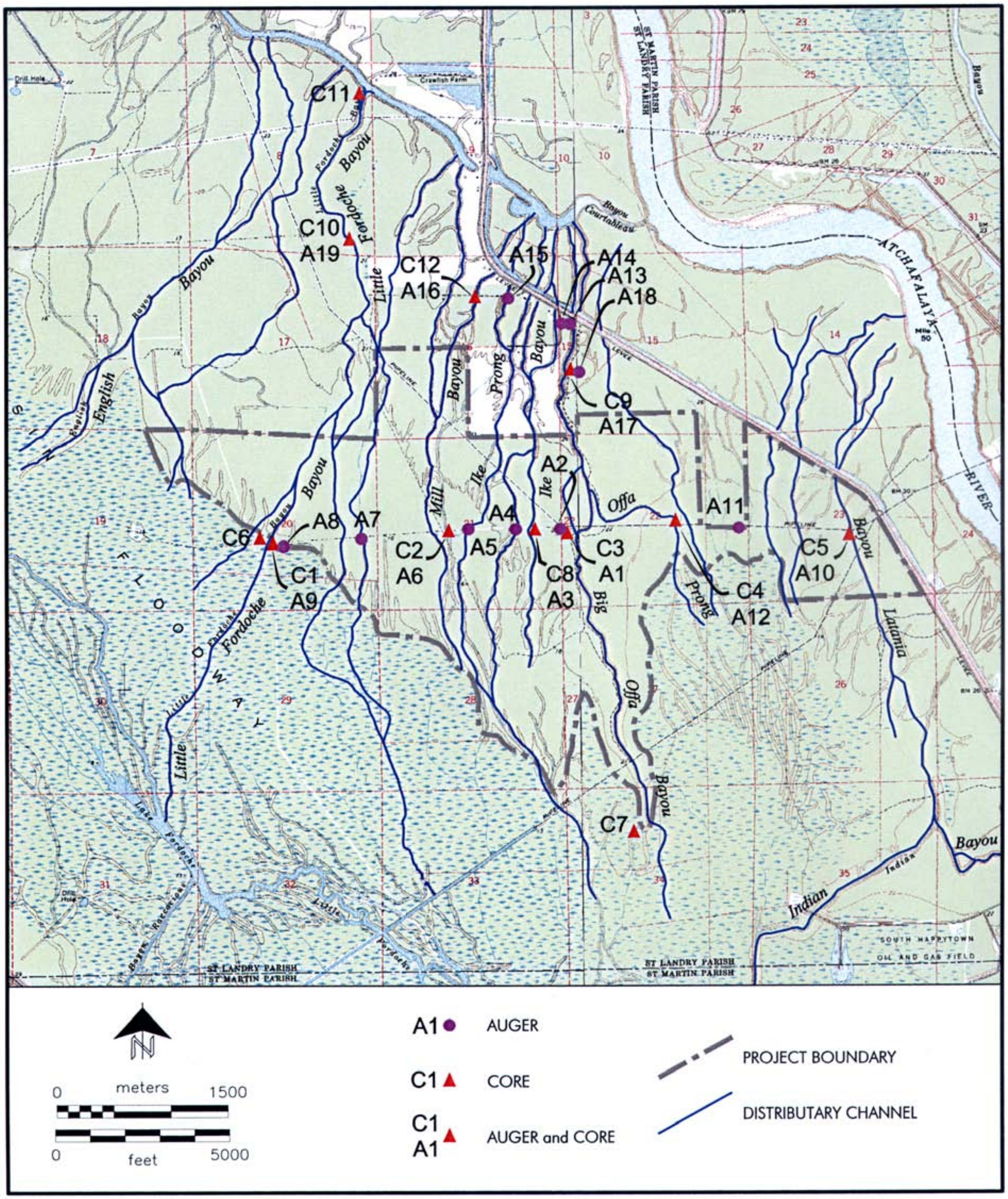

Figure 4-1. **Locations of auger borings and solid cores within the Indian Bayou North project area. The most recent courses of most obvious channels passing through the area are illustrated, along with the local names for many of them (USGS 1969, 1970).**

information then could be compared to the data acquired from the initial set of borings located farther down the respective distributaries. Once again, most of the borings (A13 through A17, and A19) were positioned immediately adjacent to the selected channel atop what was estimated to be the highest point of the associated natural levee (see Figure 4-1). One boring (A18) was located slightly away from the channel on what was thought to be a lower portion of the associated natural levee.

All of the auger borings were drilled with a 3/4-inch screw-bit auger that could collect 30-cm-long samples of soil within its bit (Figure 4-2). However, due to the compact and tenacious nature of much of the soil in the area, the augering crew resorted to 15-cm-long samples that could be pulled from the ground without destroying the crew's backs. Thus, for each boring, multiple 15-cm-long samples were required and the data from each were combined to form the results of a single auger boring. All stratigraphic information was recorded on separate auger forms, including soil type and consistency, soil color, and the presence or absence of oxidation, mottling, and possible inclusions.

Since the main aim of this part of fieldwork was to gather data related to specific distributary channels, each channel and its associated borings will be discussed separately, moving from east to west across the project area. Also, since many of these channels have been given names by residents who reside near the project area (names that do not appear on USGS quadrangle maps), a channel's local name will be utilized, if known. Specific channels will be reviewed from east to west across the project area.

Bayou Latania
(Auger A10)

The easternmost channel selected for augering was the Bayou Latania distributary located in Section 23. Unlike all other channels chosen for investigation, this channel does not appear to emanate from Bayou Courtableau. Instead, it probably represents a distributary off the modern Atchafalaya River. As such, it may be significantly younger than most of the other channels in the project area. It is not illustrated on any of the available maps dating to

Figure 4-2. Field crew drilling the auger boring at Auger A10 along the western natural levee of the Bayou Latania channel. View to the east-northeast. Date: 8/29/03.

the 1800s (i.e., Newcomb 1842; Abbot 1863). In fact, its earliest appearance occurs on the 1935 Osca Bayou, La., 15-minute quadrangle (USACE 1935) where it is shown as a prominent crevasse channel extending from the Atchafalaya River in Section 14 southward to a point in the extreme western part of Section 36 where it intersects with Indian Bayou (Figure 4-3). Although not likely to be old enough to have supported prehistoric archaeological sites, this channel was included in the overall augering scheme as an example of a relatively recent feature whose natural levees hopefully could be distinguished from the levees of the older distributaries.

Table 4-1 provides the results of Auger A10, drilled adjacent to the western edge of the Bayou Latania channel, while Figure 4-4 provides an illustration of the boring's stratigraphy. The upper 30 cm consisted of a recent plow zone represented by a layer of dark grayish brown (10YR 4/2) silty sand. This was underlain by alternating bands of pale brown (10YR 6/3) and brown (10YR 4/3 and 5/3) sand, clay, silt, and slightly sandy silty clay that most likely represent channel-fill deposits extending down to a depth of –3.5 m. From that point downward, the auger encountered dark grayish brown (10YR 4/2) and dark gray (10YR 4/1) silty clays that extended to the base of the boring at –4.25 m. These may also represent channel-fill deposits, although it was thought possible that they might indicate original backswamp deposits that predated the Bayou Latania channel. Presumably, data from the coring program would help resolve this question.

Between Bayou Latania and Offa Prong (Auger A11)

This auger boring was placed down about midway between the borings at A10 (at Bayou Latania) and A12 (at Offa Prong, to be discussed next). It was designed to fill in the gap between those two borings in order to better produce a cross sectional profile through the project area. Although several minor channels emanating from the modern Atchafalaya River passed through the area, none was specifically associated with the boring. Nevertheless, it was considered likely that A11 would sample only fairly recent natural-levee deposits.

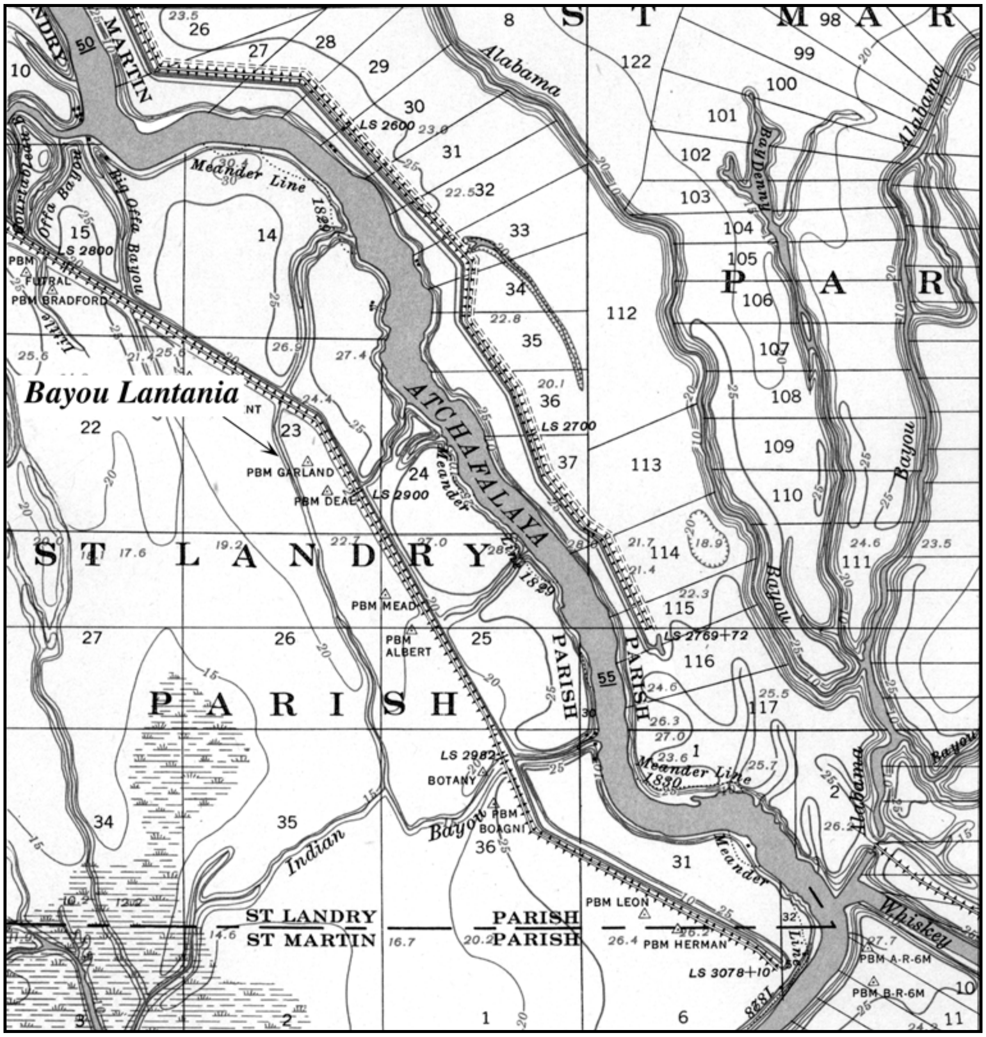

Figure 4-3. Portion of the 1935 Osca, Louisiana, 15-minute quadrangle, showing the earliest identifiable course of the Latania Bayou channel within the eastern portion of the current project area (after U.S. Army Corps of Engineers 1935).

Table 4-1. Data Relative to Auger Boring A10.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 622402 Easting 3367016	0-30 cm	10YR 4/2	Dark grayish brown	Silty sand	None	Plow zone
	30-55 cm	10YR 6/3	Pale brown	Slightly silty sand	None	None
	55-100 cm	10YR 4/3	Brown	Soft silty clay	None	None
	100-150 cm	10YR 5/3	Brown	Sandy silt	None	None
	150-350 cm	10YR 4/1	Dark gray	Very slightly sandy silty clay (soft)	None	None
	350-385 cm	10YR 4/2	Dark grayish brown	Silty clay	None	None
	385-425+ cm	10YR 4/1	Dark gray	Silty clay	Organic materials at 410 cm.	None

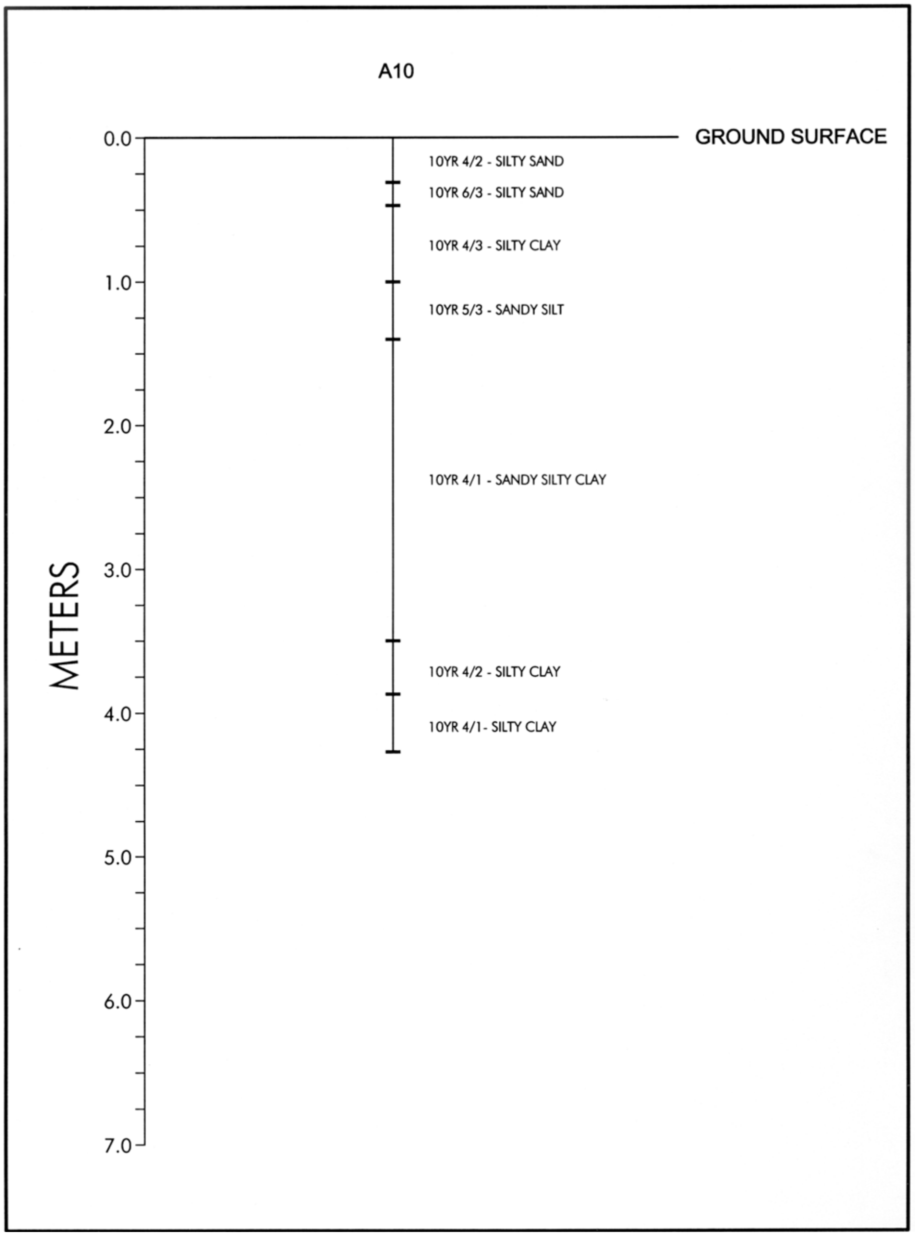

Figure 4-4. Stratigraphic profile of Auger A10.

Table 4-2 lists the stratigraphic data acquired from the boring, while Figure 4-5 shows these data graphically. As can be seen, the auger penetrated silts and dark gray, slightly silty clays to –3.15 m. These most likely represent natural-levee or crevasse splay deposits. Below the natural-levee material, the auger hit probable backswamp clays that extended to the base of the boring at –4.1 m.

Offa Prong
(Auger A12)

Although this channel is not named on any of the quadrangle maps examined for the present project, local informants noted that it is called "Offa Prong" or "Bioche Prong," having derived its name from the main channel off of which it branches. This main channel (to be discussed next) represents the most prominent distributary in the project area and is known to local residents either as "Big Offa Bayou" or "Bioche."

Offa Prong most likely represents one of the oldest channels in the project area, as it is shown on the 1842 plat map of Township 7 South, Range 7 East (Newcomb 1842) (Figure 4-6). This map was based on a boundary and section-line survey conducted in 1807 (McLester 1807) and a channel survey conducted in 1829 (Newcomb 1842). It is interesting to note that the southern portion of today's main distributary channel (Big Offa Bayou) is not shown on the 1842 plat map, although it almost certainly was present. Rather, the map only shows the northern part of Big Offa Bayou and Offa Prong winding through Sections 15, 16, and 22, having left Bayou Courtableau in the southeastern corner of Section 9.[1] Since both Big Offa Bayou and Offa Prong were considered to be two of the best candidates for early distributaries in the area, they were subjected to six of the project's 19 auger borings. Only one of these (A12), however, was located adjacent to Offa Prong proper (see Figure 4-1).

[1] It also is interesting to note that the 1935 Osca Bayou, La., quadrangle illustrates Big Offa Bayou (and Little Offa Bayou, as well) as channels emanating from Bayou Courtableau to the east of today's Big Offa channel. To confuse matters more, today's Big Offa channel is identified as "Courtableau Bayou" on the 1935 quadrangle. Regardless of how these channels were named in the 1930s, the present study will identify them by the names currently used by the local residents of the area.

Table 4-2. Data Relative to Auger Boring A11.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 621449 Easting 3367021	0-20 cm	10YR 4/3	Brown	Silt	None	None
	20-50 cm	7.5YR 4/3	Brown	Slightly silty clay	None	Some oxidation
	50-170 cm	7.5YR 4/2 mottled with 10YR 5/1	Brown mottled with gray	Slightly silty clay	Concretions	None
	170-315 cm	10YR 4/1	Dark gray	Slightly silty clay	Organic material at 220 cm.	None
	315-340 cm	5BG 4/1	Dark greenish gray	Very slightly silty clay	None	None
	340-360 cm	7.5YR 4/2	Brown	Clay (stiff)	None	None
	360-410+ cm	10YR 4/1	Dark gray	Slightly silty clay (stiff)	None	None

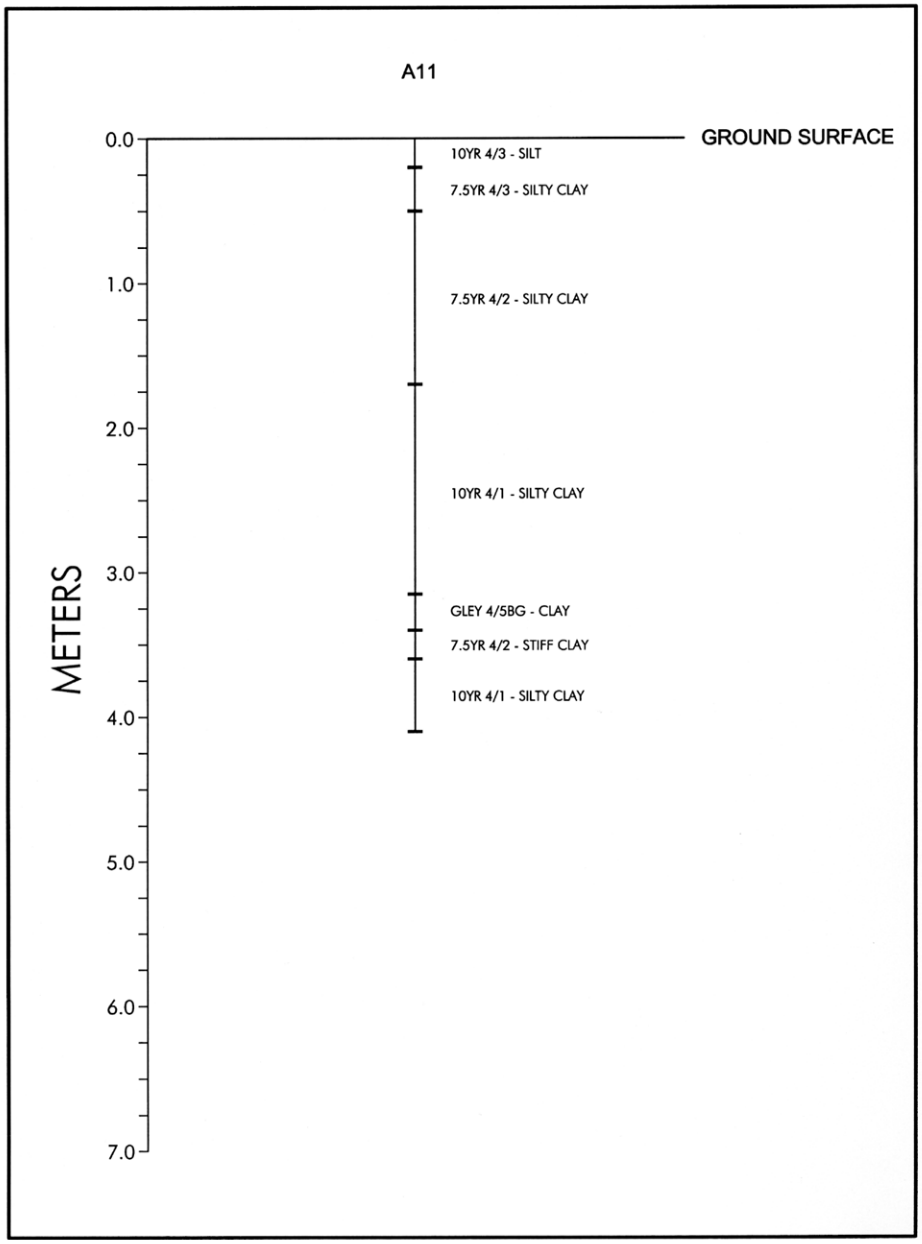

Figure 4-5. Stratigraphic profile of Auger A11.

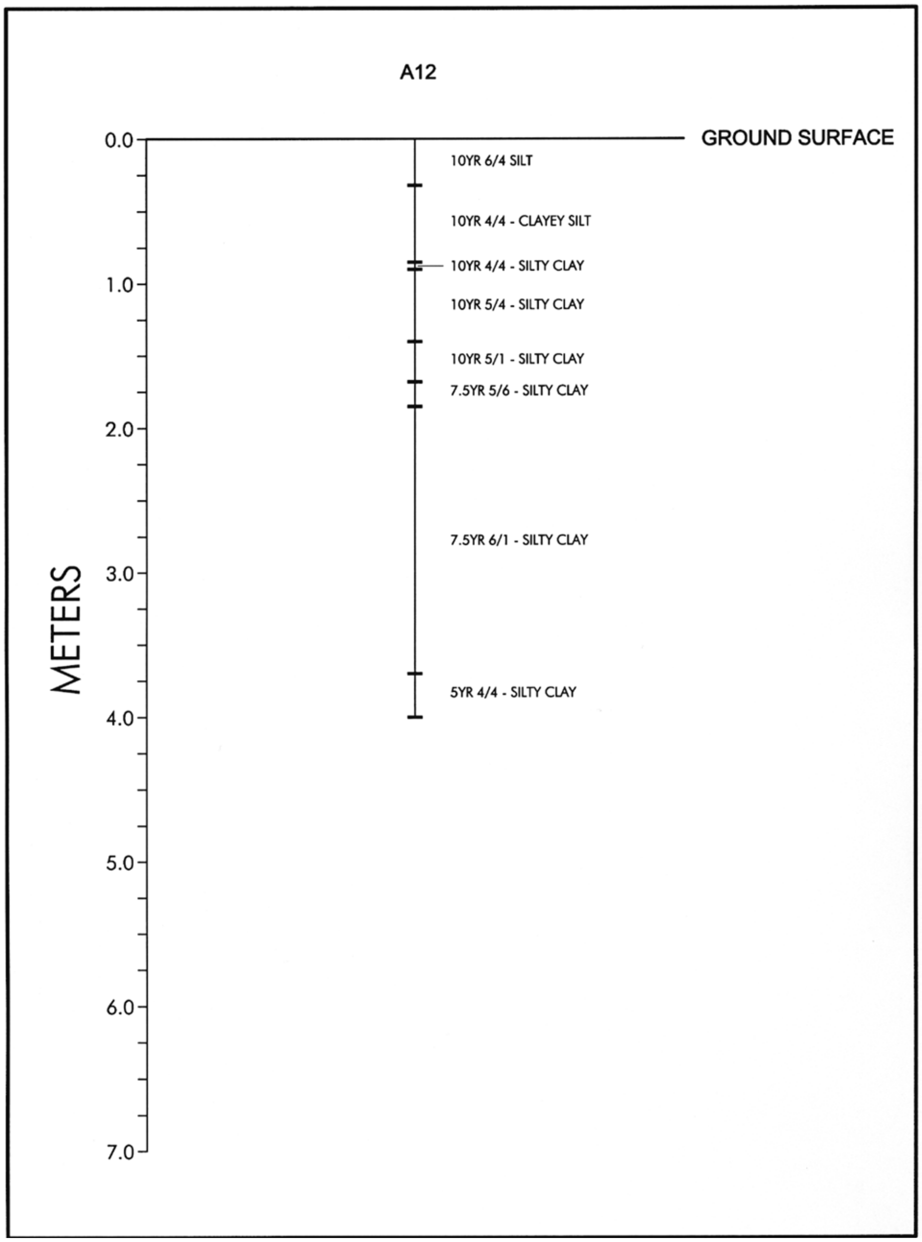

Figure 4-6. Stratigraphic profile of Auger A12.

Table 4-3 provides the results of the boring drilled at A12. Again, the upper 32 cm of the sequence consisted of a light yellowish brown (10YR 6/4) silty plow zone. This overlay a natural-levee deposit of dark yellowish brown (10YR 4/4) clayey silt, that, in turn, rested upon dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/4), and gray (10YR 5/1) layers of silty clay that together extended to –1.68 m. It is likely that these latter layers form the lower section of Offa Prong's natural levee. Interestingly, the next three strata, extending from –1.68 m to at least –4.0 m, consisted of bands of silty clays with strong brown or reddish-hued colors (7.5YR 5/6 and 6/1, and 5Y 4/4), all suggestive of a Red River origin. Whether these clays represent pre-Offa Prong backswamp deposits, or simply clayey layers within the overall sequence of the channel's natural levee was unknown at the time the auger was drilled. Again, it was envisioned that the subsequent core data would provide the detailed information needed to help identify the true nature of the deposits.

Big Offa Bayou
(Augers A1, A2, A13, A17, and A18)

Three auger borings (A1, A13, and A17) were placed adjacent to the Big Offa channel, while two other borings (A2 and A18) were positioned on the backslope of the channel's natural levee, slightly to the west and east, respectively, of the channel proper. One other boring (A14) also was located slightly to the west of the channel in a similar backslope position. However, due to the presence of one of the minor braided channels in that area (which appears to be part of the Ike Bayou system), it actually was closer to that channel than to Big Offa Bayou. For that reason, it will be discussed below in relation to that waterway.

Big Offa Bayou is the most prominent distributary channel still visible in the project area today. As discussed above, it most likely represents one of the earliest channels, as its upper portion is shown on the 1842 plat map (Newcomb 1842). It also is clear from the 1807 survey notes upon which the plat is based, that the channel's lower portion must have been present as well, although, for some unknown reason, that part of the distributary is not illustrated on the plat map.

Table 4-3. Data Relative to Auger Boring A12.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 620888 Easting 3367066	0-32 cm	10YR 6/4	Light yellowish brown	Silt	None	Plow zone
	32-85 cm	10YR 4/4	Dark yellowish brown	Clayey silt	None	Turning to a 10YR 3/4 with depth
	85-90 cm	10YR 4/4	Dark yellowish brown	Silty clay	None	Some oxidation
	90-140 cm	10YR 5/4	Yellowish brown	Silty clay	None	None
	140-168 cm	10YR 5/1	Gray	Silty clay	None	None
	168-185 cm	7.5YR 5/6	Strong brown	Silty clay	None	None
	185-370 cm	7.5YR 6/1	Gray	Silty clay	None	Becoming darker with depth, turning to N5 5/. Some oxidation.
	370-400+ cm	5Y 4/4	Reddish brown	Silty clay	None	None

Tables 4-4 through 4-8 provide information on the five borings associated with Big Offa, while Figures 4-7 through 4-11 illustrate the stratigraphy of the borings. As can be seen, the stratigraphy revealed by Auger A1 (see Table 4-4), situated along the lower part of the channel, shows a natural-levee deposit extending from the surface to at least –2.1 m. It consists of six separate layers of dark gray (10YR 4/1) to yellowish brown (10YR 5/4) clayey silts, silty sands, silty clays, and clayey sands. The natural levee likely extends to –2.54 m, as evidenced by the next three strata of dark gray (10YR 4/1) to brown (7.5YR 4/4) sandy and silty clays and clayey sand. Possible backswamp deposits may have been encountered in the next three strata, extending from –2.54 to at least –3.14 m, although they just as easily could represent deeper natural-levee material. All consist of dark gray (10YR 4/1) to gray (10YR 5/1) silty clays that are mottled with brown (7.5YR 4/3 and 4/4) slightly sandy clay. The latter mottling probably reflects influence from the Red River. It will be necessary for the coring data to help decipher the true nature of these deeper deposits.

The stratigraphy of the two borings (A13 and A17) located near the proximal end of the distributary has been presented in Tables 4-6 and 4-7 and Figures 4-9 and 4-10. The northernmost of the two (A13) appears to have penetrated only channel-fill deposits to a depth of 6.1 m, as all but one strata consist of silts or sands. The lone exception is the brown (7.5YR 5/3) sandy clay layer situated between –1.15 and –1.5 m. Since it is encapsulated between obvious channel-fill deposits, however, it must represent a period of slightly less discharge within the overall channel-fill sequence.

Auger A17, situated only a few hundred meters south of A13, provides a similar stratigraphic picture (see Table 4-7 and Figure 4-10). Obvious channel-fill deposits are represented by the upper six strata, extending from the surface to –2.6 m. What may be backswamp deposits were encountered at –2.6 m and extended down to at least –4.05 m. These may, however, represent nothing more than deeper channel-fill deposits, and it will be left for the core data to determine the proper interpretation.

The two augers on the fringes of the Big Offa natural levee provide stratigraphic profiles similar to their sister borings located nearer the channel. Auger A2 (see Table 4-5

Table 4-4. Data Relative to Auger Boring A1.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 619936 Easting 3366966	0-75 cm	10YR 5/4	Yellowish brown	Slightly clayey silt	None	None
	75-82 cm	10YR 4/3	Brown	Clayey silt	None	None
	82-160 cm	10YR 4/2	Dark grayish brown	Slightly clayey sandy silt	None	Becoming darker with depth
	160-180 cm	10YR 4/1	Dark gray	Clayey silt	None	None
	180-192 cm	10YR 4/1	Dark gray	Silty clay	None	None
	192-210 cm	10YR 5/4	Yellowish brown	Silty sand	None	Very wet
	210-234 cm	10YR 4/1	Dark gray	Sandy clay	None	Saturated
	234-239 cm	7.5YR 4/4 mottled with 10YR 4/1	Brown mottled with dark gray	Silty clay	None	Saturated
	239-254 cm	GLEY N5/	Gray	Clayey sand	None	None
	254-284 cm	10YR 4/1 mottled with 7.5YR 4/4	Dark gray mottled with brown	Silty clay mottled with stiff slightly sandy clay	Small fragments of organic material at 254 cm; a few small concretions	None
	284-296 cm	10YR4/2 mottled with 7.5YR 4/3	Dark grayish brown mottled with brown	Silty clay mottled with slightly sandy clay	None	Very saturated
	296-314+ cm	10YR 5/1 mottled with 7.5YR 4/3	Gray mottled with brown	Slightly sandy silty clay	None	None

Table 4-5. Data Relative to Auger Boring A2.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 619875 Easting 3367015	0-20 cm	10YR 5/4	Yellowish brown	Slightly clayey silt	None	None
	20-50 cm	10YR 5/3 mottled with 10YR 6/3	Brown mottled with pale brown	Slightly sandy clayey silt	None	Slight oxidation
	50-60 cm	10YR 5/3 mottled with 10YR 6/2	Brown mottled with light brownish gray	Slightly sandy clay	None	None
	60-65 cm	10YR 5/4	Yellowish brown	Slightly sandy silty clay	Organic material	Heavy oxidation
	65-170 cm	10YR5/1	Gray	Slightly silty sandy clay	None	Becomes more saturated at 145 cm
	170-220 cm	10YR 5/3 becoming 10YR 5/2	Brown becoming grayish brown	Slightly silty sandy clay	None	None
	220-250 cm	GLEY N5/	Gray	Slightly silty sandy clay	Small fragments of organic material at 220 cm	Continues to 250 cm
	250-260 cm	7.5YR 4/3	Brown	Slightly silty sandy clay	None	Saturated
	260-300+	5Y 5/1	Gray	Slightly silty sandy clay	None	Super-saturated

Table 4-6. Data Relative to Auger Boring A13.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 619962 Easting 3368829	0-20 cm	10YR 5/3	Brown	Silt	None	None
	20-115 cm	10YR 6/3 mottled with 10YR 4/3	Pale brown mottled with brown	Slightly silty sand	None	More silty, less sand from 65-85 cm
	115-150 cm	7.5YR 5/3	Brown	Slightly silty sandy clay	None	None
	150-170 cm	10YR 5/3 mottled with 7.5YR 5/3	Brown mottled with brown	Silty sand	None	Becoming wet
	170-195 cm	10YR 4/4	Dark yellowish brown	Clayey silt	None	None
	195-217 cm	10YR 5/1	Gray	Sand	None	Saturated
	217-610+ cm	10YR 4/1	Dark gray	Slightly silty sand	Organic material at 590 cm	Becomes stiffer at 270 cm

Table 4-7. Data Relative to Auger Boring A17.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 619966 Easting 3368415	0-10 cm	10YR 3/2	Very dark grayish brown	Sandy silt	None	None
	10-30 cm	10YR 4/4	Dark yellowish brown	Silty sand	None	None
	30-70 cm	10YR 6/4	Light yellowish brown	Sand	None	None
	70-130 cm	10YR 5/3	Brown	Silty sand	None	Soil is siltier and stiffer at 110 cm. Mottled with 7.5YR 4/5 at 120 cm.
	130-230 cm	10YR 5/4	Yellowish brown	Slightly sandy silty clay	Organic material at 210 cm	Oxidation at 175 cm
	230-260 cm	10YR 5/2	Grayish brown	Silty sandy clay	None	Oxidation
	260-330 cm	10YR 5/1	Gray	Very silty clay (stiff)	None	Becoming increasingly wetter with depth.
	330-405+ cm	GLEY 4/N	Dark gray	Sandy silty clay	None	Saturated

Table 4-8. Data Relative to Auger Boring A18.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 620042 Easting 3368405	0-42 cm	7.5YR 5/4	Brown	Silt	None	Recent root mat
	42-69 cm	10YR 6/4	Light yellowish brown	Sandy silt	None	Becomes sandier with depth.
	69-144 cm	10YR 5/4	Yellowish brown	Silt to sand	None	Becomes sandier with depth. Sand at 112 cm.
	144-154 cm	10YR 4/6	Dark yellowish brown	Clayey silt	None	None
	154-168 cm	10YR 5/6	Yellowish brown	Silt	None	None
	168-185 cm	10YR 5/6	Yellowish brown	Slightly clayey silt	None	None
	185-234 cm	10YR 5/2	Grayish brown	Clayey silt	None	None
	234-264 cm	GLEY N5/	Gray	Clayey silt	None	None
	264-299 cm	10YR 4/3	Brown	Silty clay	None	Color gradually becomes 10YR 4/1 with depth.
	299-310 cm	10YR 4/1	Dark gray	Clayey silt	None	None
	310-315 cm	10YR 4/1	Dark gray	Silty clay	None	None
	315-350+ cm	10YR 4/1	Dark gray	Clayey silt	None	None

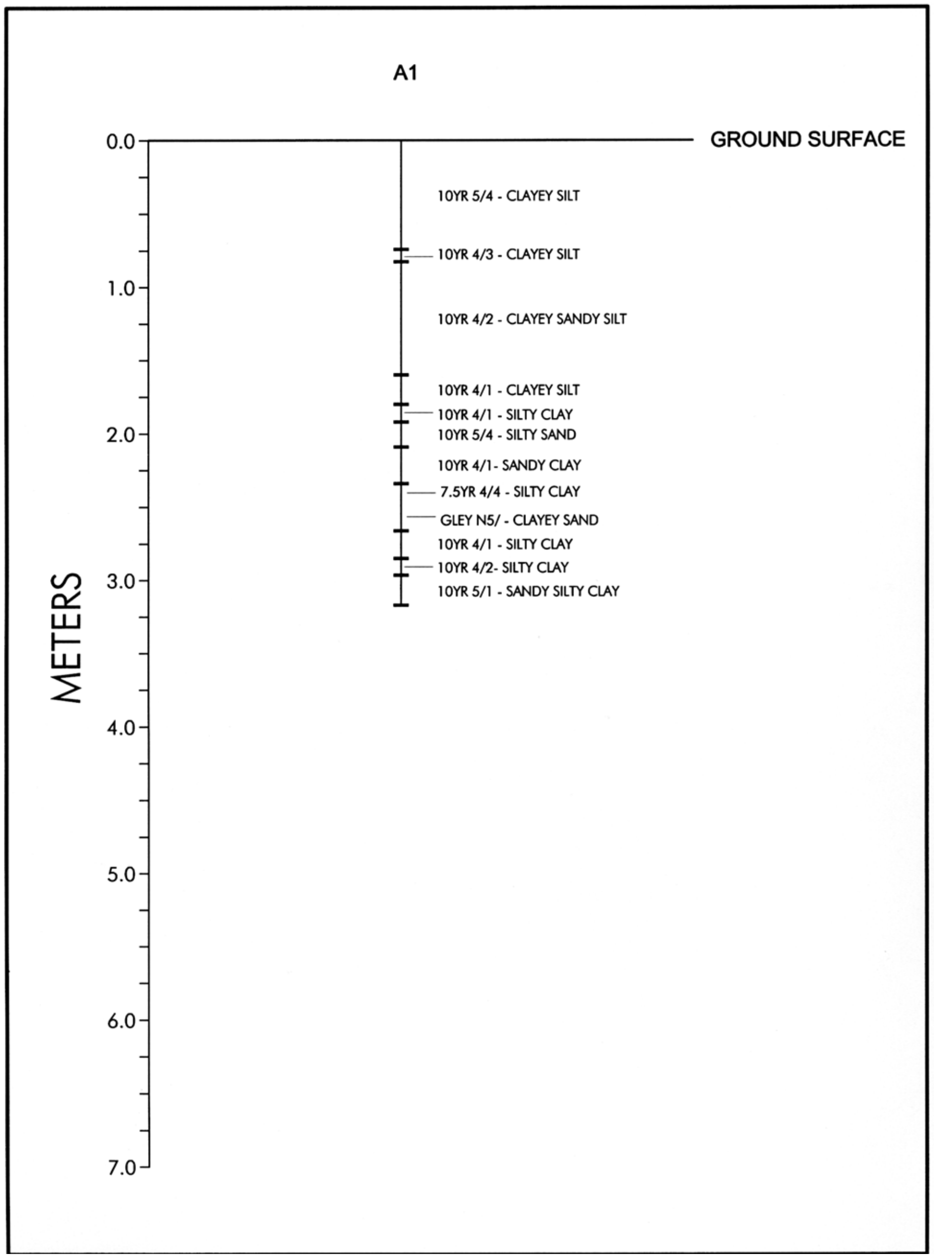

Figure 4-7. Stratigraphic profile of Auger A1.

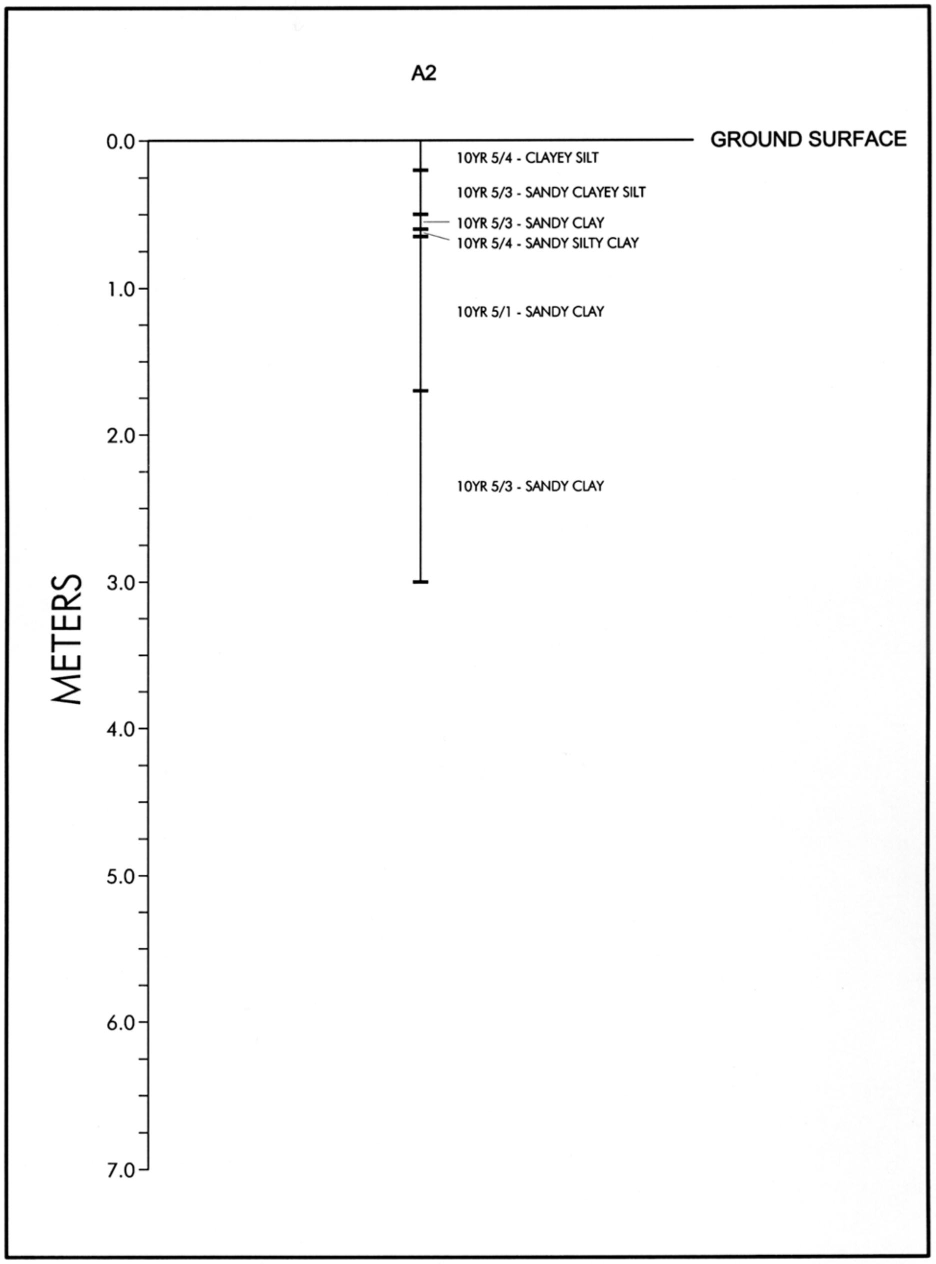

Figure 4-8. Stratigraphic profile of Auger A2.

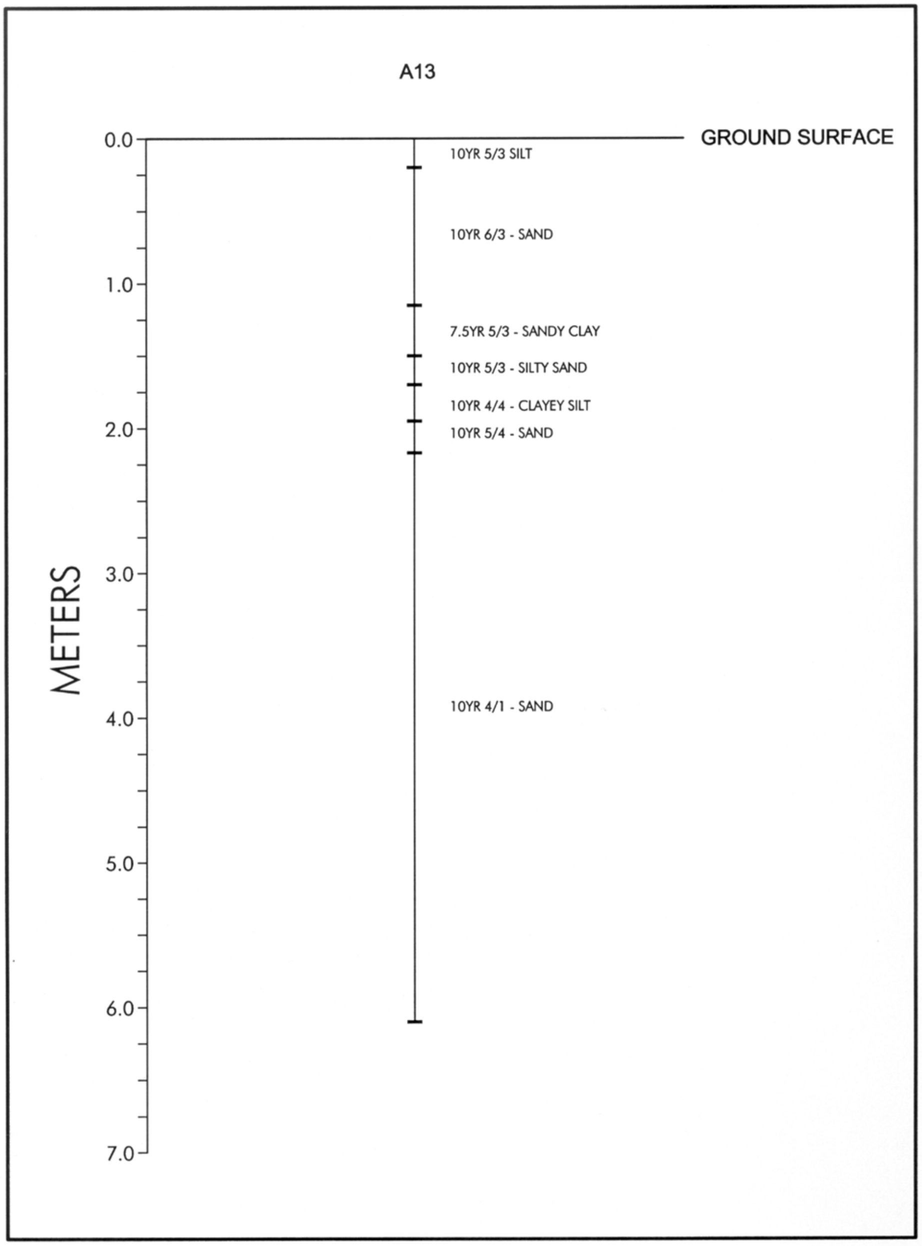

Figure 4-9. Stratigraphic profile of Auger A13.

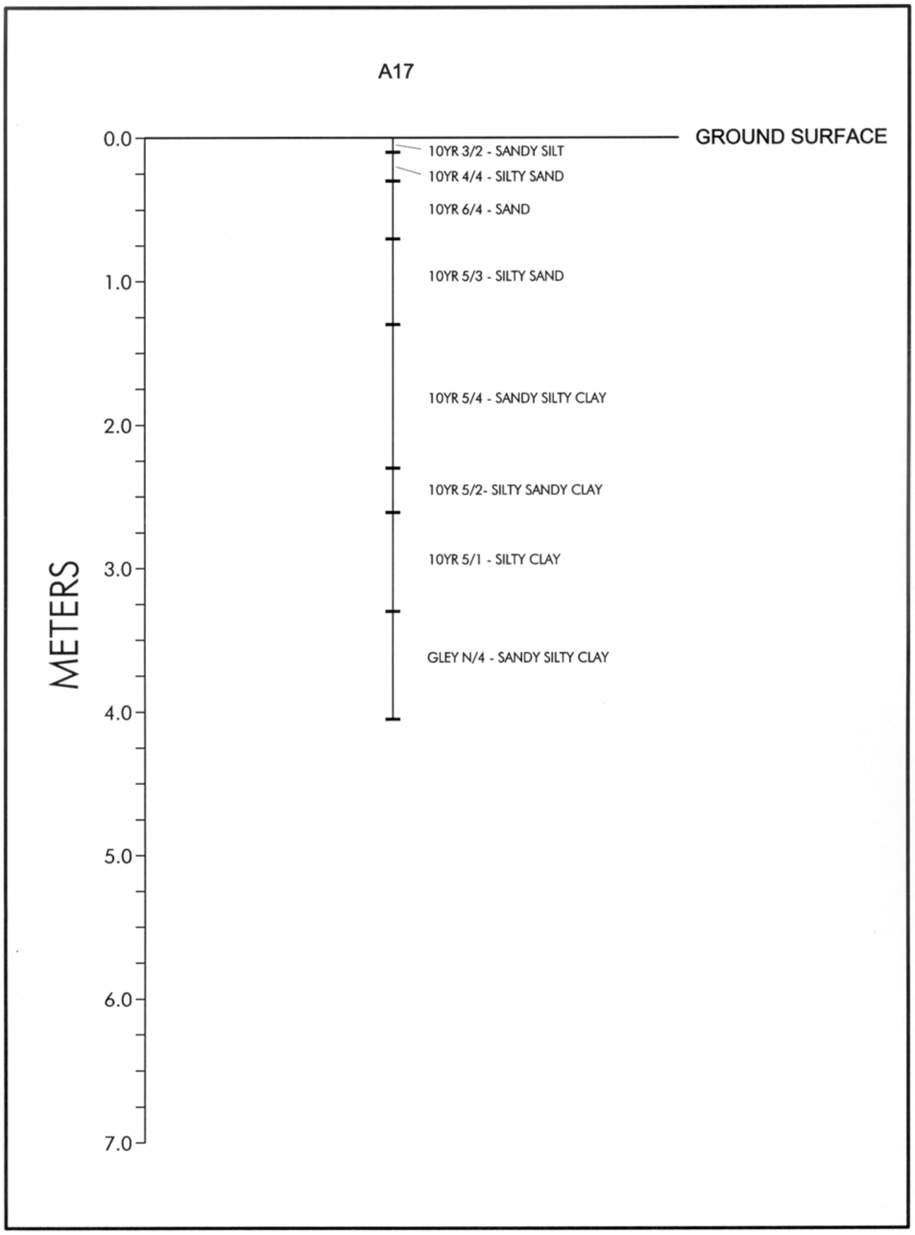

Figure 4-10. Stratigraphic profile of Auger A17.

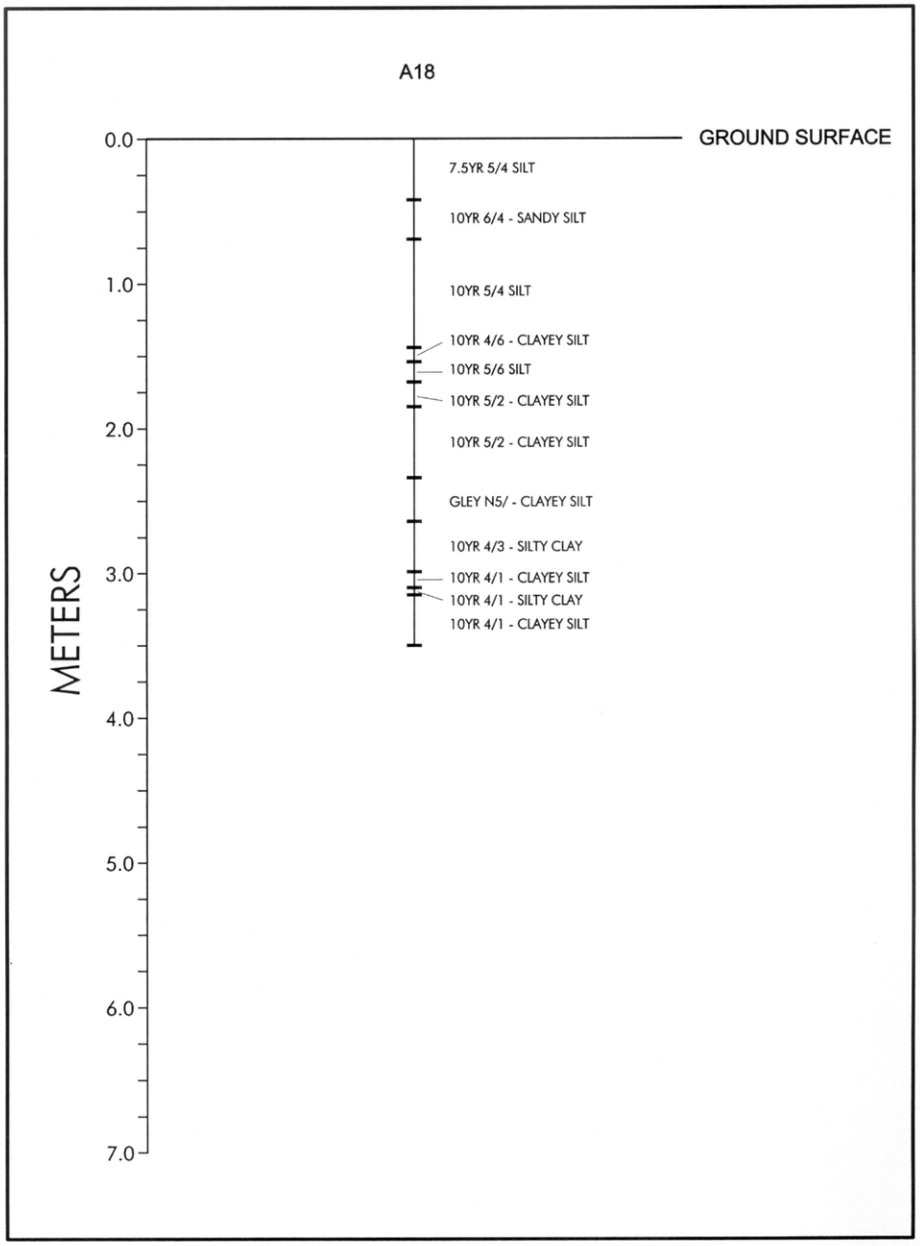

Figure 4-11. Stratigraphic profile of Auger A18.

and Figure 4-8) encountered probable natural-levee deposits to a depth of –2.2 m, at which point possible underlying backswamp material was hit. Auger A18 (see Table 4-8 and Figure 4-11) also may have encountered the possible backswamp deposits at –2.34 m, although, again, both of these deeper deposits may be nothing more than channel fill containing greater amounts of clay.

Ike Bayou and Unnamed Branch (Augers A3, A4 and A14)

A confusing series of braided channels extends southward from Bayou Courtableau in the region west of Big Offa Bayou. These are relatively minor waterways that appear to represent recent crevasse distributaries off Bayou Courtableau. However, their ages are unknown and they may have some time depth to them. For that reason they were chosen for investigation. Several have received local names, although most remain unnamed. Due to their anastomosing nature, it is very difficult to trace their courses, and many coalesce and then diverge from one another as they head southward. The easternmost of these channels plus one of its branches are included in this discussion. Locals refer to the main channel of this set as "Ike Bayou," while its branch is unnamed.

One auger boring (A14) was drilled adjacent to the eastern arm of the Ike Bayou system near its proximal end, while another boring (A3) was placed down adjacent to the lower end of the main Ike Bayou channel (see Figure 4-1). A third boring (A4) was drilled adjacent to an unnamed channel that branches off of the southern part of Ike Bayou.

Results of these three borings are presented in Tables 4-9 through 4-11, and in Figures 4-12 through 4-14. Auger A14 is particularly interesting, as this is the boring alluded to earlier in regard to its position on the backslope of the Big Offa natural levee. It shows natural-levee deposits extending to a depth of at least 2.3 m. Below that, possible backswamp clays were encountered to the base of the boring at –6.0 m. The depth of 2.3 m is similar to that recorded for the base of the natural levee in Augers A17 and A18 located along Big Offa to the south and southeast. It is drastically different, however, from the

Table 4-9. Data Relative to Auger Boring A3.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 619651 Easting 3367003	0-45 cm	10YR 4/4	Dark yellowish brown	Slightly clayey silt	None	None
	45-85 cm	10YR 5/3 mottled with 10YR 4/4	Brown mottled with dark yellowish brown	Silty clay	None	Some oxidation
	85-105 cm	7.5YR 4/6	Strong brown	Slightly clayey sandy silty clay	None	None
	105-115 cm	7.5YR 5/4	Brown	Silty clay	None	None
	115-120 cm	10YR 5/2 mottled with 7.5YR 4/6	Grayish brown mottled with strong brown	Slightly silty clay	None	None
	120-190 cm	10YR 4/1	Dark gray	Clayey silt	Possible charcoal at 90 cm	Becoming wet at appx. 170 cm
	190-310 cm	Transition between 2.5YR 4/1 and 10YR 4/1	Transition between dark reddish gray and dark gray	Clay	None	Water table reached at 300 cm.
	310- 330+ cm	10YR 4/1	Dark gray	Clay (stiff)	None	Saturated

Table 4-10. Data Relative to Auger Boring A4.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 619538 Easting 3367001	0-25 cm	10YR 4/4	Dark yellowish brown	Slightly clayey silt	None	None
	25-40 cm	10YR 5/4 with pockets of 10YR 7/4	Yellowish brown with pockets of very pale brown	Clayey silt with pockets of silty sand	None	None
	40-52 cm	7.5YR 5/4	Reddish brown	Slightly sandy clayey silt	None	None
	52-62 cm	7.5YR 5/6	Red	Slightly sandy clayey silt	None	None
	62-75 cm	10YR 5/1	Reddish gray	Silty clayey silt	None	None
	75-135 cm	2.5Y 5/2	Weak red	Slightly clayey sandy silt	None	Becomes wet at approx. 130 cm
	135-160 cm	2.5Y 5/1	Reddish gray	Sandy clay	None	None
	160-200 cm	2.5Y 5/1	Reddish gray	Slightly silt clay	At appx. 160 cm a small piece charcoal (?)	None
	200-220 cm	10YR 5/1	Gray	Clay		None
	220-245 cm	10YR 5/1 mottled with 10YR 4/1	Gray mottled with dark gray	Clay (stiff)	Charcoal (?) and slight amount of other organic material.	None
	245-290 cm	10YR 4/1 mottled with 10YR 4/4	Dark gray mottled with dark yellowish brown	Slightly silty clay	Some charcoal (?) and organic material.	Water table reached at 245 cm.
	290-300 cm	10YR 4/1	Dark gray	Sandy clay	None	Saturated
	300-320 cm	10YR 4/1 mottled with 7.5YR 4/4	Dark gray mottled with brown	Slightly silty clay	Organic matter, roots, possible charcoal	Saturated
	320-355+ cm	10YR 4/1	Dark gray	Clay (stiff)	Large amount of organic matter.	Saturated

Table 4-11. Data Relative to Auger Boring A14.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 619862 Easting 3368860	0-16 cm	10YR 4/3	Brown	Clayey silt	None	Probable plow zone
	16-75 cm	10YR 5/4	Yellowish brown	Slightly clayey silt	None	Becoming 7.5YR 5/4 with depth. Also becoming oxidized with depth.
	75-91 cm	7.5YR 5/4	Brown	Silty clay	none	Some oxidation
	91-106 cm	10YR 6/6	Brownish yellow	Slightly clayey silt	None	None
	106-132 cm	5YR 5/6	Yellowish red	Silty clay	None	Becoming darker with depth.
	132-181 cm	7.5 YR 6/2	Pinkish gray	Clayey silt	None	Becoming grayer with depth, small pockets of oxidation are present.
	181-230 cm	10YR 5/1 mottled with 10YR 5/2	Gray mottled with grayish brown	Silty clay	None	None
	230-310 cm	5GY 4/1	Dark greenish gray	Silty clay	None	Becoming clayier brown with depth.
	310-320 cm	10YR 5/4	Yellowish brown	Very clayey silt	None	None
	320-386 cm	10YR 5/1	Gray	Silty clay	None	None
	386-585 cm	10YR 5/1	Gray	Clayey silt	Organic matter at 490-495 cm.	None
	585-590 cm	2.5YR 5/6	Red	Clay (stiff and tenacious)	Some organic matter.	None
	590-600+ cm	GLEY N5/	Gray	clay	None	None

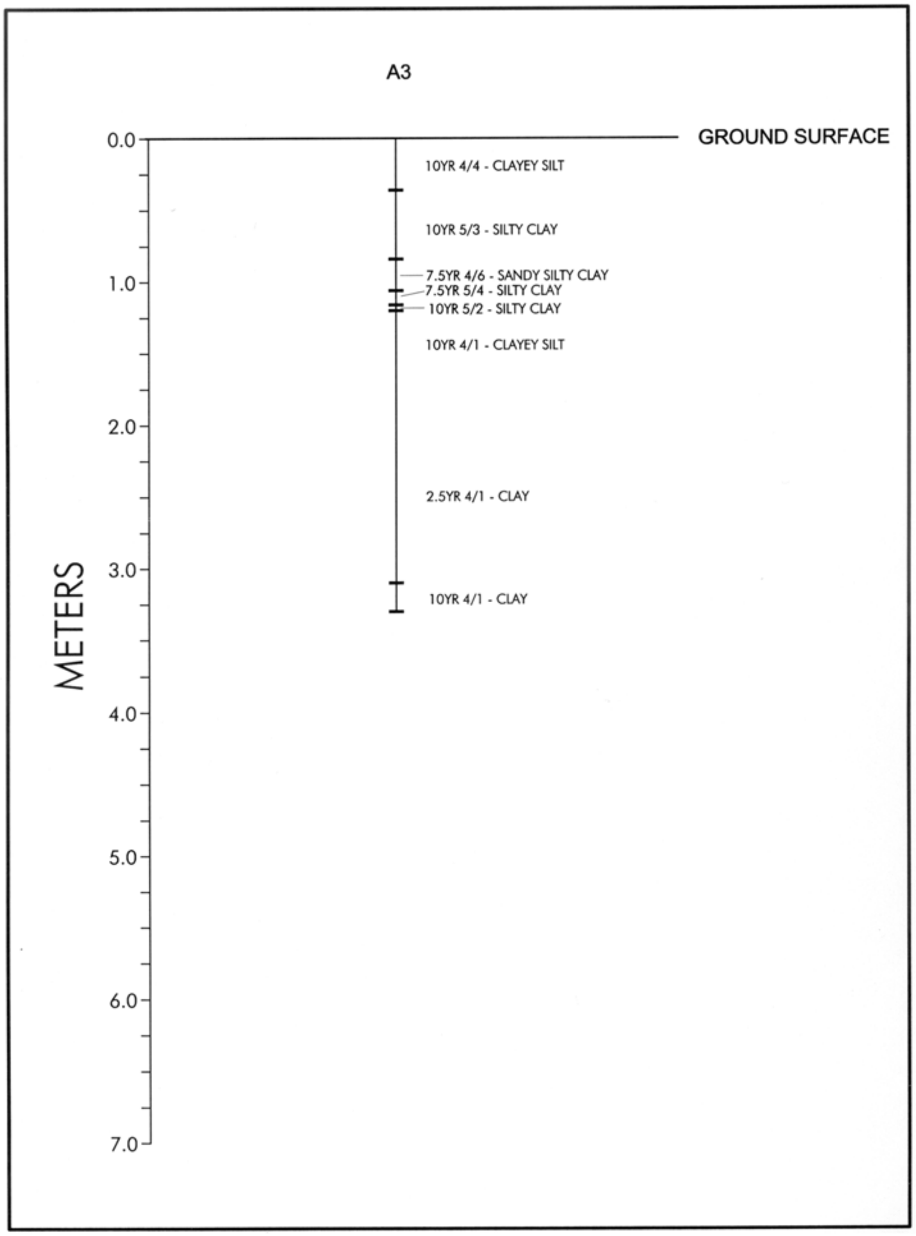

Figure 4-12. Stratigraphic profile of Auger A3.

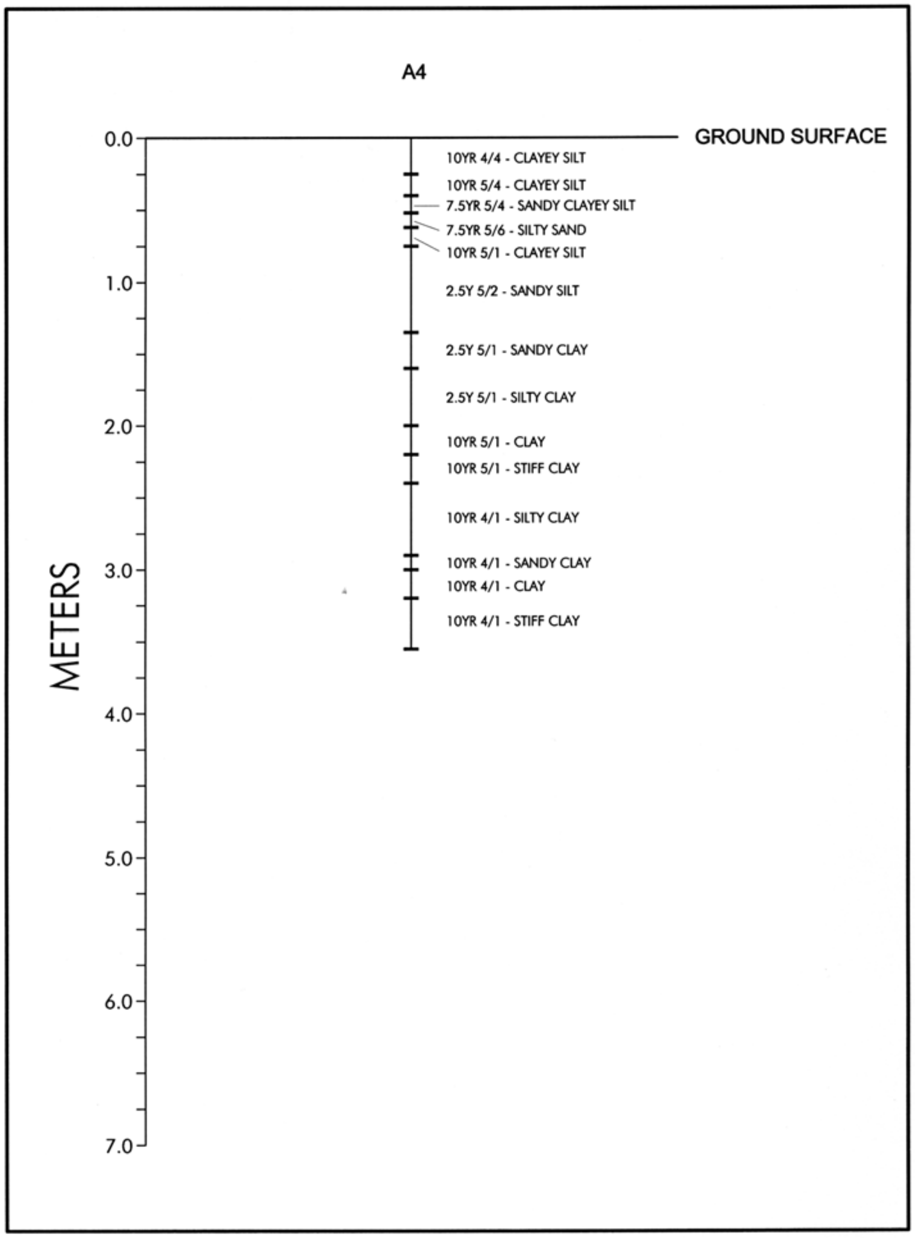

Figure 4-13. Stratigraphic profile of Auger A4.

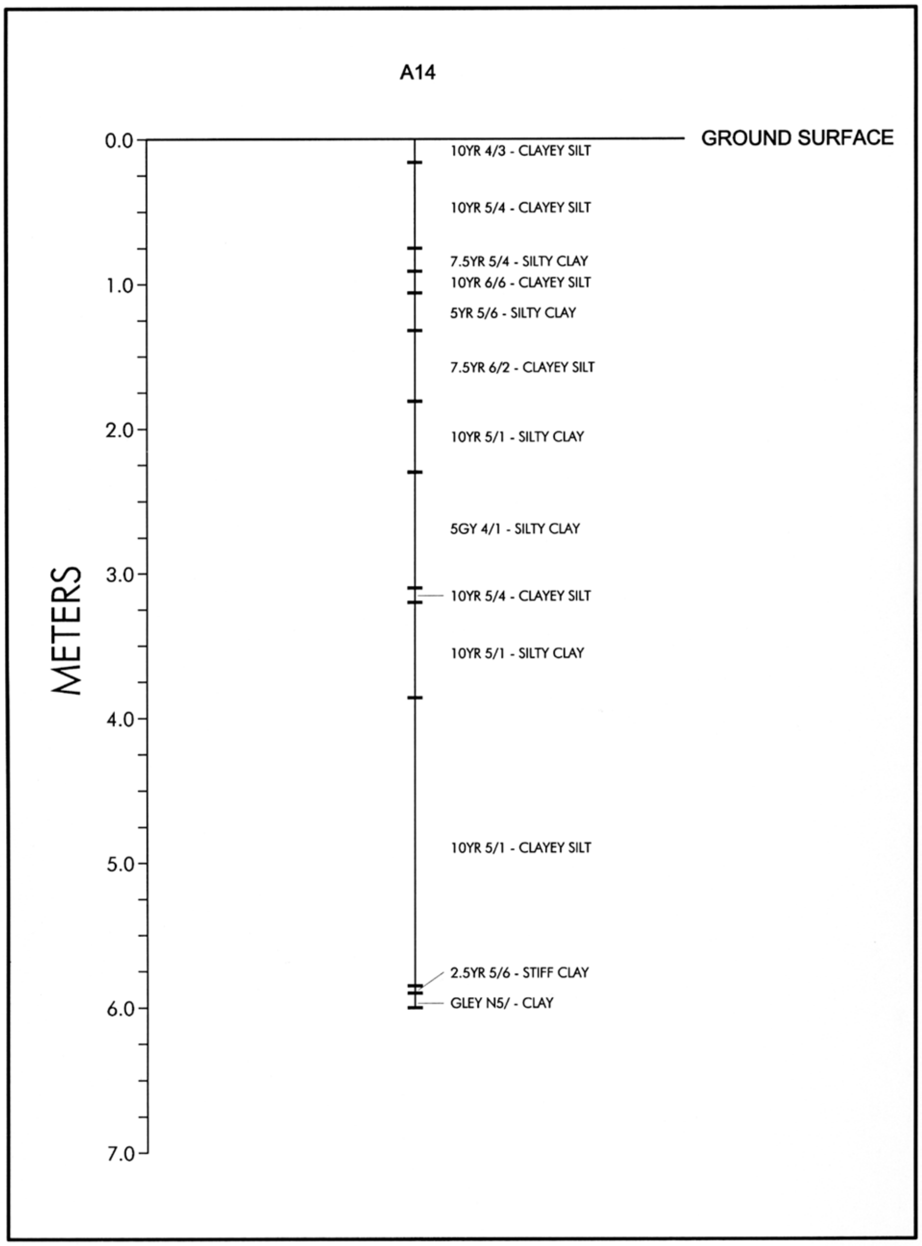

Figure 4-14. Stratigraphic profile of Auger A14.

nearby boring at A13 which apparently penetrated channel-fill sands to at least –6.1 m (see Table 4-6). This suggests that Auger A14 may have been positioned far enough away from Big Offa Bayou to have missed being placed down within its old channel.

Regardless of the above, the two augers farther down Ike Bayou and its branching channel (A3 and A4) show virtually the same stratigraphy as one another (see Tables 4-9 and 4-10). Auger A3 penetrated definite natural-levee deposits to a depth of –1.9 m, while A4 recorded natural-levee soils to a depth of 2.0 m. Below these were deposits of mixed silts and sands, probably marking deeper portions of the same natural-levee unit. Interestingly, the two borings showed strong evidence of Red River influence, both within the accreting natural-levee deposits and the underlying backswamp material. This is different from the borings along Big Offa Bayou and Offa Prong, where Red River material was evidenced almost entirely within the deeper backswamp deposits.

Ike Prong
(Augers A5 and A15)

The next recognizable channel to the west of Ike Bayou is known locally as Ike Prong. Although difficult to separate from Ike Bayou and other unnamed minor channels near its proximal end, Ike Prong forms a relatively obvious channel southward from the southeastern corner of Section 16 to the south end of Section 21. At one point, within the northeastern part of Section 21, the Ike Prong channel comes within about 50 m of the unnamed branch coming off Ike Bayou. Near its southern end, at about the midpoint of Section 21, Ike Prong comes within about 100 m of the next channel to the west, the latter identified by local residents as Mill Bayou (to be reviewed shortly). As with Ike Bayou, Ike Prong is believed to have formed within the recent past, although the age of this formation is unknown. It was hoped that data from associated auger borings and cores would help determine the age of the channel.

Two auger borings were positioned adjacent to the Ike Prong channel, one (A15) near its proximal end where it emanates from Bayou Courtableau, and the other (A5) near its southern end within the project area. The stratigraphy of these borings is presented in Tables 4-12 and 4-13 and Figures 4-15 and 4-16. Unfortunately, the crew recording the soil for A15 had a difficult time separating silty clay from clayey silt, resulting in a profile that would, at first glance, appear to consist entirely of backswamp deposits. Since this is virtually impossible, especially given the results of the nearby boring at A16 (to be discussed below), it is likely that the upper 2.4 m, at least, actually consists of natural-levee deposits, while only the bottom stratum, from –2.4 m to over 4.0 m, may represent the underlying backswamp.

Interpreting the stratigraphy revealed by A5 is a bit less ambiguous, although the upper strata again exhibit too much clay and it is likely that clayey silt was misidentified as silty clay. That being the case, it probably is safe to say that possible backswamp deposits were not encountered until ca. –2.15 m when very stiff gray clays were reached. This is in keeping with data from most of the other borings in the area, which hit the possible backswamp clays at ca. –2 m.

Mill Bayou
(Augers A6 and A16)

The next obvious channel to the west of Ike Prong is known locally as Mill Bayou (see Figure 4-1). It also appears to represent a relatively recent waterway within the series of braided channels that pass through the project area west of Big Offa Bayou. Auger borings and cores along the channel were considered necessary, however, before such a supposition could be confirmed.

Accordingly, two auger borings (A6 and A16) were placed down adjacent to Mill Bayou, again with one boring (A16) near the northern end of the channel, and the other (A6) near the southern end. The results of the borings are presented in Tables 4-14 and 4-15 and Figures 4-17 and 4-18. As can be seen, A16 penetrated natural-levee deposits to a depth of at least 2.19 m. Auger A6 may have encountered the underlying backswamp deposits at –1.9 m, although, once again, it seems clear that the recording crew had a difficult time separating silty clay from clayey silt, and those layers of silty clay above 190 cm probably should have been identified as clayey silt.

Table 4-12. Data Relative to Auger Boring A5.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 619084 Easting 3366983	0-45 cm	10YR 5/3	Brown	Sandy silt	None	None
	45-75 cm	7.5YR 4/6 mottled with 10YR 5/3	Strong brown mottled with brown	Silty clay	None	None
	75-110 cm	10YR 5/2	Grayish brown	Slightly silty clay	None	None
	110-145 cm	10YR5/3 mottled with 7.5YR 4/6	Brown mottled with strong brown	Slightly silty clay	Iron concretions.	None
	145-190 cm	10YR 5/4	Yellowish brown	Very slightly silty clay	Iron concretions	None
	190-205 cm	7.5YR 4/2	Brown	Clay	None	None
	205-215 cm	10YR 5/2	Brown	Slightly silty clay	None	
	215-?	7.5YR 6/1	Gray	Very stiff clay	Organic material at 220 cm.	Water table reached
	?-345+ cm	N5 5/ mottled with 10YR 4/4	Gray mottled with dark yellowish brown	Clay (Stiff)	Organic material at 320 cm	None

Table 4-13. Data Relative to Auger Boring A15.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 619420 Easting 3369062	0-30 cm	10YR 4/1	Dark gray	Silty clay	None	None
	30-60 cm	10YR 4/4 mottled with 5YR 4/3	Dark yellowish brown mottled with reddish brown	Slightly sandy clay	None	None
	60-110 cm	10YR 5/4 mottled with 5YR 4/3	Yellowish brown mottled with reddish brown	Sandy silty clay	None	None
	110-120 cm	10YR 6/1	Gray	Silty clay	None	Heavily oxidized
	120-240 cm	10YR 5/1	Gray	Slightly silty sandy clay	organic matter fragments at 200 cm.	Mottled with 10YR 5/3 at 220 cm. Clay becomes more tenacious at 180 cm.
	240-420+ cm	10YR 5/1	Gray	Clay	none	Saturated

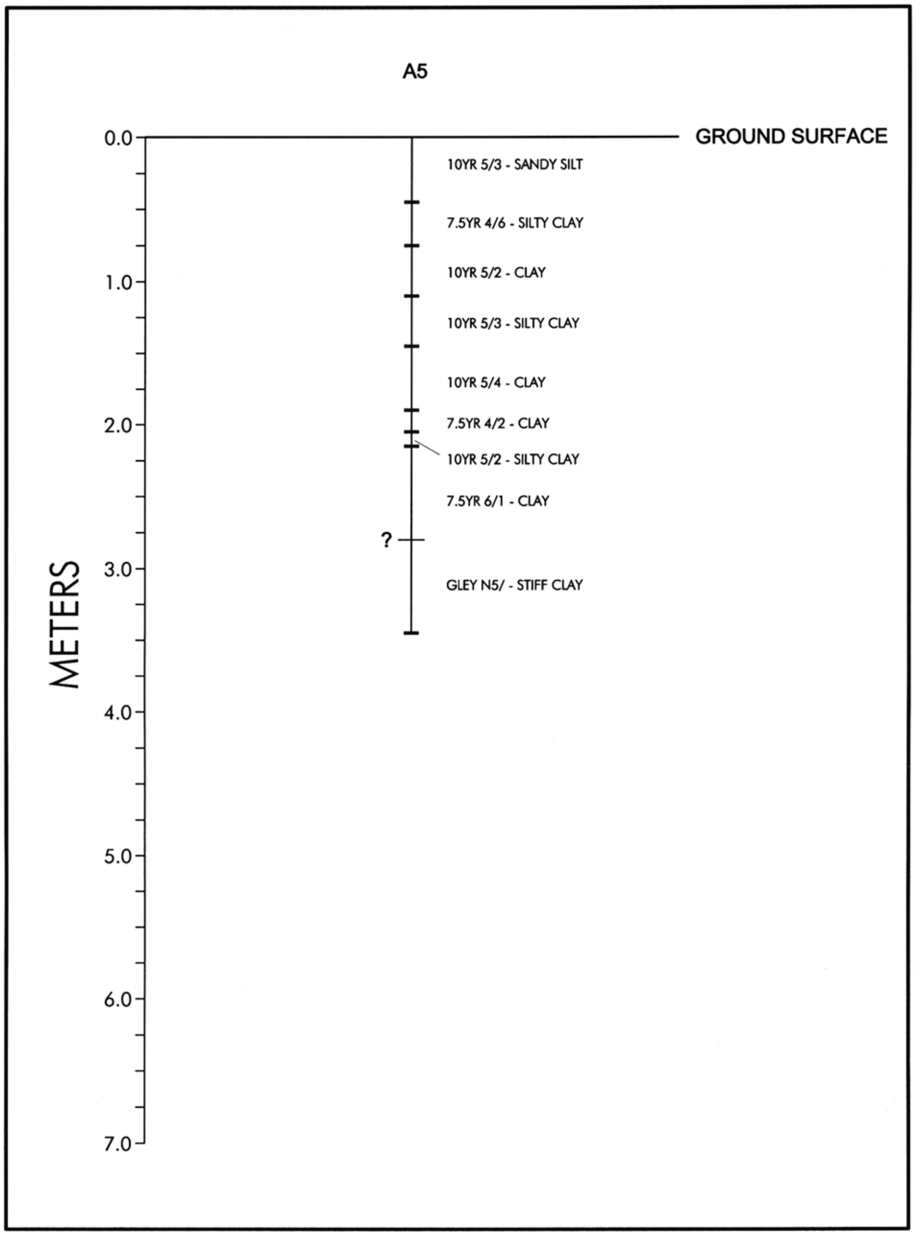

Figure 4-15. Stratigraphic profile of Auger A5.

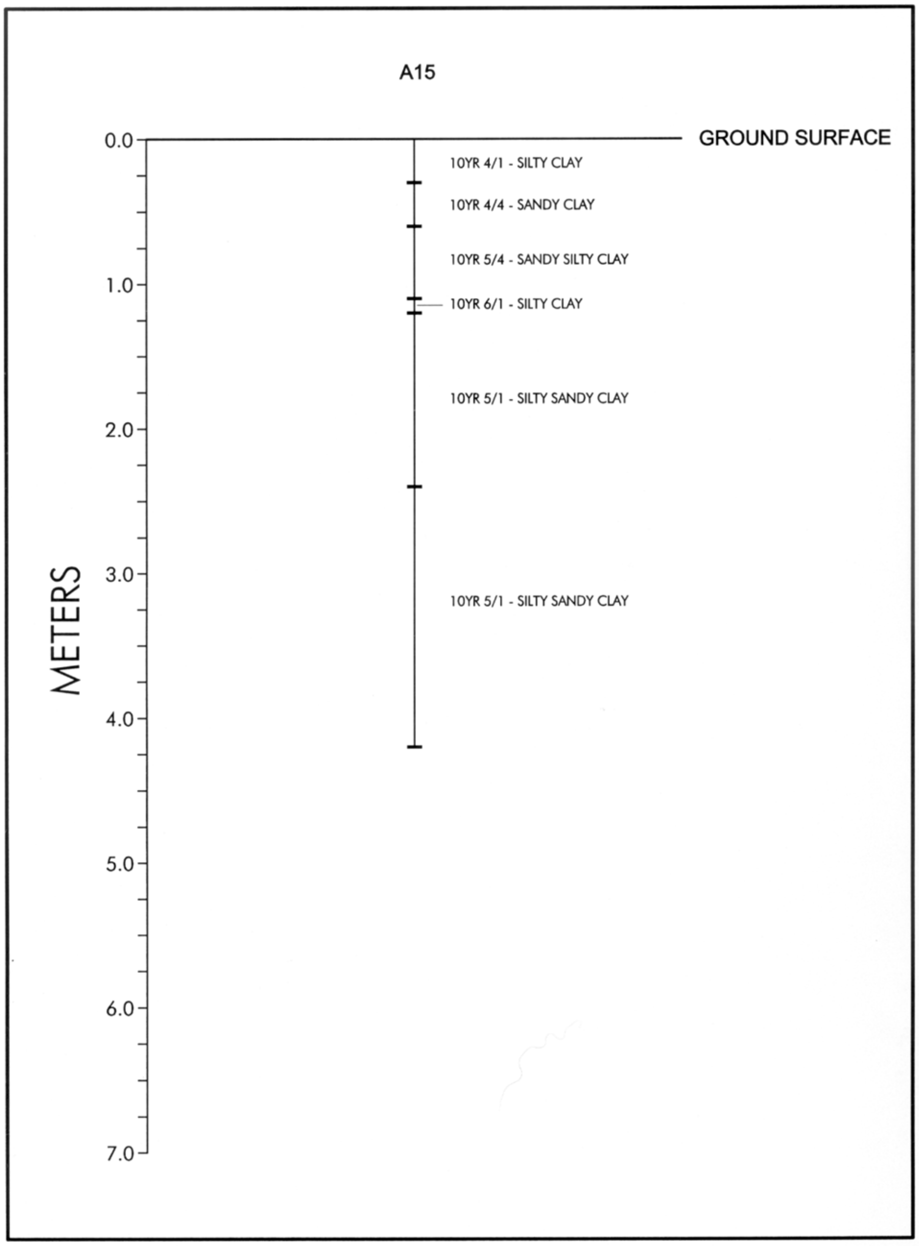

Figure 4-16. Stratigraphic profile of Auger A15.

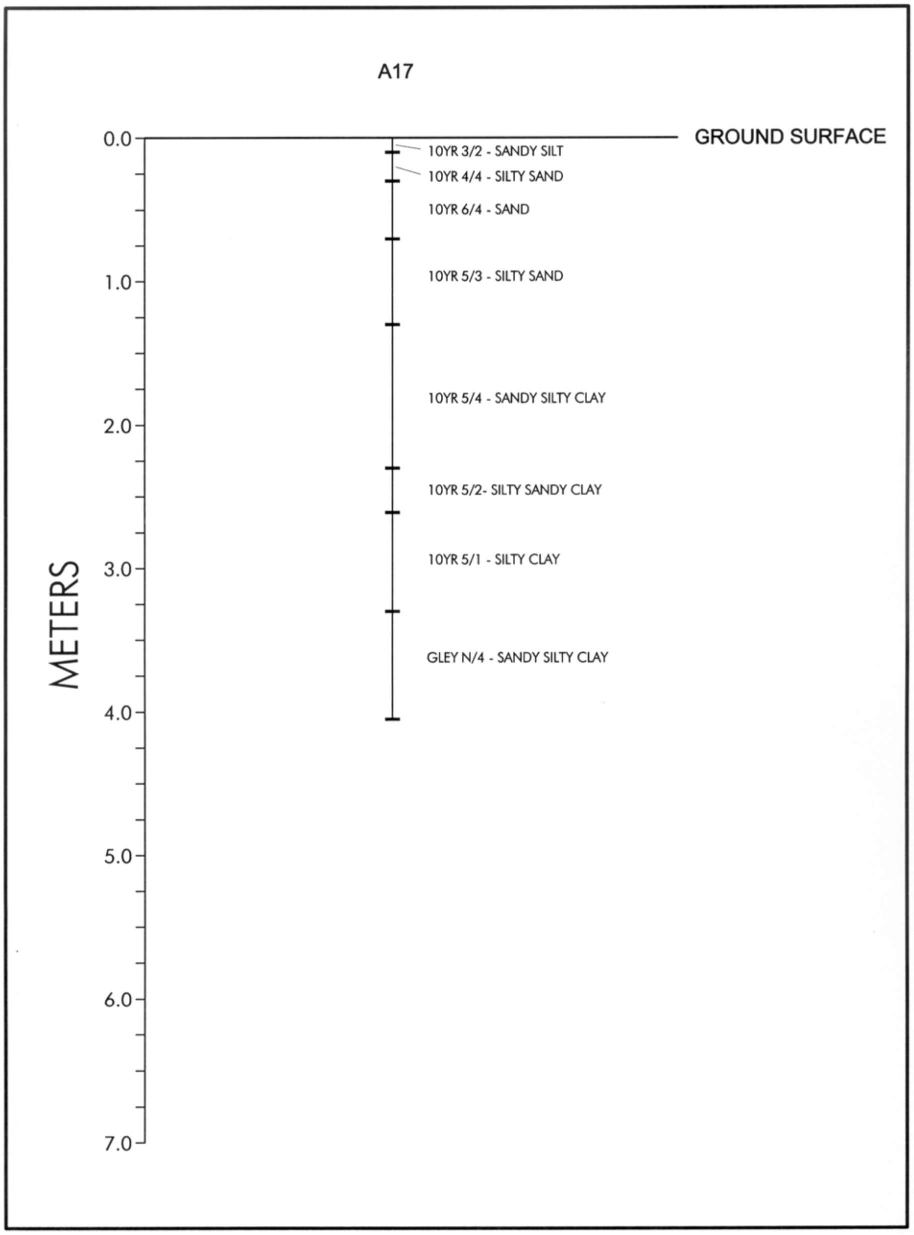

Figure 4-17. Stratigraphic profile of Auger A6.

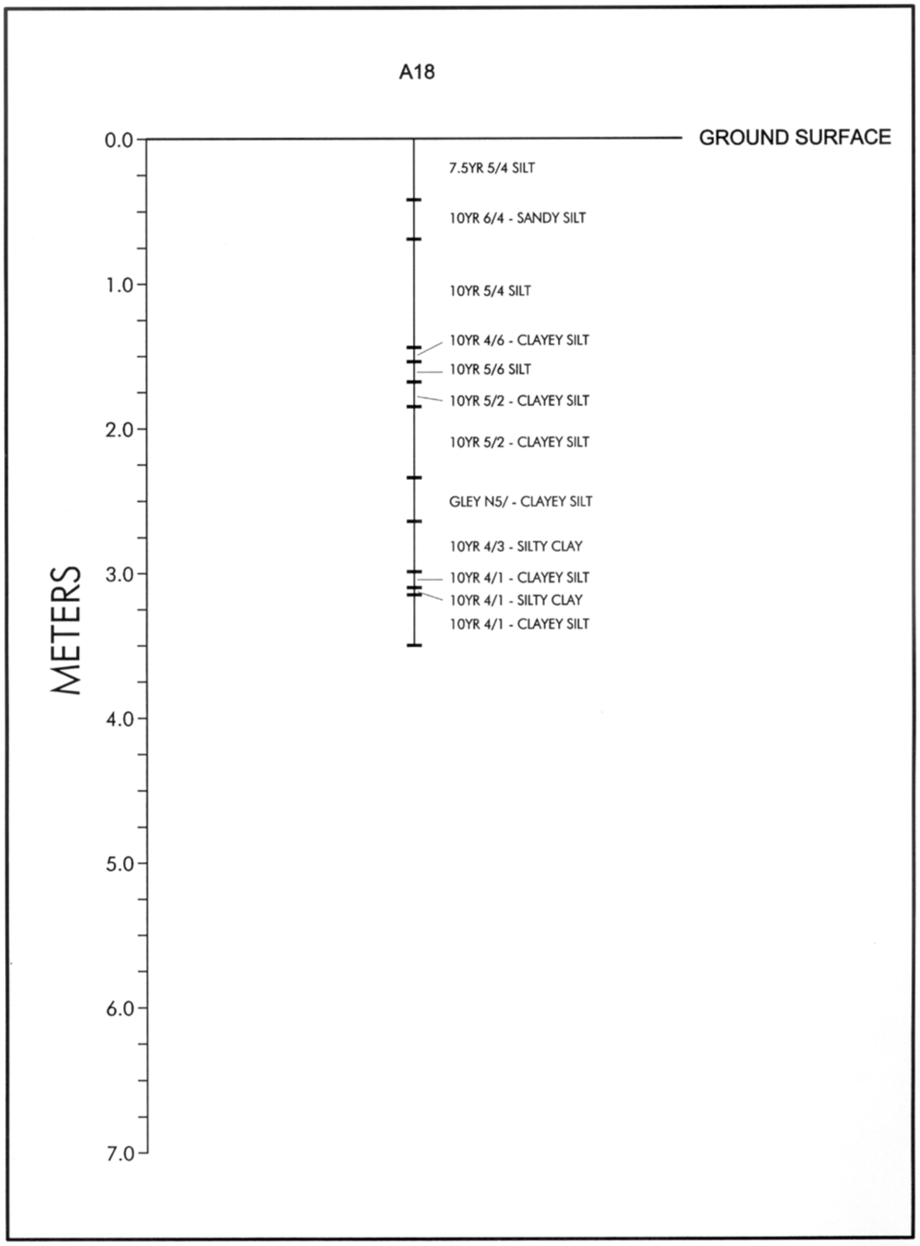

Figure 4-18. Stratigraphic profile of Auger A16.

Table 4-14. Data Relative to Auger Boring A6.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 618951 Easting 3366982	0-40 cm	10YR 5/2	Grayish brown	Silty	None	None
	40-55 cm	10YR 5/3 mottled with 7.5YR 4/4	Brown mottled with brown	Silty clay	None	None
	55-65 cm	10YR 5/4	Yellowish brown	Clayey silt	None	None
	65-75 cm	7.5YR 4/6	Strong brown	Silty clay	None	None
	75-130 cm	10YR 4/3	Brown	Slightly silty clay (stiff)	None	None
	130-190 cm	10YR 4/3	Brown	Silty clay	Iron concretions, modern (?) roots.	None
	90-265 cm	10YR 4/1	Dark gray	Clay (stiff)	Charcoal and organic material at 210 cm. Layer of organic matter at 250-260 cm	Water table at 220 cm
	265-330 cm	10YR4/1	Dark gray	Clay (stiff, clean)	None	None
	330-350+ cm	5B 5/1 mottled with 10YR 4/4	Bluish gray mottled with dark yellowish brown	Clay	Some organic material.	Saturated

Table 4-15. Data Relative to Auger Boring A16.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 619130 Easting 3369064	0-46 cm	10YR 4/3	Brown	Silt	None	Becomes lighter with depth.
	46-74 cm	10YR 6/3	Pale brown	Sandy silt	None	None
	74-95 cm	10YR 6/4	Light yellowish brown	Sand	None	None
	95-150 cm	10YR 5/6	Yellowish brown	Clayey sand	None	None
	150-196 cm	10YR 5/1	Gray	Clayey silt	None	None
	196-219 cm	10YR 5/1	Gray	Silty clay	None	None
	219-285 cm	5GY 4/1	Dark greenish gray	Slightly silty clay	Organic-rich layer at 244-254 cm.	Color gradually changes from 10YR 5/6 to 5GY 4/1
	285-300 cm	7.5YR 5/4	Yellowish brown	Slightly silty clay	None	None
	300-350+ cm	GLEY N4/	Dark gray	Silty clay	None	None

Unnamed Channel Between Mill Bayou and Little Fordoche Bayou (Auger A7)

Several very minor channels are evident between Mill Bayou and Little Fordoche Bayou. Most appear to be offshoots of Little Fordoche, and such probably is the case for the channel in question here. However, because of the unclear routes displayed by many of these courses, such a relationship cannot be stated for certain. Regardless, it was felt that at least one auger along one of these channels would help clarify its possible age and association, plus help fill in a noted gap in the planned east-west profile across the project area.

Table 4-16 and Figure 4-19 provide data on the stratigraphy revealed by Auger A7. Unfortunately, once again recognition of the boundary between natural-levee and backswamp deposits is blurred to some extent by the inability of the augering crew to differentiate between silty clays and clayey silts. Nevertheless, it would appear that the upper stratum, from the surface down to –1.65 m, must have penetrated natural-levee deposits, while the next stratum, down to –1.9 m, may be part of the same levee formation. Underlying backswamp soils probably were hit below 1.9 m, and these extended beyond the base of the auger at –4.0 m.

Little Fordoche Bayou (Augers A8, A9, and A19)

Little Fordoche Bayou once was one of the main channels linking Bayou Courtableau with Lake Fordoche in the swamps to the southwest. It is shown on the 1842 plat map (Newcomb 1842), noted in the earlier survey notes used to create the plat, and is a prominent channel on the 1863 Abbot map of the Atchafalaya Basin. Today, only the northern portion of the bayou (within Section 8 and the northeast corner of Section 17) is well preserved and recognizable. Most of the southern portion (within the remainder of Section 17 and all of Section 20) has been obscured by agricultural activities and/or increased sedimentation. In fact, it was very difficult to identify the main course of the bayou within the project area, and the survey crew spent a significant amount of time and effort trying to locate the bayou's true channel. This task was made all the more difficult by the fact that the most recent 1970

Table 4-16. Data Relative to Auger Boring A7.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 618165 Easting 3366933	0-165 cm	10YR 4/3	Brown	Slightly silty clay (stiff)	Iron concretions at approx. 100-200 cm.	None
	165-190 cm	10YR 5/1	Gray	Clay (stiff)	Small piece of wood (?) at approx. 170 cm.	None
	190-220 cm	10YR 4/4 mottled with 10YR 5/2	Dark yellowish brown mottled with grayish brown	Clay (stiff)	Small amount of organic material.	None
	220-260 cm	7.5YR 4/4 mottled with 10YR 5/2	Brown mottled with grayish brown	Clay (stiff)	None	Water table reached
	260-400+ cm	10YR 5/1	Gray	Clay (stiff)	Iron concretions at 315 cm	Heavily oxidized

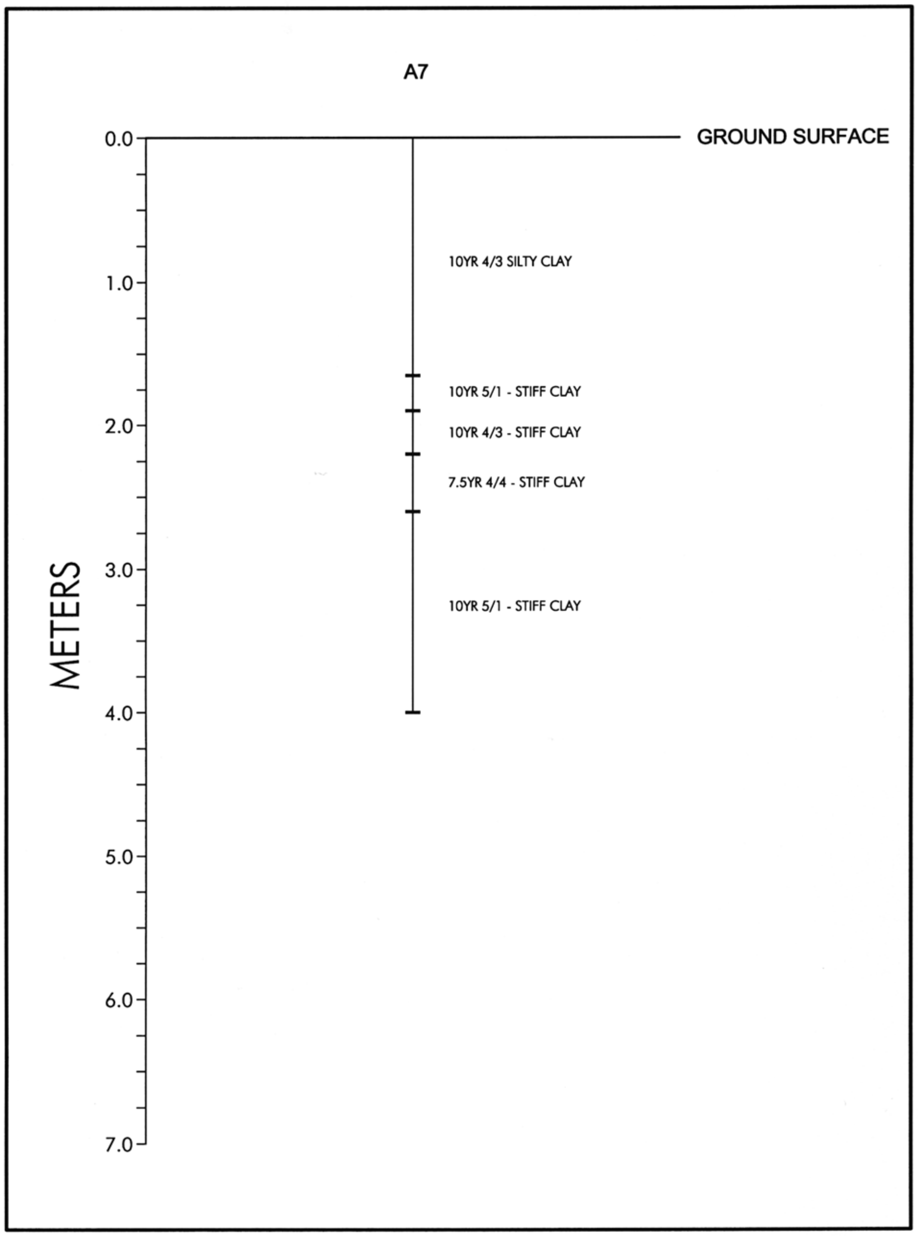

Figure 4-19. Stratigraphic profile of Auger A7.

Portage, La., 7.5-minute quadrangle map (U.S. Geological Survey 1970) mistakenly identifies a borrow ditch running parallel to an old logging road as Little Fordoche Bayou. The bayou's actual channel is situated about 100 m farther to the west. Because of these problems, two of the borings (A8 and A9) drilled to assess Little Fordoche Bayou actually were placed down adjacent to the old logging road and not the bayou proper. Luckily, a subsequent core (C6) was taken adjacent to the real channel, at the location of one of the oldest cypress trees discovered in the project area (see Chapters 5 and 8).

In any event, Augers A8, A9, and A19 were used to help assess Little Fordoche Bayou (Tables 4-17 through 4-19 and Figures 4-20 through 4-22). The first two borings were situated near the logging road in Section 20 within the project area, while A19 was placed down in Section 17 adjacent to a well-preserved portion of the bayou at the edge of one of the plowed fields north of the project area. The two augers adjacent to the logging road are very difficult to interpret, as their upper strata alternate between clays, silts, and sands. Nevertheless, the sands and silts probably reflect various spurts of floodwater that entered the area as the fields to the north were cleared and subsequent erosion and sedimentation increased. The clays undoubtedly indicate periods of less sustained flooding. Perhaps the stiff gray (10YR 5/1) clay hit at –2.7 m in A8 and the dark gray (GLEY N/4) slightly silty clay encountered at –2.55 m in A9 mark the top of the backswamp deposits in the area. These depths are little deeper than those recorded for the backswamp deposits in most of other borings, but that may reflect the greater amount of sediment introduced into the area as the fields to the north were cleared and deflated. Another possibility is that both augers were placed down within the old channel-fill deposits of a once-wider course of Little Fordoche Bayou. In fact, as will be seen in the following chapter, that is the interpretation provided for Core C1 which was obtained from the same location of Auger A9.

Auger A19 also is difficult to interpret (see Table 4-19 and Figure 4-22). Given its position along the northern part of Little Fordoche Bayou, one would expect a fairly thick natural-levee deposit. Such does not appear to be the case, however, as clay deposits were encountered at only –1.25 m. Perhaps this boring also was placed down within the filled channel of Little Fordoche Bayou, thereby negating its potential for identifying the depth of

Table 4-17. Data Relative to Auger Boring A8.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 617446 Easting 3366855	0-90 cm	7.5YR 4/2	Brown	Slightly silty clay (stiff)	None	None
	90-105 cm	7.5YR4/4	Brown	Clay	None	None
	105-150 cm	10YR 4/2	Brown	Slightly silty clayey sand	Organic material at approx. 120 cm	None
	150-160 cm	10YR 4/2	Brown	Clay	Organic material at 100 cm	
	160-190 cm	10YR 4/2 mottled with 7.5YR 4/1 and 7.5YR 3/3	Brown mottled with dark gray and dark brown	Clay	None	Oxidized
	190-235 cm	7.5YR 4/2	Brown	Clay (stiff)	None	None
	235-270 cm	10YR 5/1	Gray	Clay (stiff)	None	None
	270-295 cm	10YR 5/1 mottled with 7.5YR 3/3	Gray mottled with dark brown	Clay (stiff)	Iron (?) concretions	None
	295-360 cm	2.5YR 4/6 mottled with 2.5 YR 5/1	Red mottled with reddish gray	Clay (stiff)	Organic material at appx. 310 cm	None
	360-415+ cm	2.5YR 5/1 mottled with 2.5YR 4/6	Reddish gray mottled with red	Clay	None	None

Table 4-18. Data Relative to Auger Boring A9.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 617352 Easting 3366870	0-74 cm	10YR 4/3	Brown	Silty clay	None	Oxidation mottling at 55 cm
	74-80 cm	10YR 5/4	Brown	Silty sand	None	None
	80-85 cm	10YR 4/3	Brown	Silty clay	None	None
	85-95 cm	7.5YR 4/4	Brown	Silty clay	None	None
	95-115 cm	5YR 4/4	Reddish brown	Silty clay	None	Some oxidation
	115-122 cm	10YR 5/2	Grayish brown	Silty clay	Organic matter	None
	122-132 cm	5YR 4/4	Reddish brown	Silty clay	None	None
	132-185 cm	10YR 5/2	Grayish brown	Clayey silt	None	Becoming sandy with depth.
	185-200 cm	5YR 5/8	Yellowish red	Silty sand	None	None
	200-240 cm	10YR 5/4	Yellowish brown	Sand	None	Becoming darker with depth.
	240-250 cm	10YR 4/3	Brown	Clayey sandy silt	None	None
	250-255 cm	GLEY N/4	Dark gray	Very clayey sandy silt	None	None
	255-305 cm	GLEY N/4	Dark gray	Very slightly silty clay.	Organic matter present.	Some oxidation staining
	305-340 cm	10R 4/6	Dark yellowish brown	Clay (very stiff and tenacious)	None	None
	340-470+ cm	5GY 7/1	Light greenish gray	Clay	Organic matter present at 460-465 cm.	Some oxidized patches.

Table 4-19. Data Relative to Auger Boring A19.

GPS Coordinates	Depth	Munsell Color	Color Name	Soil Description	Inclusions	Comments
Northing 618027 Easting 3369573	0-25	10YR 5/3	Brown	Silty sand	None	None
	25-40 cm	10YR 6/3	Pale brown	Silty sand		None
	40-90 cm	10YR 5/1	Gray	Slightly clayey silt		Becomes a stiffer siltier clay at 75 cm
	90-125 cm	10YR 4/3	Brown	Silty clay		None
	125-410 cm	10YR 5/1	Gray	Slightly sandy silty clay	Organic samples taken at 220 cm, 360 cm, 400 cm, 410 cm	Stiffer at 300 cm.
	410-420+ cm	5YR 4/3	Reddish brown	Clay	None	None

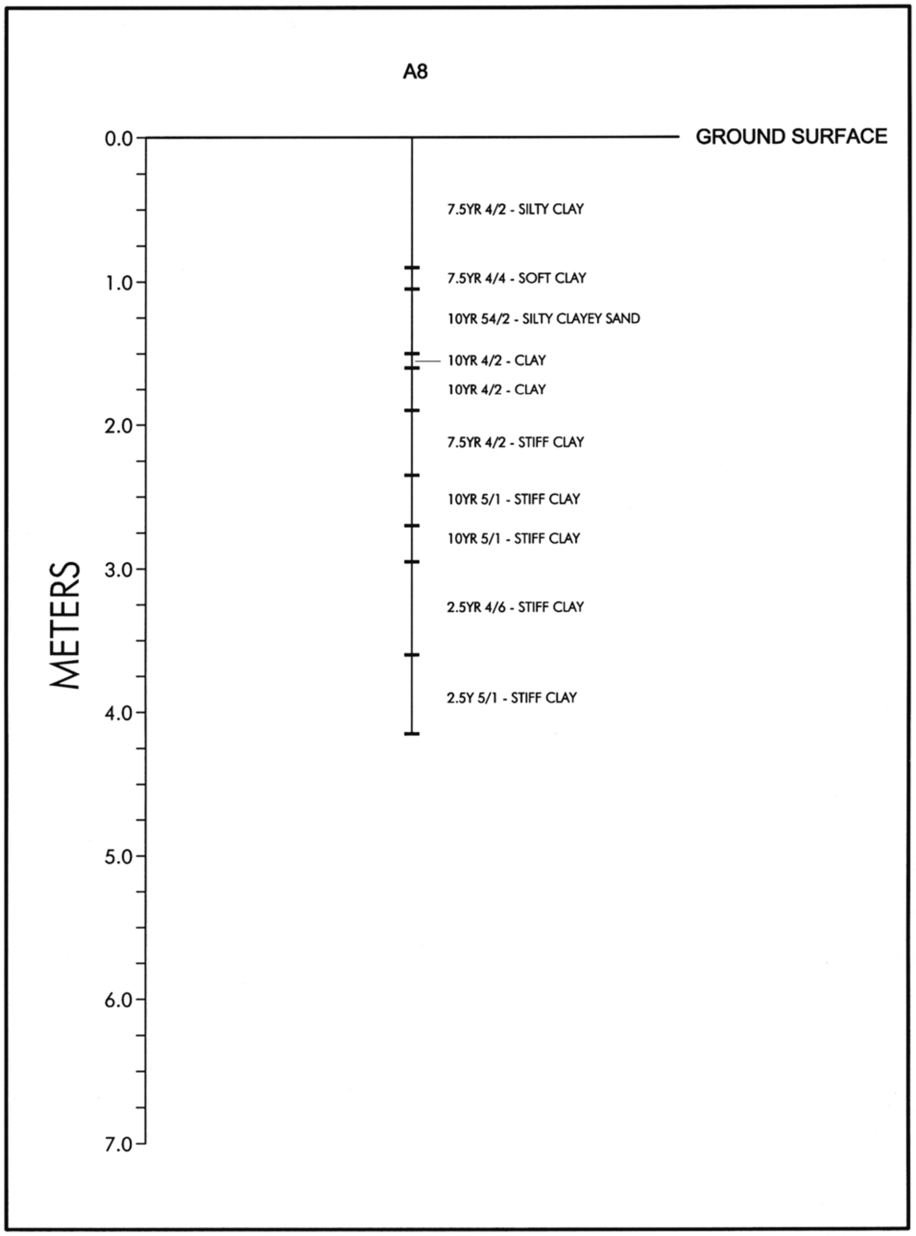

Figure 4-20. Stratigraphic profile of Auger A8.

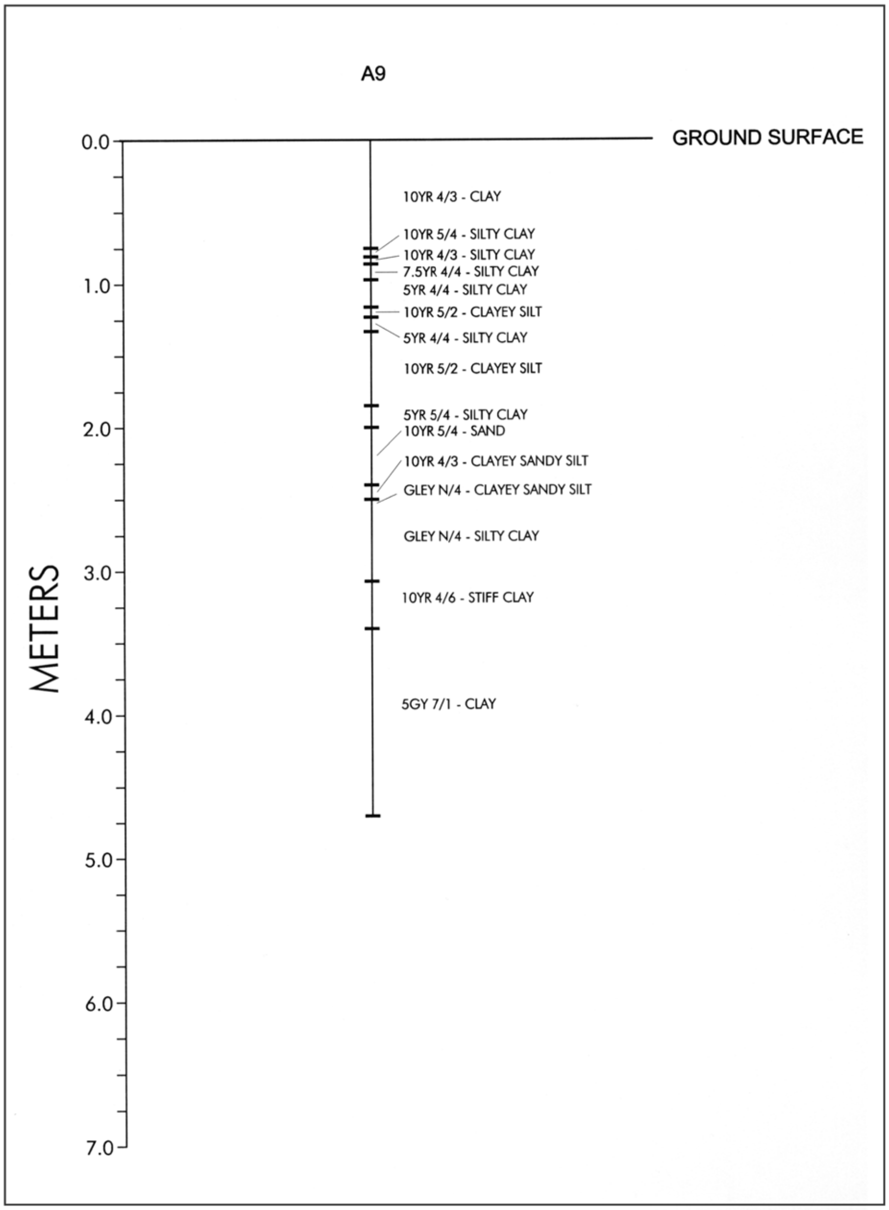

Figure 4-21. Stratigraphic profile of Auger A9.

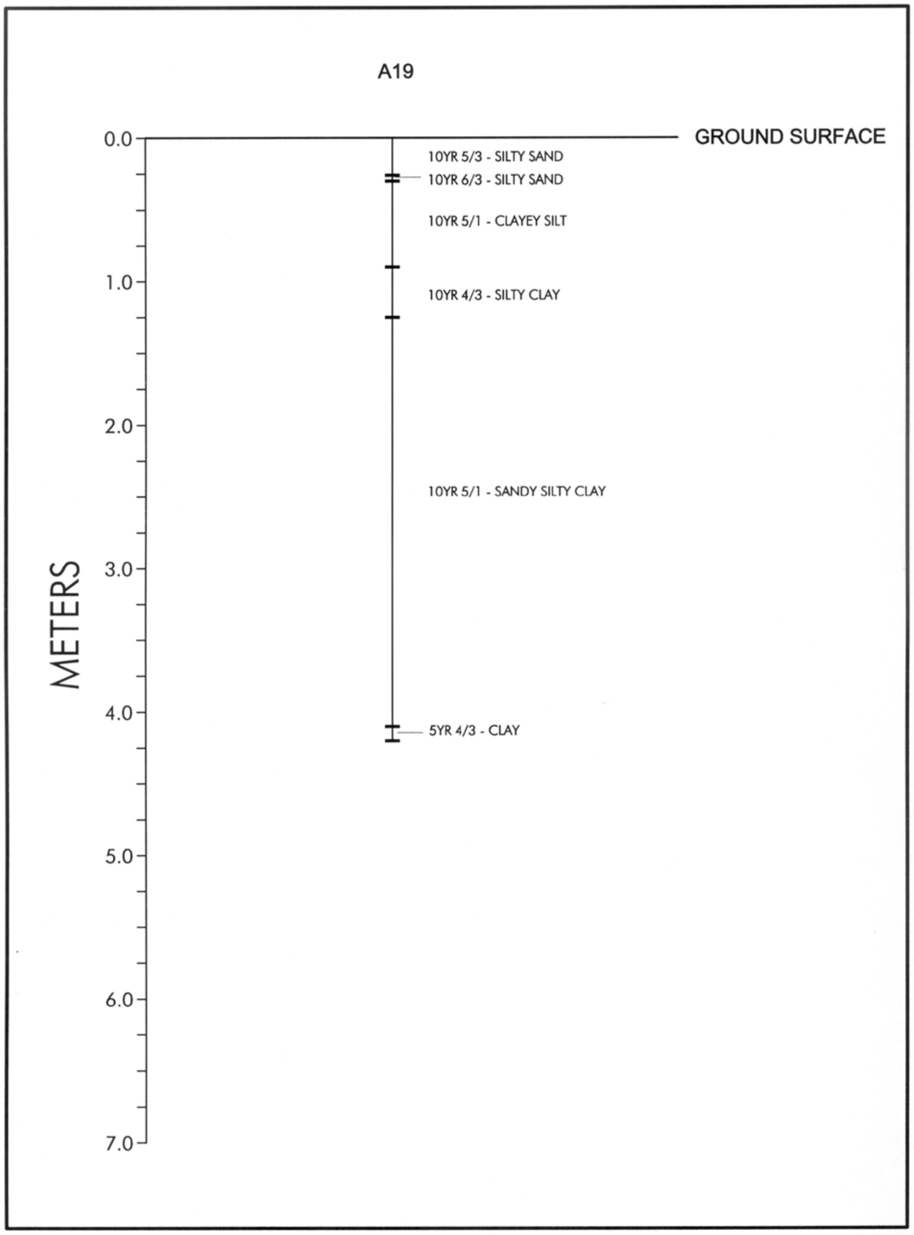

Figure 4-22. **Stratigraphic profile of Auger A19.**

backswamp deposits along the upper reaches of the bayou. Again, it will be necessary for the core data to help unravel the stratigraphic situation in the region just north of the project area.

Augering Summary

The augering program was moderately successful in achieving its stated goals. In most instances, it was possible to determine the thickness of the location's natural-levee deposits and to determine if underlying backswamp deposits were present and accessible for coring. It also was possible to identify those borings that produced reasonable amounts of organic material suitable for radiocarbon dating. It was hoped that cores placed down at the same locations also would encounter similar organic remains and provide a larger sample that could be submitted for dating. Given all of the above, nine of the auger locations (A1, A3, A6, A9, A10, A12, A16, A17, and A19) were selected for subsequent coring. The results of these cores, plus information acquired from three additional cores, will be the subject of the following chapter.

CHAPTER 5

GEOARCHAEOLOGY OF THE INDIAN BAYOU NORTH PROJECT AREA: RESULTS OF THE CORING PROGRAM

Paul V. Heinrich

Methodology

Because of the lack of subsurface exposures (i.e., no backhoe trenches or bankline cuts), plus the low-lying, water-logged nature of the crevasse splays and the lack of known archaeological sites, it was impossible to determine in the field either the stratigraphy of the area's sediments or the age of the crevasse splays and landforms comprising the Indian Bayou North project area. The only clue as to the history of the landforms and how they fit within the known history of the Atchafalaya River came from partially buried cypress stumps found at the edges of the Indian Bayou North area, as discussed in Chapter 8.

To resolve questions about the stratigraphic sequence underlying the project area, to learn the age of the area's distributaries, and to understand the sedimentation history of the region, 12 solid cores were retrieved and analyzed. These cores, with diameters of 4.44 cm (1.75 in), were collected with a self-contained Geoprobe coring rig pulled by a four-wheel all-terrain vehicle (ATV) (Figure 5-1). The geoprobe was operated by Glen H. Doran and David Thulman, professor and graduate student, respectively, from the Department of Anthropology, Florida State University. Depending on the depth of a specific core hole, each core consisted of between 4 and 7 sections, each section with a length of 1.2 m (3.9 ft). Nine of the 12 cores (C1 through C5, C8 through C10, and C12) were collected from locations adjacent to the location of prior auger borings. Two other cores (C6 and C7) came from locations adjacent to the two oldest cypress trees found within the project area. A final core (C11) was taken from a location at the very upper end of Little Fordoche Bayou at the point where the bayou emerges from Bayou Courtableau.

Figure 5-1. Coring in progress at Location C-1. Facing South. Date:9/5/03.

In the laboratory, each retrieved section of a core was first split into two halves. One half was cleaned, photographed, and stored at Coastal Environment, Inc. The other half was cleaned and examined at the Louisiana Geological Survey's laboratory at Louisiana State University. After cleaning, detailed graphic logs were prepared. These recorded the color, lithology, sedimentary structure, and other characteristics of the core. In addition, a total of 30 samples of organic material were collected from many of the cores, and these were submitted to Beta Analytic, Inc., for radiocarbon dating. Appendix A provides the close-up photographs of each core, plus the core's associated log, while Appendix B offers detailed information on the various radiocarbon samples selected from the cores.

Detailed examination of some cores (i.e., Cores C3, C10, and C11) revealed very poor recovery from those sections that had penetrated clayey sediments overlain by sandy sediments. For example in Core C11, only 26 and 38 cm (10 and 15 in) out of 140 cm (77 in) were recovered, respectively, in Sections 4 and 5. In those sections, as in other core sections, the extent of poor recovery far exceeds that which can be explained by compaction. Therefore, in addition to compaction, it appears, as the author has experienced in coring clayey sediments in slackwater lakes in Illinois, that the tube pushed aside clayey sediments instead of coring through them as a section of core tubing was pushed into it. In certain sections of Core C11, as in other core sections, this happened because the hole had partially filled at the bottom with sandy and silty sediments that slumped into it while removing the previous core and inserting the new section of tube. As a result, the core tubing became largely filled with a sandy slump leaving only a little room for coring new material. In these and other sections of cores, it was presumed that the recovered interval came from the top of the core interval.

It should be noted that attempts were made to construct cross sections of the area using descriptions of both the auger borings and the solid cores. However, these attempts resulted in a distribution of facies that defied any interpretation. Comparison of pairs of an auger boring and an adjacent core, i.e., Auger Boring A-3 and Core C8, found a consistent lack of correspondence between the augers' soil descriptions and those sediments contained within the cores, even though their locations were less than a meter apart. As a result, the auger holes descriptions were not used in construction of the project area cross sections.

Results

Data collected from an examination of most of the cores allowed for the construction of two cross sections, identified as Cross Sections 1 and 2, across portions of the project area (Figure 5-2). Two other cores, Cores C7 and C11, were not readily incorporated into these cross sections, but, instead, are described separately below.

Cross Section 1

Cross Section 1 was constructed by using the descriptions of Cores C1, C2, C3, C4, C5, C6, and C8, plus USACE Boring 598.5-RU. This cross section extends westward from the west bank of the Atchafalaya River, across the entire project area and on into the backswamp at the western project boundary. This line cuts through the channels of Big Offa Bayou, Little Fordoche Bayou, Miller Bayou, and other smaller bayous and crevasse channels.

Cross Section 1 shows that the coalesced natural-levee deposits of the Atchafalaya River and the crevasse splays originating from Bayou Courtableau underlie the Indian Bayou project area (Figure 5-3). Together, they form a wedge of sand, silt, and clay that extends over 3 km (1.8 mile) westward from the bank of the Atchafalaya River. Within Cross Section 1, the coarse-grained, sandy and silty part of the natural levee is almost 6.5 m (21.3 ft) thick adjacent to the Atchafalaya River. Between the Atchafalaya River and Big Offa Bayou, the coarse-grained sediments thin to about 3 m (9.8 ft), with a total thickness, including clayey distal natural-levee sediments, estimated to be about 4 m (13 ft). Adjacent to the banks of Big Offa Bayou, the thickness of coarse-grained sediments is at a maximum of 4 m (13 ft), with the total thickness of natural-levee deposits estimated to be about 5.5 m (18 ft). Between Big Offa Bayou and Little Fordoche Bayou, the coarse-grained natural-levee deposits grade completely into fine-grained natural-levee deposits, while the total

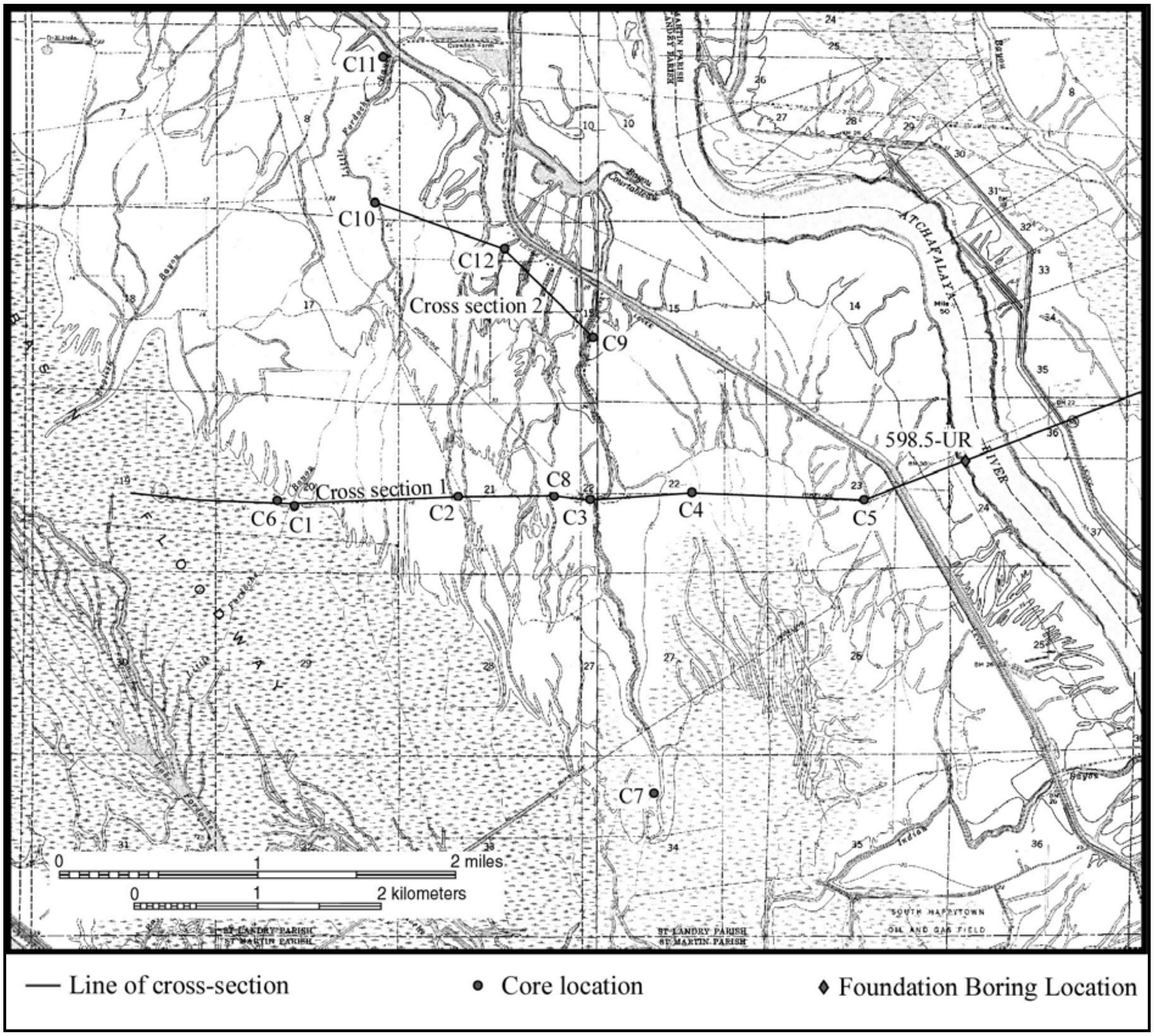

Figure 5-2. Locations of cores and cross-sections in the northern Indian Bayou project area.

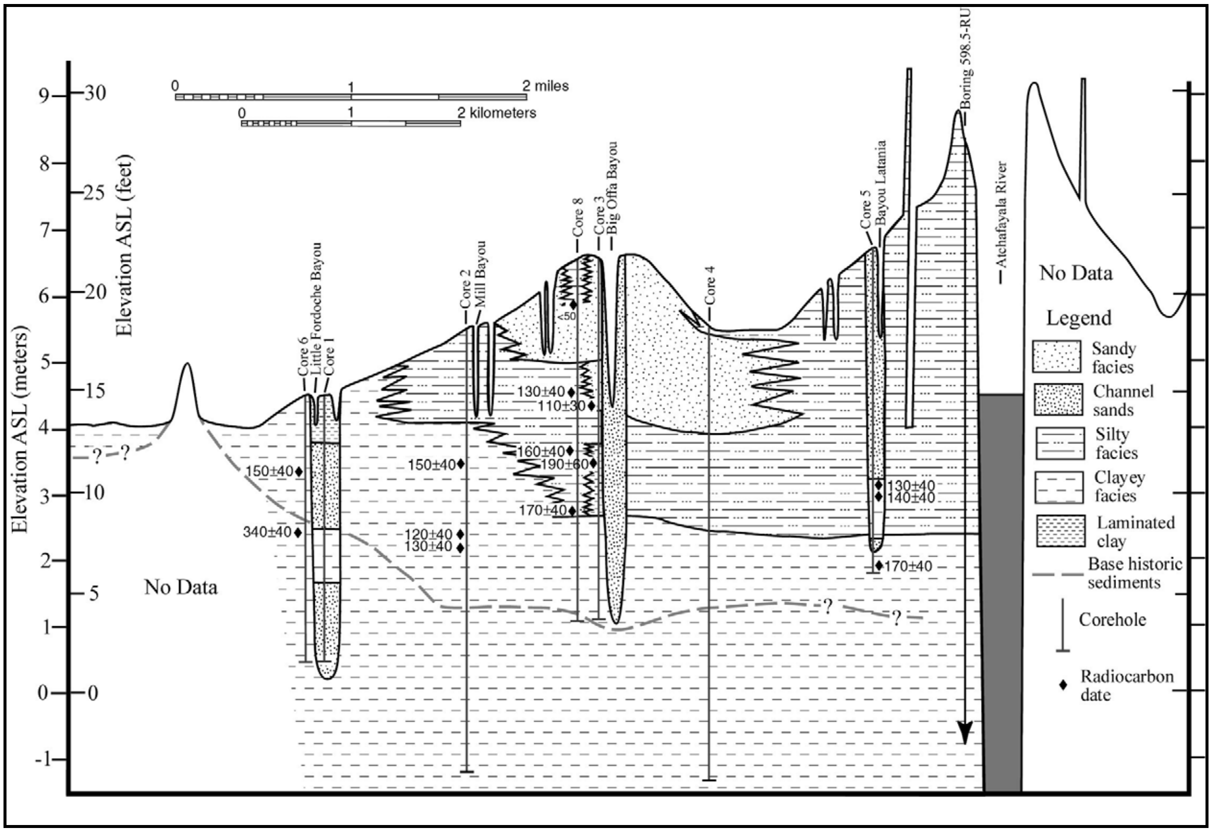

Figure 5-3. Cross Section 1 of the northern Indian Bayou Area.

estimated thickness of the natural-levee sediments decreases to about 2 m (6.6 ft) at Little Fordoche Bayou.

As shown in Figure 5-3, the sandy facies underlying the northern part of the Indian Bayou project area consists of two sandy wedges extending east and west of Big Offa Bayou. This facies was penetrated by Cores C3, C4, and C8 and consists of thinly to medium interbedded massive sand, massive silty sand, laminated sand, and laminated silty sand. Minor beds of massive and laminated silt occur within the sandy facies. Typically, these sandy sediments vary in color from light brownish gray and pale brown to yellowish brown and grayish brown. Thin beds, composed predominately of sediment of Red River origin, are present within the sandy facies and exhibit dark brown to light brown colors. Organic material is rare within the sandy facies. The relatively fresh nature of these sediments and the calibrated radiocarbon dates in the underlying silty facies (to be described below) demonstrate that these sandy sediments are relatively recent in origin.

As shown in Cross Section 1, Cores C1 and C5 penetrated sandy sediments, which are interpreted to be channel-fill deposits on the basis of their thickness and sedimentary structures (see Figure 5-3). The channel fills consist of a heterogeneous assemblage of thin to thick beds of massive sand and silty sand, laminated sand and silty sand, rhythmically interlaminated sand and silty sand, and massive silty clay and clay. Rare beds of ripple-laminated sandy silt, laminated clay, and laminated silt also occur interbedded within the channel fills. The fine-grained sediments within these fills range in color from dark gray to dark brown, although they also have thin beds of brown sediments of Red River origin. The coarse-grained sediments vary in color from brownish yellow to very pale brown and white. Thin beds of dark brown coarse-grained sediments of Red River origin frequently occur within the channel fills. Although not penetrated by any core, the wedges of the sandy facies centered on Big Offa Bayou indicate that the facies was occupied by a major distributary channel, which would have had a major, sandy, channel-fill deposit within it. As shown in Cross Section 1, three radiocarbon samples from Core C5, from within the channel fill of Bayou Latania, yielded historic calibrated dates.

Cross Section 1 also shows that Cores C2, C3, C4, and C8, along with USACE Boring 598.5-RU, penetrated a deeper wedge of silty sediments that extends westward from the west bank of the Atchafalaya River to just west of Mill Bayou. Immediately adjacent to Big Offa Bayou in Core C3, the silty facies consists of a thin bed of laminated and massive silt thinly interbedded with laminated silty sand. Further away from the channel of Big Offa Bayou, in Cores C4 and C8, the silty facies consists primarily of either laminated or faintly laminated silt with minor beds of massive silt. On the distal edge of the Big Offa Bayou natural levee, Core C2 encountered the silty facies that consists of massive silt with laminae of silt and silty sand. Silty sediments associated with the natural levees of the Atchafalaya River were penetrated by Core C10; these consist of a mixture of massive and laminated silt thinly interbedded with massive silty clay, interlaminated silty clay and silt, and laminae of silt and silty sand. Within all of these cores, the silty facies is predominately dark grayish brown and dark brown in color with frequent thin layers of brown to dark brown silts of Red River origin.

Within Cross Section 1, Cores C2, C3, C4, and C8 all penetrated a clayey facies in their lower parts, while Core C6 consisted entirely of the facies. Except for the upper 0.7 m (2.3 ft) of Core C6, the clayey facies consists of massive silty clay and clay. The upper part of Core C6 contains laminae and a thin bed of silt. Within all of these cores, the upper part of the clayey facies is noticeably unaltered by pedogenesis. In contrast, the lower part of the clayey facies, penetrated by the bottom of these cores, exhibits evidence of pedogenic alteration (i.e., either iron-manganese nodules, carbonate nodules, or intense mottling). The color of the clayey facies changes with depth from gray, dark grayish brown, and yellowish brown to light gray, dark grayish brown, light grayish brown, olive brown, and olive. Throughout the cores, thin to medium beds of dark brown and brown clayey sediments of Red River origin frequently occur. As noted, the lower part of the clayey facies is commonly heavily mottled or stained by black iron-manganese nodules.

Core C6 also is notable for being located adjacent to the oldest cypress tree discovered during the cypress survey of the project area (see Chapter 8). Cypress Tree No. 1 is estimated to be 1,337 years old, and had a root system buried under 1.93 m (6.3 ft) of sediment. As shown in Figure 5-3, samples of plant matter from Core C6 yielded calibrated radiocarbon ages of 150 ± 40 BP (Beta-186465) at a depth of 1.15 m (3.8 ft) and 340 ± 40 BP (Beta-186466) at a depth of 2.13 m (7 ft). The shallowest depth at which distinct mottling occurs within the silty clay of Core 6, is 2.07 m (6.8 ft). The lack of mottling above this depth is inferred to represent a change from very slow rates of sediment accumulation within a backswamp (during which pedogenesis could alter the sediments) to the rapid accumulation of sediments at a rate faster than they noticeably could be modified by pedogenesis. The radiocarbon dates, the depth of the root system of Cypress Tree No. 1, and the depth at which mottling first appears, all indicate that the depth of historic sediments is about -2 m (6.6 ft).

Cross Section 2

Cross Section 2 was created from the descriptions of Cores C9, C10, and C12 Figure 5-4. The section extends in an east-west line to north of the project area (see Figure 5-2). Unfortunately, because of the dominance of channel facies in Cores C9 and C12, plus differences in the ages of the other sediments, details of the correlation and extent of different facies could not be determined.

Cross section 2 shows that natural-levee sediments were penetrated only in Core C10 (see Figure 5-4). These sediments consisted of upper and lower silty units separated by about 1.5 to 2 m (5 to 6.6 ft) of clay and silty clay. The upper few of meters of Core C10 consists of thin to medium beds of interbedded massive sand, massive silt, laminated silt, interlaminated silt and silty clay, interlaminated sand and silty sand, and massive silty clay. Radiocarbon dates from the silty clay underlying this unit demonstrate that the natural-levee sediments are of historic origin.

The lower 2.2 m (7.2 ft) of Core C10 consists of massive and laminated silt. The weathered nature of these silts and the calibrated radiocarbon ages of 300 ± 40 (Beta-186451) and 290 ± 30 BP (Beta-186469) demonstrate that these silts predate historic changes within the Atchafalaya Basin.

The sediments penetrated by cores C9 and C12 consist either largely or entirely of sandy channel fills. These sediments consist of a heterogeneous variety of massive sand,

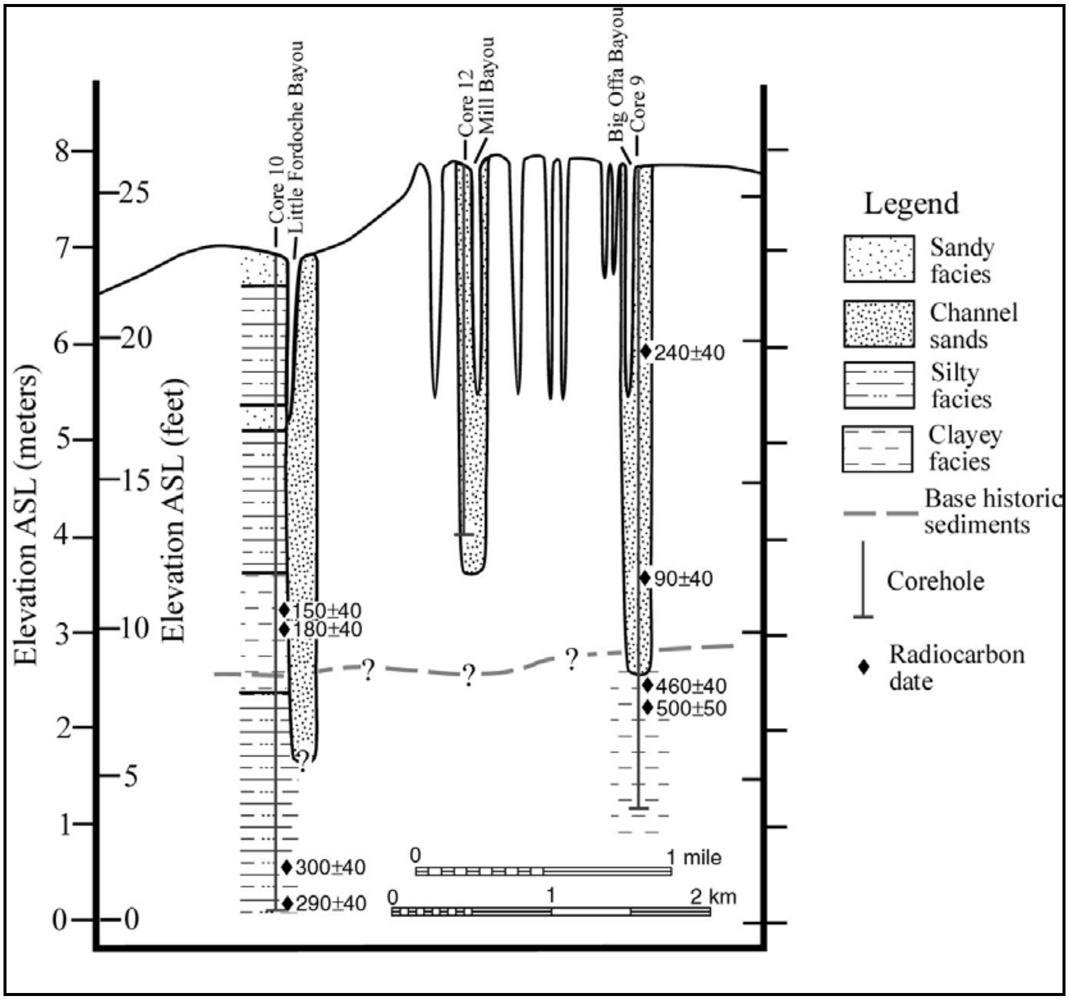

Figure 5-4. **Cross Section 2 of the northern Indian Bayou Area.**

laminated sand, cross-bedded sand, rhythmically interlaminated sand and silty sand, and uncommon thin beds of either massive or laminated silt. The sand typically is fine to very fine grained, except for the cross-bedded sand, which consists of medium-grained sand.

The channel fill associated with Big Offa Bayou is historic in age. Two samples collected from the sandy sediments of Core C9 yielded calibrated radiocarbon ages of 240 ± 40 BP (Beta-186441) and 90 ± 40 BP (Beta-186442). The older sample (Beta-18441) came from a position 3.25 m (10.7 ft) above the younger sample (Beta-186442). Because these sediments accumulated in an active channel, the older date could easily represent older material transported in from elsewhere. Therefore, the younger date provides the better indicator of the age of the channel.

Massive silty clay and clay typical of backswamp environments was penetrated by Cores C9 and C10. These sediments consist of clay and silty clay that lack any sedimentary structures. The only evidence of bedding consists of alternating medium to thin beds of dark brown, dark grayish brown, gray, and grayish brown Mississippi River sediments and dark brown Red River sediments.

Radiocarbon dates from Cores C9 and C10 demonstrate that the massive silty clay and silty clay are of quite different ages. In Core C9, plant material collected from the clayey sediments yielded calibrated radiocarbon ages of 150 ± 40 BP (Beta-186448) and 180 ± 40 BP (Beta-186449). Samples collected from underlying laminated and massive silts in Core C9 yielded radiocarbon ages of 300 ± 40 BP (Beta-186451) and 290 ± 30 BP (Beta-186469). In contrast, the samples collected from the clayey silts in Core C11 yielded ages of 460 ± 40 BP (Beta-186443) and 500 ± 50 BP (Beta-186444). It is quite clear from these dates that clayey sediments penetrated by the base of Core C11 predate the sediments penetrated by Core C10.

Core C7

Core C7 was recovered from the southern end of the project area, adjacent to the second-oldest cypress tree, Cypress Tree No. 14 (see Chapter 8). It was located near the extreme distal end of Big Offa Bayou, about 220 m west of the bayou's channel (see Figure

5-2). Cypress Tree No. 14 is estimated to be 984 years old, and its roots are buried under 0.4 m (1.3 ft) of sediment.

Core C7 was relatively short, at 5.4 m (17.7 ft) in length. Because of that, it penetrated only two different facies. The upper 1.1 m (3.6 ft) of the core consists of distal natural-levee deposits of Big Bayou Offa. These sediments include thinly to very thinly interbedded massive silty clay, laminated silt, and massive sand with one bed of ripple laminated silt. The sediments have the typical dark brown to light brownish gray colors typical of Mississippi River-dominated source deposits. Only the lower 0.4 m (1.3 ft) of this unit contains very thin interbeds of dark brown sediments from a Red River-dominated source. The remainder of Core C7 penetrated massive backswamp clays. These sediments lack any evidence of stratification and sedimentary structures except for occasional thin to very thin layers of brown to dark brown sediments of Red River origin that occur within dark grayish brown and gleyed gray and grayish brown clays. Between 2.9 and 3.7 m (9.5 to 12.1 ft) below the surface, abundant ironstone nodules occur within the clays. One piece of plant material from the backswamp clay, at a depth of 1.85 m (6.07 ft), yielded a calibrated age of 190 ± 40 BP (Beta-186465).

The largely undisturbed nature of the thinly to very thinly interbedded distal natural-levee sediments, composed mainly of Mississippi River-source sediments, indicates a period of relatively rapid sedimentation. This would not have occurred until after the Atchafalaya River had been opened up to the flow of the Mississippi River and not until Big Offa Bayou had built its crevasse splay southward into the area of Core C7. Thus, at least the upper 1.1 m (3.6 ft) of Core C7, plus part of the underlying backswamp clays, have accumulated over the last couple of hundred years as substantiated by the radiocarbon age of 190 ± 40 BP (Beta-186465). The disappearance of ironstone nodules at -2.9 m (-9.5 ft) possibly indicates a time when increased sedimentation rates precluded significant alteration of sediments by pedogenesis and weathering as they accumulated. The upper 1.1 m (3.6 ft) of Core C7 and part of the underlying clayey sediments are representative of the distal edge of the sandy and silty facies identified in Cross Sections 1 and 2.

The estimated age of 984 years for Cypress Tree No. 14, along with the fact that its roots were buried under only 0.4 m (1.3 ft) of sediment, contradict the above interpretation. If the upper 0.4 m (1.3 ft) had accumulated over the last 984 years and, by extrapolation, the upper 1.1 m (3.6 ft) had accumulated over the last 2,700 years, then these sediments should have been extensively churned by bioturbation and weathered into a homogenous mass showing a significant degree of soil development. Yet, they lack these characteristics. Given the conflicting data, it is felt that both the nature of the sediments and the associated radiocarbon date provide more credible information indicative of the age of the deposit. Furthermore, as pointed out in Chapter 8, it is thought likely that the root layer found buried at a depth of 0.4 m (1.3 ft) represents a secondary or tertiary root crown, and not the tree's original root crown. The latter should be present at a much greater depth.

Core C11

Core C11 is located at the northern end of Little Fordoche Bayou where it joins Bayou Courtableau (see Figure 5-2). The core was positioned atop the prominent natural levee of Bayou Courtableau, whose origin is a matter of considerable dispute. Because of this location, Core C11 was pushed deeper depth than any of the other cores to better understand the prehistory of both Little Fordoche Bayou and Bayou Courtableau. For Core C11, seven sections were recovered for a total depth of 9.4 m (30.8 ft). The interval between -4.0 and -7.5 m (-13 and -24.6 ft) is difficult to interpret because of very poor recovery—somewhere between 0.25 and 0.4 m (0.8 to 1.3 ft) of the core (within individual Sections 4 and 5) was subjected to slumping of sand, laminated sand, and silty sand that fell into the hole from above.

Regardless, Core C11 penetrated an upper sandy facies and a lower deposit of silty clay and silt. The upper 3.8 m (12.5 ft) consisted largely of thin-bedded, massive, very fine sand; laminated very fine sand; and interlaminated very fine sand and silty sand. Occasional beds of massive silt, laminated silty sand, and cross-bedded sand also were present. The sands in this facies vary from dark grayish brown, yellowish brown, and pale brown in the upper part to gleyed dark grayish brown and light grayish brown in the lower part. Only one very thin bed of brown Red River sediment was observed.

Between -3.8 m (-12.5 ft) and the bottom of Core C11 at -9.4 m (-30.8 ft), the sediments consisted of massive silty clay that was separated by a layer of massive silt. This latter massive-silt deposit occurred between –7.4 and -8.2 m (-24.3 and –26.9 ft). The silty clay below -8.2 m (-26.9 ft) contained a very thin bed of massive sand and a bed of interlaminated sand and silty sand. The silty clay is typically gleyed, with colors of dark grayish brown, olive brown, and gray. Rare beds of dark brown Red River sediments occurred within the silty clay, but only above a depth of 5.8 m (19.2 ft) and above the massive silt. The shallowest indication of alteration by weathering occurs at a depth of 5.6 m (18.4 ft) with well-defined mottling and iron-manganese staining. The massive silt bed appears to be somewhat weathered with dark grayish brown colors that are heavily mottled with dark yellowish brown. Its origin is uncertain.

Three ^{14}C samples (Beta-1686452, -186453, and –186454) were collected from Core C11. Plant material from within the upper sandy unit, at a depth of 2.25 m (7.38 ft), yielded a calibrated radiocarbon age of 140 ± 40 BP (Beta-1686452). A piece wood recovered 6 cm (2.4 in) below the base of the upper sandy unit, at a depth of 3.8 m (12.5 ft), yielded a calibrated radiocarbon age of 170 ± 40 BP (Beta-1686453). Unfortunately, the deepest sample (Beta-186454), collected from the lowermost silty clay at a depth of 8.6 m (28.2 ft), lacked sufficient organic material for dating.

The sediments penetrated by Core C11 provide evidence of a historic period of rapid natural-levee construction starting after 170 ± 40 BP (Beta-1686453). The rapid rate of accumulation of sediments is demonstrated by the radiocarbon age of 140 ± 40 BP (Beta-1686452) from natural-levee sediments about 1.6 m (5.2 ft) above the radiocarbon sample represented by Beta-1686453. That the sediments consist of Mississippi River-source sediments shows that significant Mississippi River water was flowing down the Atchafalaya River at that time.

Within the backswamp sediments underlying the historic natural-levee deposits, beds of massive silt occur between 7.4 to 8.2 m (24.3 to 26.9 ft) below the surface. As previously discussed, the origin of this unit is uncertain. The color of the massive silt bed only demonstrates that the source channel carried water and sediment from a prehistoric course of the Mississippi River instead of a course of the prehistoric Red River. Additional cores would be needed to determine the exact origin of the thick bed of massive silt.

The remainder of Core C11 consists of massive silty clay. These silty clays clearly represent classic, well-drained backswamp deposits as described by Coleman (1966). The abrupt change from highly mottled silty clays to silty clay of relatively uniform color at about a depth of 5.8 m (19.2 ft), suggests an increase in the rate at which sediments accumulated within the local backswamp along Bayou Courtableau. This might be related to the initial clearing of the log rafts within the Atchafalaya River and increased flow from the Mississippi River.

Discussion

From the core descriptions, radiocarbon dates, and other data collected during the present study, it is quite clear that the landforms and surficial sediments within the Indian Bayou North Area accumulated over the last couple of hundred years. Numerous radiocarbon dates demonstrate that a historic wedge of natural-levee sediments (plus associated channel fills and crevasse splays) overlies the project area, and that this wedge has a thickness ranging from less than 1 m (3.3 ft) to over 6 m (20 ft). Furthermore, many of the radiocarbon dates have overlapping standard deviations, thus indicating that the sediments accumulated rapidly within a relatively brief period of time, possibly over a period of only a several decades. The few modern ^{14}C dates indicate that the accumulation of sediments continued at a much slower rate right up until the time that Bayou Courtableau was cut off from the Atchafalaya River when the river's artificial levee was built between 1921 and 1952.

Nevertheless, the calibrated radiocarbon dates present a minor problem. Some of the dates suggest that the accumulation of sediment within the project area had already commenced several decades prior to 1851, the year during which the historical records indicate the onset of significant flooding (and, presumably, sediment accumulation) along the upper Atchafalaya River. Additionally, some of the ^{14}C dates have standard deviations whose upper ranges make them contemporaneous with the opening up of the Atchafalaya River Raft and the beginnings of increased flow down the Atchafalaya River between 1840 and 1860. However, other ^{14}C samples are from woody materials that predate 1840 by several decades to over 100 years.

One possible explanation for these discrepancies is that the older samples actually consist of a mixture of woody material contemporaneous with the accumulation of the sediments plus older woody material representing remnants of the Atchafalaya River Raft washed downstream and redeposited within crevasse sediments as the raft was broken up. The oldest dates (i.e., Beta-186446 in Core C3, Beta-186457 in Core C5, and Beta-186463 in Core C8) support this hypothesis, as they are contemporaneous with the time when some researchers have suggested that the Atchafalaya River Raft formed. Regardless of the reason for the discrepancy between the radiocarbon dates and the historic record, the sediments comprising the thick blanket of natural-levee deposits within the Indian Bayou North Area all accumulated during historic times.

A striking finding is the complete lack of any natural-levee deposits, except in Cores C10 and C11, in those prehistoric sediments penetrated by the cores. For example, in Cross Section 1, no natural-levee deposits were found in Cores C2, C4, and C6, which penetrated several meters into prehistoric deposits. Similarly, Core C9, located only 1 km (0.6 mi) from the junction of Big Offa Bayou with Bayou Courtableau, penetrated over a meter of backswamp deposits as old as 460 to 500 years. The absence of natural-levee sediments in these cores demonstrates that the natural levees of the Atchafalaya River and crevasse splays originating from Bayou Courtableau and associated their channels are all historic features. The terrain within the Indian Bayou North Area in late prehistoric times, prior to the diversion of flow down the Atchafalaya River, consisted entirely of backswamp. Quite likely, channels such as Little Fordoche Bayou, Mill Bayou, and Big Offa Bayou did not exist in prehistoric times in their present forms. If any part of these channels did exist in prehistoric times, then they most probably would have been nothing more than relatively insignificant backswamp drainages.

The only evidence for prehistoric natural levees came from Cores C10 and C11. Three observations indicate that the sediments present at the base of Core C10 represent silty natural-levee deposits closer to the source channel than those silty sediments found in the middle of Core C11. First, the silty sediments within Core C10 contains beds of silt that are either well or faintly laminated, while the silty sediments in Core C11 consist of massive beds lacking any recognizable sedimentary structures. The preservation of sedimentary structures within the silt beds is an indicator of more rapid rates of sedimentation, thus suggestive of a more proximal position relative to the source of the sediment. Second, the thickness of silty sediments in Core C10, more than 2.2 m (7.2 ft) thick, is significantly greater than the thickness of the silty sediments found in the middle of Core C11, which are just over a meter (3.2 ft) thick. If these were natural-levee deposits, then their total thickness would be expected to be greater closer to the source channel. Finally, the silty sediments in Core C10 exhibit intervals indicative of greater weathering under more well-drained conditions than in Core C11. This would be indicative of the sediment being deposited on the higher, more proximal portion of a natural levee. Given that Core C11 lies closest to Bayou Courtableau and directly between the bayou and Core C10, then these observations contradict the hypothesis of Bayou Courtableau being the source of the older natural-levee deposits found in Cores C10 and C11. Instead, an unknown channel. now completely buried by backswamp sediments, is indicated.

Conclusions

The investigation into the geology of the Indian Bayou North Area demonstrates that this region has a negligible potential for the occurrence of prehistoric cultural resources within its surficial deposits. As previously discussed and shown in Figure 5-5, a large amount of the project area is covered by over 1 to 5 m (3.3 to 16 ft) of sediments that have

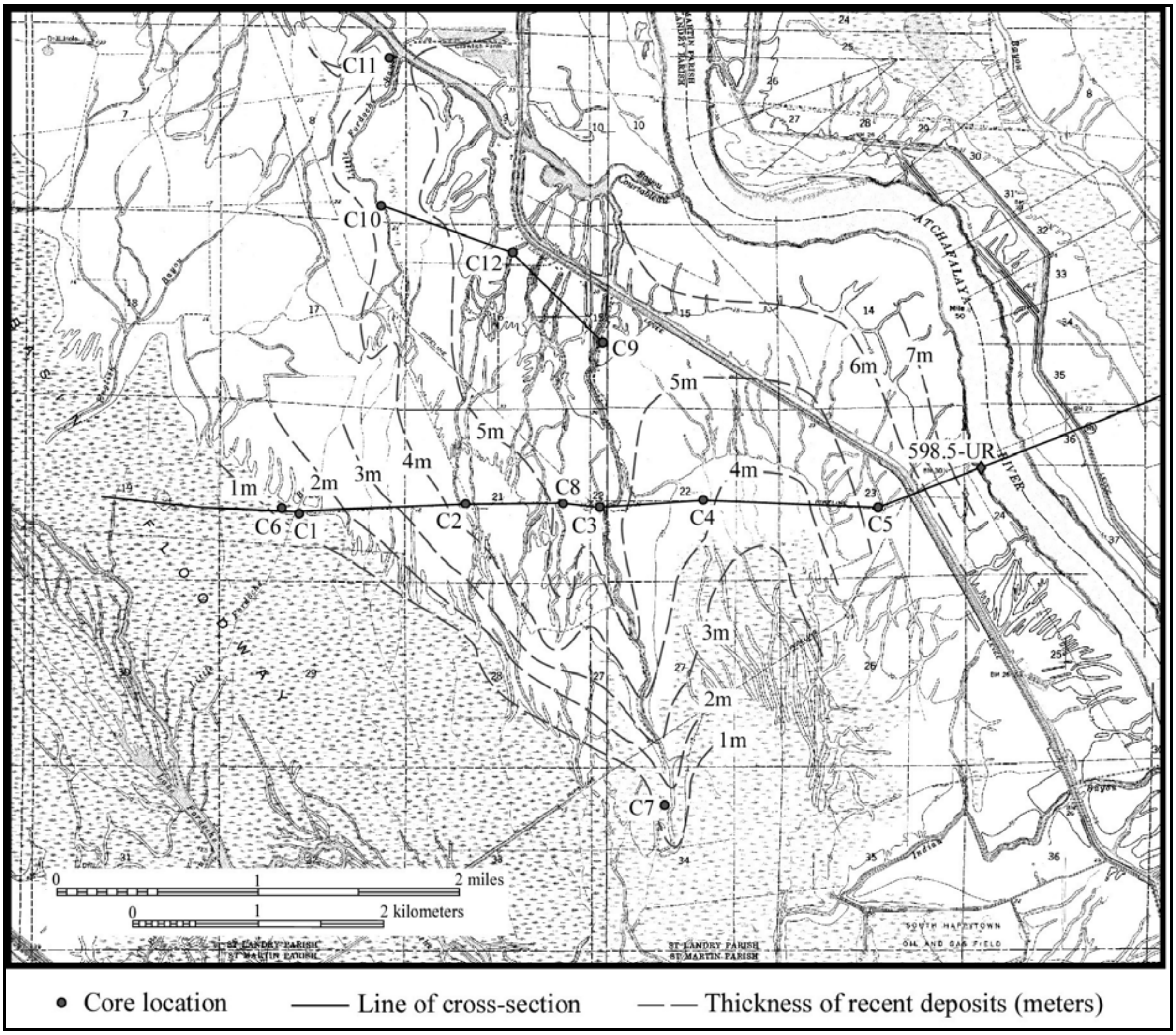

Figure 5-5. Thickness of historic non-channel deposits in the Indian Bayou Area.

accumulated during historic times. Thus, any prehistoric sediment (or surface) that might contain aboriginal cultural deposits is deeply buried under a large part of this area. As indicated by Cores C6 and C7, the edge of the crevasse splays marks the position where historic natural-levee and backswamp deposits become thin enough to allow prehistoric-age sediments to occur relatively close to the surface (see Figure 5-5).

In addition, it should be noted that those cores which penetrated deeply into the older sediments underlying the historic natural-levee deposits encountered only backswamp sediments. They found no evidence of any older channels related to Little Fordoche Bayou, Mill Bayou, Big Offa Bayou, or the other unnamed bayous or natural levees now present in the project area. Thus, even where prehistoric sediments are close to the surface of the Indian Bayou North Area, there is no evidence that landforms potentially attractive to human habitation (i.e., either natural levees or major channels) existed at the time that these sediments accumulated. Of course, it is possible that such landforms existed within the Indian Bayou North Area at some time during the Holocene. However, the available data indicate that if such landforms existed in the past, then they, along with whatever cultural resources may be associated with them, lie deeply buried beneath backswamp deposits, presumably at depths well below those penetrated by the various cores.

It is only at locations situated outside the Indian Bayou North project area, such as at the Bayou Fordoche Mounds (16SL39) and in Cores C10 and C11, that the potential exists for the occurrence of buried prehistoric sites. Core C6, as shown in Cross Section 1, demonstrated an abrupt thinning of the historic natural-levee deposits at, and west of, the western edge of the project area. As indicated by the presence of the Bayou Fordoche Mounds, the swampy area to the west of Core C6 is one of those locales where ancient sediments, with a potential of containing prehistoric cultural material, lie buried beneath a relatively thin blanket of historic sediments.

CHAPTER 6

SEISMIC TESTING OF SHALLOW QUATERNARY FLUVIAL FACIES

Juan M. Lorenzo

Introduction

As a follow-up to the coring program described in Chapter 5, a sample seismic survey was conducted across two small portions of the project area. Normally, seismic surveys obtain reliable readings only from depths greater than 30 m, a depth clearly beyond the need of the current investigations. However, by using extremely close-spaced shot points, it was considered possible to obtain useful data from the upper 30 m, allowing for the discovery of completely buried, yet relatively shallow surfaces and, possibly, their associated stream channels. If found, these locations then could be assessed for their potential for containing buried archaeological sites. It also was deemed important to check the accuracy of the seismic data against the findings of the coring program by placing the actual seismic lines near one or more of the core locations.

Research Questions

The primary question guiding the seismic investigations was: Could aboriginal archaeological surfaces be located using seismic techniques at shallow depths of only 4 to 5 meters? If so, what would be the most efficient seismic technique, and could this technique be used during future investigations of similar type in order to collect shallow (0 to -5 m) seismic cross sections?

The oil and gas industry normally targets geological layers thousands of feet below the surface. For this target depth, seismic phones or detectors (geophones) and seismic shot locations are spaced several hundred feet apart. Geophones are planted in the ground and moved by hand between individual shot locations. However, for our much shallower target range, it was necessary for the geophones and shot points be spaced no more than one foot apart. A geological cross section of only a few hundred feet would require several hundred shots and many phases of geophone collection and planting. Would it be possible to devise an efficient and economically sound method of moving geophones during data acquisition in the field?

Location of Seismic Experiments

Seismic tests were conducted at two principal areas within proximity to those locations sampled by the coring program (Figure 6-1). The first was located approximately 8 m east of Core C-1, at Universal Transverse Mercator (UTM) coordinates 617,360 m E and 3,366,900 m N.[1] The second area was located within sight of the Atchafalaya River's western artificial levee at UTM coordinates 622,378 E and 3,367,047 N, or roughly 20 meters north and west of the location of Core C-5.

Introduction to Seismic Techniques

We analyzed seismic refraction and reflected seismic signals (echoes) from both acoustic waves and a horizontal-component wave in order to determine the shallow geological structure in the two sample areas. Acoustic waves are known as P-waves or compressional waves, but they also can be accurately referred to as sound waves. We tested one horizontal-component-wave seismic source and three different types of acoustic seismic sources (Figures 6-2 through 6-4) against two different arrangements of seismic phones or detectors (geophones). In the first arrangement, we planted geophones in the ground. In the second arrangement, done for comparison, we mounted geophones rigidly on one-foot-long sections of standard channel steel or on four-foot-long wooden sleds (Figures 6-5 and 6-6).

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[1] Herein all GPS readings are assumed to have a nominal error of +/- 10 m in both the easting and northing values and are given using reference ellipsoid WGS-84, for Zone=15. WGS-84 and NAD-83 are equivalent within a few meters, which is less than the error we estimate for our easting and northing values.

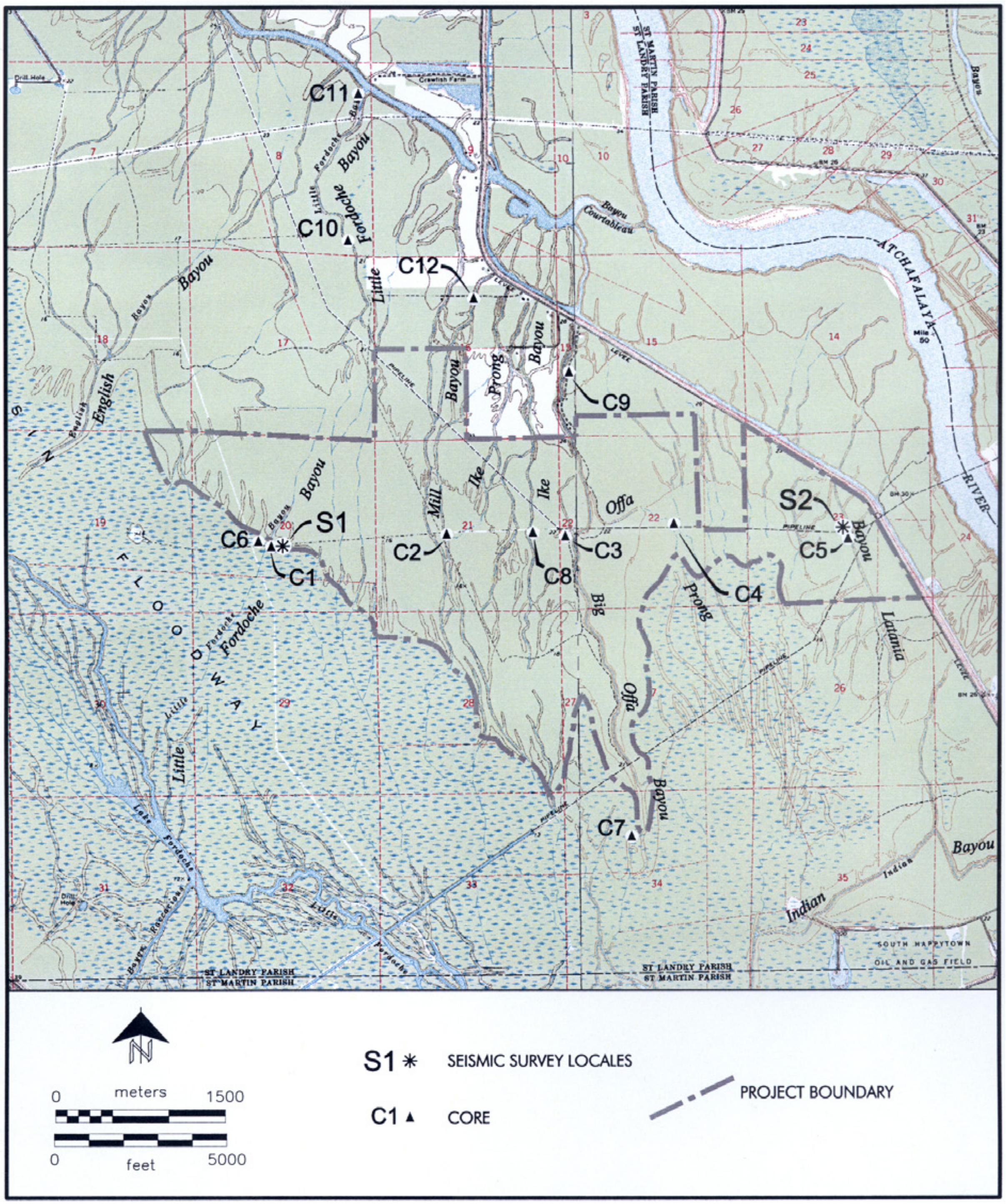

Figure 6-1. Locations of seismic survey in the northern Indian Bayou project area (USGS 1969, 1970).

Figure 6-2. Steel I-beam struck by claw hammer. Shear phones in the ground and on steel platforms (Case 1). View to south. Date: 5/20/04.

Figure 6-3. PowerHammer (Remington Trademark) 0.22 caliber shell set off by blow from claw hammer. Hammer piston is pushed out and impacts underlying 2-in square steel plate (Case 3). Date: 5/20/04.

Figure 6-4. **Flat-lying 12-in square aluminum plate (below vertical metallic bar) is struck by Accelerated Weight Drop (AWD) mounted on a four-wheel All-Terrain Vehicle. Data is collected both by geophones mounted on steel sleds and placed in the ground for comparison (Case 4). Date: 5/20/04.**

Figure 6-5. Twenty-four 100-Hz vertical geophone sensors are rigidly attached to two four-foot wooden sleds. Each sled weighs approximately 50 lbs. to assure suitable coupling with the ground. The seismic source was a PowerHammer (Remington Trademark) impacting on a 2-in square metal baseplate. LSU graduate student Adeniyi Saanumi is picture above near the first site, adjacent to Core C-1. Date: 1/24/04.

Figure 6-6. Twenty-three 100-Hz vertical geophone sensors are rigidly attached to C-channel, soft steel platforms plus one in the ground. Each sled weighs ~20 lbs. and is 10 in. long. The heavy weight assures suitable mechanical coupling with ground. The seismic source was generated by (1) a claw hammer (Case 2), (2) the impact of an AWD on a 12-in square aluminum plate (Case 4). This line of geophones is oriented from west (farthest point) to east). Geophones are placed one foot apart. This site is adjacent to Auger A-10 and Core C-5. Date:

As noted, commercial seismic surveys, with targets at thousands of feet below the surface, plant geophones hundreds of feet apart. However, our much shallower targets of 0 to -5 m required geophones and shots spaced no more than one foot apart. Although beyond the scope of this contract, in order to collect profiles hundreds of feet long we tested a new, more efficient method of collecting long seismic cross sections of the shallow subsurface. This new method used geophones mounted rigidly on heavy, steel sleds. In comparison to geophones planted in the ground, sled-mounted geophones can be moved more efficiently when collecting long seismic profiles. Sled-mounted geophones can increase efficiency and thereby reduce field costs tenfold. On the other hand, sound waves (P or compressional waves) are very sensitive to near-subsurface conditions and P-wave reflections in the higher frequency range (which are necessary to obtain the greatest resolution) can be attenuated completely.

Normally, the oil and gas industry creates continuous seismic images of the subsurface by collecting acoustic echoes generated by different buried geological surfaces. In the soft soil conditions of the Atchafalaya Basin, seismic echoes from the subsurface are absorbed by the porous nature of the ground. Horizontal-component seismic waves are not sensitive to the presence of partially saturated voids in the near subsurface because they only travel within the matrix as voids and fluids have no shear resistance and cannot transmit horizontal-component waves. For both these reasons combined, we obtained the buried geological structure by careful analysis of seismic *refracted* signals in horizontal-component seismic data. Refracted seismic signals travel through the sediments and return to the surface recorders without requiring sharp geological boundaries to produce echoes.

Horizontal-Component Geophones (" 30 Hz") and Vertical-Component Geophones ("100-Hz P-Wave/Sound Geophones")

We recorded the seismic data sets generated from ~200 shots. Twenty-four geophones were used for each shot. In all cases data were collected with both platform-mounted geophones and ground-planted geophones (see Figures 6-5 and 6-6). Geophones were spaced at either 4-inch or one-foot intervals. Two large wooden platforms allowed for a four-inch horizontal separation (see Figure 6-5). All other experiments used a one-foot separation between geophones (see Figures 6-2 through 6-4).

No literature exists on the applicability of geophones mounted on steel sleds to collect adequate seismic data for our shallow target depth. The degree of mechanical coupling between the sled-mounted geophones and the ground will determine the quality of the data. However, we expected that any poor quality in the data would be offset by the efficiency gained due to the much quicker data-collecting time.

We sampled the strength of the returning seismic signals at very fast rates (8,000 to 32,000 samples per second) to record the highest resolution. For every shot, we listened and recorded the first 0.5 to 0.25 seconds (two-way travel time) of seismic returns. This was the necessary amount of data to determine the first few meters of the subsurface.

Sources of Seismic Signal

Four different seismic sources were used:

Case 1. A 2-pound claw hammer striking a 6-in broad, steel I-beam, side on from the north and south (horizontal-component seismic waves) (see Figure 6-2).

Case 2. A 2-pound claw-hammer vertically striking a 6-in square aluminum striker plate (sound waves).

Case 3. A 0.22 caliber powered-PowerHammer (Remington Trademark) vertically striking a 2-in square, 1/16-in-thick steel plate (sound waves) (see Figure 6-3).

Case 4. An Accelerated Weight Drop (from Digipulse) striking a flat-lying, 12-in square aluminum plate (sound waves) (see Figure 6-4).

For Case 1 (horizontal-component seismic source), seismic wave returns from the subsurface were sensed by 30-Hz horizontal-component geophones. Horizontal-component waves can be half as slow as sound waves. Although these phones pick up lower frequencies than the vertical-component geophones, the slower speed of shear waves in the same material can produce the same effective resolution of the subsurface.

For those cases (2 through 4) where the seismic sources generated sound waves, we used 100-Hz (high-frequency) vertical-component geophones that are able to detect frequencies of up to up to several thousand Hz.

Multiple Blows

For all the above cases, while maintaining the location of the source and receivers, we varied the number of impacts on the aluminum striker plates and the steel I-beam, with 1, 3, 5 and 7 blows. Each additional two blows improved the signal-to-noise ratio. Each additional blow provided data that were stacked onto the data recorded by the previous blows. Because the accelerated weight drop (AWD) (Case 4) provided such a heavy blow, only 1, 3, and 5 blows were struck for it. For all sound wave and horizontal-component wave experiments, one blow proved sufficient to generate the seismic data needed for refraction studies.

Horizontal-component, wave-based data sets also were collected while experimenting with multiple blows (1, 3, 5, and 7 blows). In addition, both sides of the I-beam were struck to further improve the signal-to-noise ratio. The I-beam was positioned on its side, forming a capital "H" in profile where the legs of the "H" were struck horizontally from both the north and south direction. These resulting data-set pairs were subtracted from each other in order to destroy vertical-component noise but enhance the desired horizontal-component wave signal.

Seismic Data

Seismic data are shown in Figures 6-7 and 6-8 and represent information received from 72 geophones. In all cases, the left-most geophone is closest to the seismic source. Our

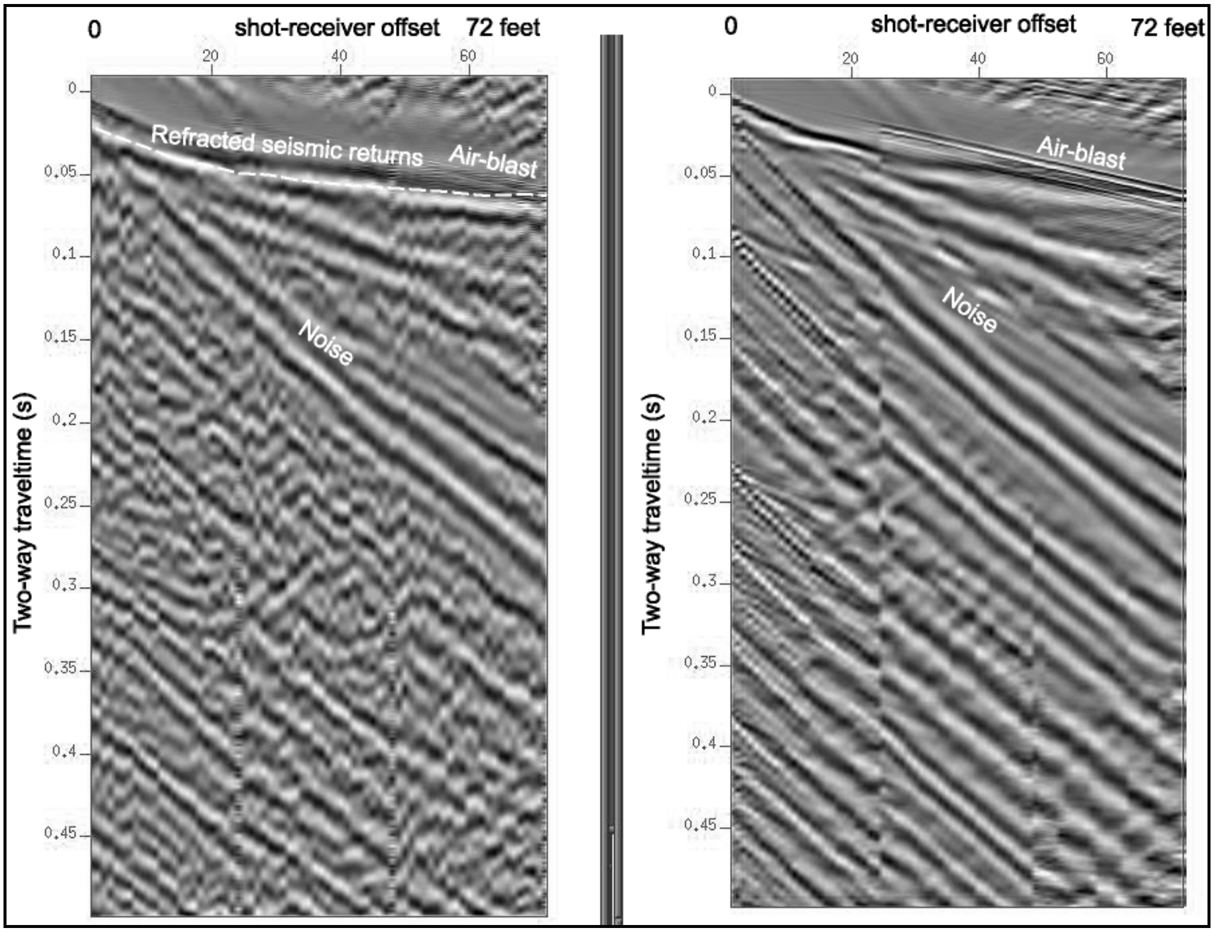

Figure 6-7. P-wave pseudo-walkaway tests. Each has a horizontal offset that varies from 0 to 72 feet, left to right. Seismic data on left is noisier(more "jittery") than data on the right. Both were collected with an AWD (See Figure 6-4). Data on the left were collected using geophones mounted on a steel sled. Data on the right were collected using geophones placed in the ground. Refracted seismic returns on the left image are adequate to derive a detailed velocity structure of the upper 4-5 m.

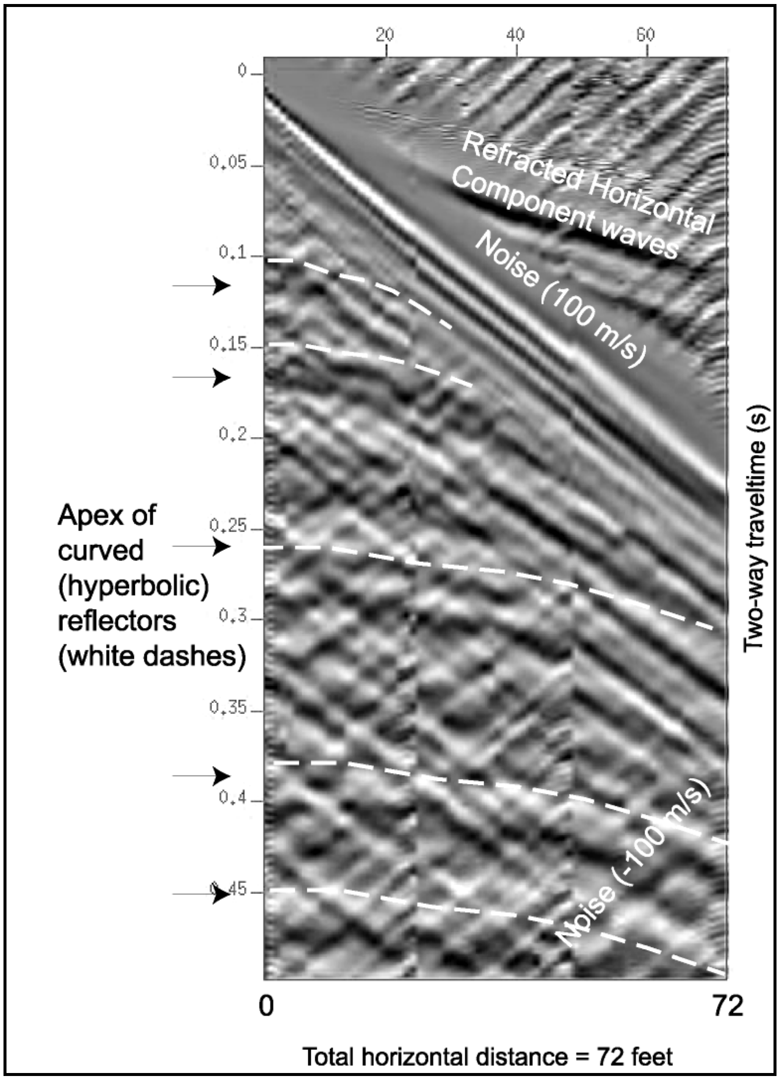

Figure 6-8. Horizontal-component seismic data show reflections (dashed) starting at 0.1s. Apex of the curved (hyperbolic) reflections shows time of flight from the surface (0 seconds) to and from each target boundary. These data were generated with 3 horizontal blows of a claw hammer against a steel I-beam (See Figure 6-2).

seismic recording system was a 24-channel Strataview built by Geometrics. By taking a total of three shots at different distances from the geophones we were able to build a panel of 72 geophones. In this manner the subsurface is illuminated with seismic rays that sample different depths and distances. Of all the experiments, we selected the data shown in Figures 6-7 and 6-8 as the best and most representative examples.

Core Analysis

To complement the seismic data, it was decided that non-destructive geophysical logging of the nearest cores might prove useful. Thus, through the generosity of Dr. Sam Bentley of the Coastal Studies Institute at Louisiana State University, a Geotek Multi-sensor Core Logger collected physical parameters of each of the two cores. Data collected included magnetic susceptibility, bulk sediment density, and electrical resistivity.

The core logger produces physical-property measurements of sediments still in place within core sleeves (Figure 6-9). It permits high-resolution, non-destructive measurements of sediment compressional wave speed, wet-bulk density (via γ-ray attenuation), resistivity, and magnetic susceptibility on sealed or split cores. Spatial resolutions for sensor measurements are ~0.5 cm for bulk density, ~1 cm for P-wave speed, and 2 to 8 cm for magnetic susceptibility and resistivity. The precision and accuracy of the sensors (after calibration) are ~0.5 to 1 percent of measured values.

Results

(1) Geophones Mounted on Steel Sleds Proved to be the Best Technique for Collecting Good-Quality Seismic Data.

In future data acquisition, collection rates can be increased tenfold by using sled-mounted geophones, as opposed to traditional methods that plant geophones in the ground. Both horizontal-component seismic receivers (geophones) and vertical-component geophones on steel sleds provided good, refracted seismic data that could be analyzed for velocity information in the shallow (0 to 4 m) subsurface.

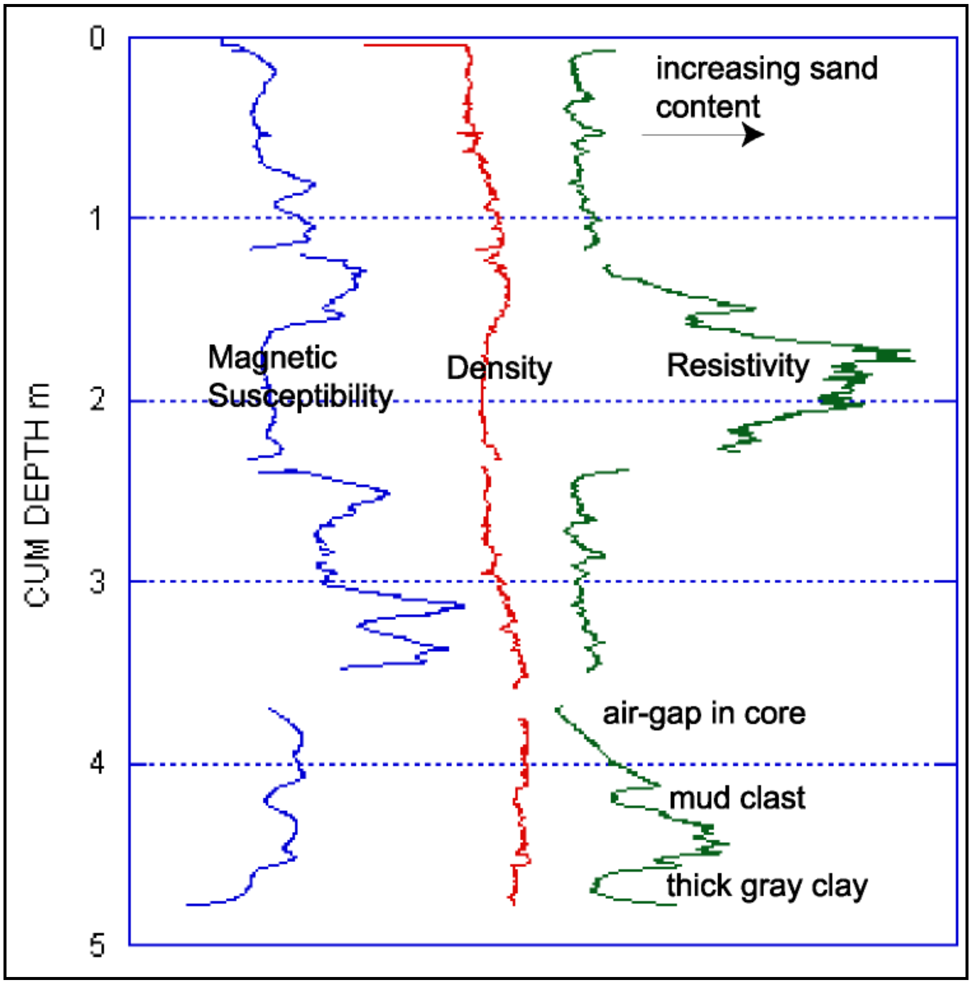

Figure 6-9. Physical properties measurements carried out on Core C-1. Together with a visual correlation of the curve values at a few points in the cores, these graphs assist in the interpretation of grain size trends and bed thicknesses.

We found that, whereas the data collected by mounting geophones on steel sleds may not be of optimal quality, it is still of sufficient quality for our objectives. A good model of the subsurface (Figure 6-10) was generated using refraction data collected by geophones mounted on steel sleds. We note that in the case of acoustic seismic data (P-wave data, compressional wave data, or sound) the best seismic refraction data were obtained using a combination of geophones planted in the ground and an Accelerated Weight Drop seismic source.

***(2) None of the Tests that Used Sound Waves Could Detect any Reflections from the Subsurface*.**

The absence of reflections may be caused by the attenuation of high-frequency components in the sound waves, or the absence of suitable sediment contrasts. Because the core analyses displayed many contrasts in sediment type and physical properties (see Figure 6-9), we assume that natural seismic attenuation is responsible for the poor reflections from the shallow subsurface. The shallow subsurface consists of partially saturated soils with many visible and microscopic voids that make sound travel (but not reflect) at half the velocity it does normally in air. By comparison, then, air proves to be a more rigid medium than the loose soil of the study area!

A confirmation of the high attenuation of seismic signal was found using the Geotek multi-sensor core-logger. This tool was not able to provide any usable sound-wave velocity values because transmitted signal values were considered too weak/attenuated. Only complete whole cores, while still in the original liner, were run through the Geotek tool. Visual inspection of the cores after cutting the liner did not reveal air gaps that could also be responsible the attenuation. Thus, we conclude that the nature of the soils is responsible for this attenuation.

(3) Only Horizontal Component Waves Provided Seismic Echoes

Horizontal-component seismic waves have the greatest potential for collecting echoes, or reflections, from the near subsurface (upper 20 m) in this environment. Of the

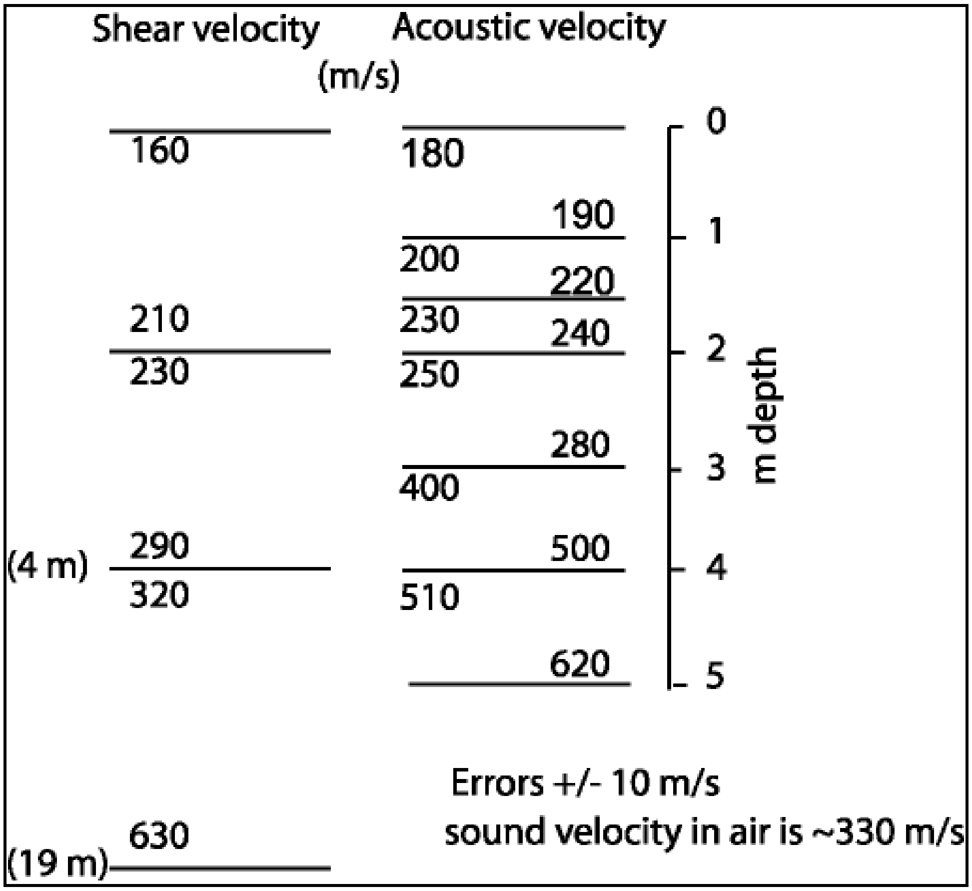

Figure 6-10. Velocity-depth models of refracted seismic data from both shear and acoustic (P wave) data sets collected with geophones mounted on steel sleds rather than the traditional geophones planted directly in the ground. Velocity values are shown at the top and bottom of layers and velocity values within the layers can be estimated. Because there are no actual reflections visible in the shear wave data down to about 4 m (~ .043s) small differences in velocities (+/- 20m/s) across layer boundaries are not deemed capable of producing reflections.

four types of seismic sources we used, only horizontal-component wave data (Case 1) produced any detectable reflections from the subsurface. Unfortunately, the shallowest reflection occurred from a boundary at about 19 m below the surface. The nature of this surface is unknown at present, but it clearly is well below the depth of any potential disturbances resulting from future improvement projects in the study area.

We suggest that low ground-roll velocities correlate with poor P-wave reflections and that, in these cases, shear-wave data be collected instead. We find that when ground-roll arrivals (Rayleigh waves) show velocities in the low range of 80 m/s, attenuation of seismic sound waves is detrimental, and horizontal-component waves are the only type of seismic energy that can provide reflections in the shallow subsurface.

(4) Refracted Shear-Wave and Acoustic Seismic Rays Can Both Give Detailed Velocity Information of the Upper 4 to 5 Meters of the Subsurface

We adjusted our estimates of velocity and thickness until we were able to match the seismic data refracted arrivals. Figure 6-10 shows these results. Note that horizontal-component seismic wave velocities are lower than the seismic sound-wave velocities at the same depth. From the combination of both acoustic-wave and shear-wave velocities, useful engineering properties, such as the shear modulus and bulm modulus of the soils, can be calculated.

Recommendations

In the future, for very shallow deposits (0 to -4 m), quick/cheap refracted seismic data should be collected for refraction tomographic modeling. Tomography (e.g., medical CAT scan imaging) is an established technique used to image human bodies; it also can be applied to seismic refraction (P-wave and shear-wave) data. Modeling the travel times of refracted data can generate seismic velocity models of the upper 2 to 4 meters of the subsurface (see Figure 6-10). Tomographic modeling of refraction data has become a standard specialty technique over the past 20 years in the oil and gas industry.

Future seismic experiments that aim to use reflections (echoes) to create seismic cross sections in the study area, should only use shear-wave data for target depths at and below about -20 m.

Lastly, refracted seismic data and its interpretation should be optimized for speed and cost by employing seismic platform imaging. This will allow the collection of 200-foot-long profiles per day of field work.

CHAPTER 7

SHOVEL TESTS

Richard A. Weinstein
Jeramé J. Cramer

Another aspect of the Phase I field work involved a terrestrial survey of selected high-probability areas in an effort to locate historic archaeological sites. The original plan called for an examination of the natural levees of several of the major water courses in the project area. If sites were found, then the survey would be expanded to include selected low-probability locations (natural levees of smaller channels and non-channel areas). Fifty percent of the effort was to be devoted to the high-probability areas, while the remaining fifty percent was to be expended on the low-probability locales, if necessary.

Four channels were selected as the initial high-probability search locations: Bayou Latania, Offa Prong, Big Offa Bayou, and Little Fordoche Bayou (Figure 7-1). The natural levees of both sides of each channel were systematically walked and a single line of shovel tests was excavated at 30-m intervals along each bank (Figure 7-2). In some cases, the presence of low, swampy areas, small water-filled channels, and/or wet sloughs made it impossible to dig tests at the required 30-m intervals, and the placement of the tests had to be adjusted accordingly. Overall, a total of 493 shovel tests was excavated (see Figure 7-1).

Most shovel tests were excavated to depths of between 30 and 50 cm, although some went as deep as 60 or 70 cm. All fill was screened through 1/4-inch wire mesh, and the stratigraphy of each test was recorded. In addition, the location of each test was stored in a hand-held global positioning system (GPS) with an accuracy of ca. 6 m. In some instances, due to heavy tree cover, the GPS produced readings that clearly were inaccurate. These were adjusted by placing the plotted location midway between the positions for the two adjacent shovel tests. As can be seen on Figure 7-1, there were two instances where it became difficult to accurately follow the respective channels: the distal end of Big Offa Bayou and

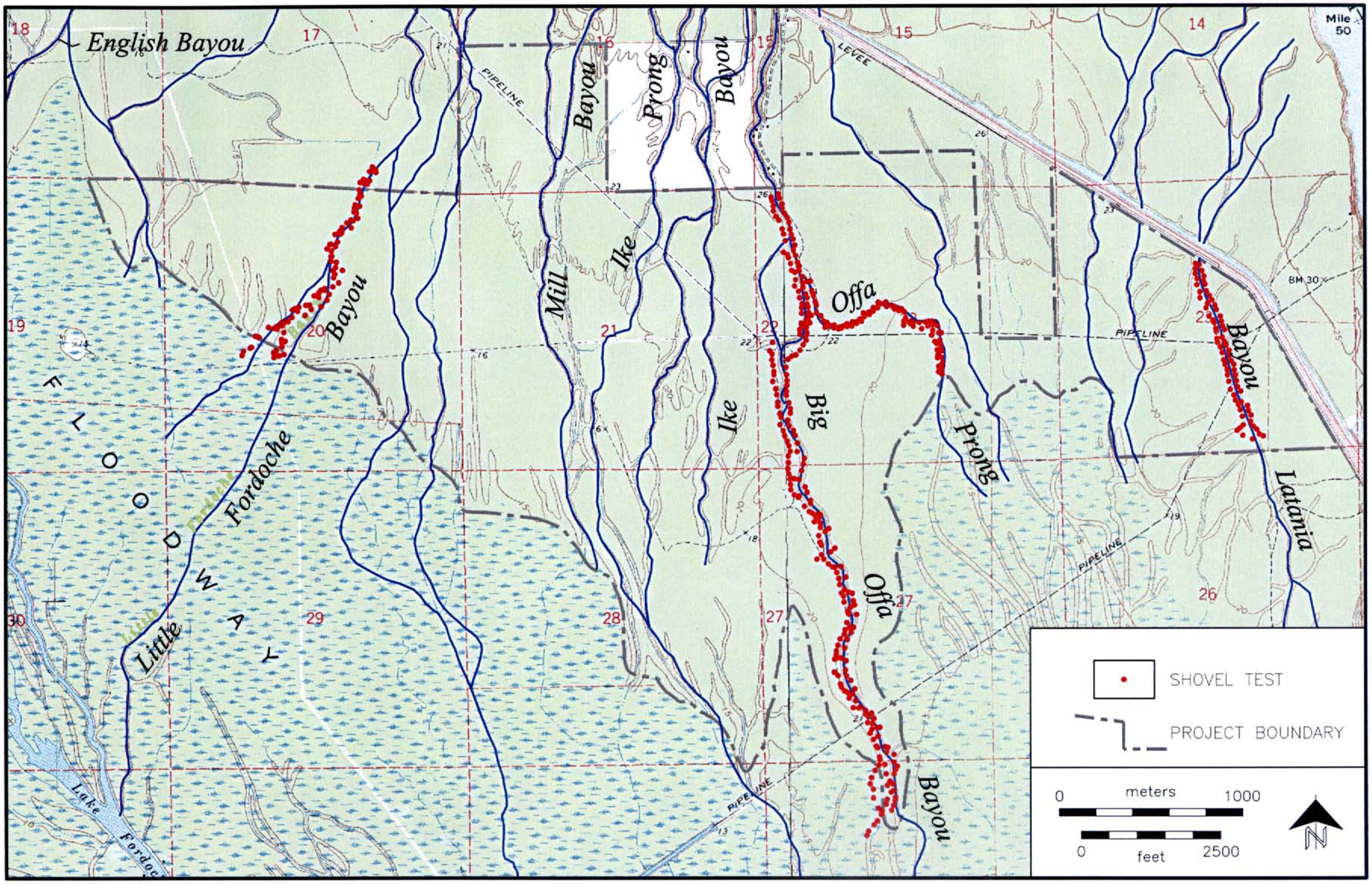

Figure 7-1. Locations of shovel tests excavated along the high-probability natural levees of Bayou Latania, Offa Prong, Big Offa Bayou, and Little Fordoche Bayou in an attempt to locate historic sites. Note the lines of shovel tests to the west of the Little Fordoche channel. These were dug along what appeared to be the main channel in the area; a channel different from that illustrated on the quadrangle map (USGS 1969, 1970).

Figure 7-2. Crew member digging shovel test along the northern portion of Big Offa Bayou. View to the southwest with Big Offa Bayou in the background. Date: 8/21/03.

along the lower portion of Little Fordoche Bayou within the project area. In both cases, tests were excavated along what was thought to be the main channel of each bayou, while extra lines were dug along apparent secondary channels that passed nearby through the area.

Results

Only four shovel tests produced any evidence of cultural material. Test 59, located along the west side of Big Offa Bayou near the line separating Sections 22 and 27, yielded fragments of a cotton T-shirt within the upper 10 cm. Tests 136, 137, and 138, all situated along the east side of Big Offa Bayou in the west-central portion of Section 22 (and adjacent to a fenced-off area where pesticides once were stored), produced a few tiny brick fragments within the upper 10 cm. Test 137 also yielded a copper tack within the upper 10 cm. All of these items are very recent and undoubtedly represent trash discarded along an old field road and adjacent to a former agricultural storage complex. No evidence was found of any eighteenth-, nineteenth-, or early-twentieth-century sites or activity areas.

Given the results of the shovel testing program along the high-probability landforms, it was decided that additional survey effort on low-probability features would not be necessary. Accordingly, the search for historic sites within the project area was terminated at that point.

CHAPTER 8

INVESTIGATION OF CYPRESS TREES AND CYPRESS STUMPS

George J. Castille III
Joy Young

Phase I Investigation of Cypress Trees and Cypress Stumps

Determining the cause and timing of landform changes is often the objective of several scientific disciplines. Understanding how a land surface changed over time can provide information that can be applied to changes in prehistoric human populations and human migration. Recently, the development of a baldcypress tree-ring chronology in North Carolina allowed reconstruction of climate for the past 1,700 years and provided insight into the causes that might have resulted in the disappearance of the inhabitants of the "Lost Colony" on Roanoke Island, North Carolina, long a subject of mystery to historians (Stahle et al. 1998).

Dendrochronology, the development of a chronology based on changes in annual ring width, can also be used to assign precise calendar dates to the study of geologic or geomorphic events such as arroyo formation (Gonzalez (2001), debris flows (Santilli and Pelfini 2002), changes in river channels (Lookingbill et al. 1987; Brown et al. 2001), tectonic activity (VanArsdale et al. 1991), the formation of alluvial fans (Hereford et al. 1996; Santilli and Pelfini 2002), flooding and subsequent sediment deposition (Butler 1979; McCord 1987; Kycnl and Dobry 1993), changes in salinity within coastal wetland settings (Montz 1970), and the alteration of local hydrology through permanent inundation (Young et al. 1995).

The recent acquisition of land on the western side of the Atchafalaya Basin by the U.S. Army Corps of Engineers has prompted research into the history of the present project area, including the evaluation of locations that may have archaeological potential. Carbon-14 dating provides approximate calendar years for organic materials that were imbedded in sediment layers. However, determining the precise dating of the prehistoric and historic land surfaces, and developing a chronology of aggradation events, can best be accomplished through an integrated program utilizing dendrochronology and archaeological techniques. At many sites, the presence of only short-lived species makes the precise dating of historic land surfaces difficult. The presence of baldcypress within the Indian Bayou study area provides sample material that may allow the development of long-term chronology from trees that most likely became established on the prehistoric and historic land surfaces.

Phase I Research Design

Cypress trees offer a unique potential for measuring rates of sedimentation in wetland areas. This potential exists because of several characteristics of cypress: (1) they produce growth rings that can be measured, (2) they can live for hundreds of years, and (3) once established, the primary root system serves as a marker for the original ground surface. For over 60 years, Louisiana foresters and geographers have used tree age analysis as a tool for dating natural features such as lake shorelines (Brown 1942, 1943; Russell 1941, 1942; Brown and Montz 1986). Despite an abundance of research on cypress growth rates and responses to various environmental conditions, very little research has been conducted on tree response to sedimentation. It has long been assumed that where rapid sediment accumulation occurs, cypress usually die (Brown and Montz 1986). More recently, some research has shown that cypress survive when sedimentation occurs slowly. If conditions are favorable, local sedimentation rates can be determined by comparing tree age to the depth of the primary (original) root system (Castille 2001) (Figure 8-1).

Because of its characteristic wetland nature and its well-documented history of sedimentation, the Atchafalaya Basin provides a unique setting for investigating the relationship between tree age, root response, and rate of sedimentation. In the northern part of the basin, the western floodway offers one of the best settings for an investigation of sedimentation rates because the sediment-accumulation rate has not been rapid enough to kill

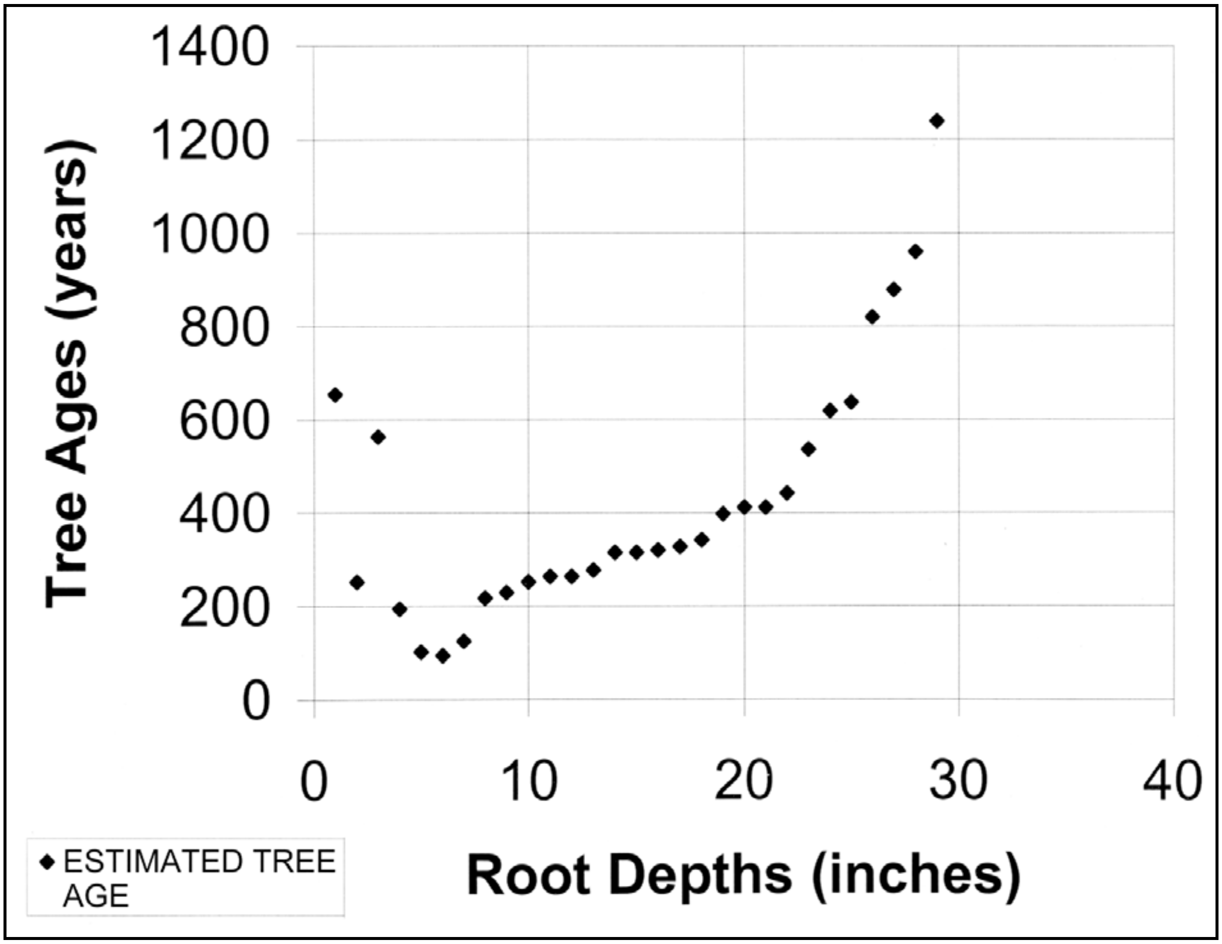

Figure 8-1. Sedimentation measurements from cypress trees in Iberville Parish, Louisiana (Castille 2001).

the older cypress. In areas where old-growth cypress remain, the proposed research offers a chance to identify old land surfaces that are hundreds of years old, and if conditions are favorable, up to 1,000 years old. Such a dating technique has obvious applications for identifying buried natural levees and other features considered high-probability areas for prehistoric or early historic occupation.

For the initial Phase I study, an examination was made of selected trees within the study areas examined by CEI and Earth Search, Inc. (ESI). Tree selection was based on several criteria, including estimated age, physical setting, and ease of access. For each tree examined, the following data were collected:

(1) Tree size. Measurements included diameter at ground level and diameter above the butt swell (dbh).

(2) Depth of root system

(3) Increment-core samples (2 per tree)

(4) GPS coordinates

(5) Photographs of each tree

Tree size (diameter) serves as one measure for determining tree age. Because most old-growth cypress are hollow, their ages must be estimated, either by comparing them to dated trees of similar size or by examining core samples from the surviving outer trunk and extrapolating the growth rate to the center of the tree. For younger trees that are solid, obviously the best age determination is derived by counting growth rings to the tree center. The depth of the root system can be determined by probing with metal probes.

The primary goal of the Phase I cypress investigation was to determine whether a correlation existed between the age of cypress trees and the depth of the root crown. Cypress trees do not maintain a tap root. Instead, in a typical swamp setting, the primary root system consists of a lateral splay of roots (the root crown) just below the surface. Most cypress trees produce knees that are simply vertical extensions of selected roots that protrude above the ground. Studies have determined a correlation between knee height and the elevation of annual high water events (Brown and Montz 1986; Kernell and Levy 1990; Mattoon 1916). Very little research has been done on the response of cypress to sedimentation, due to the long-held assumption that, like most other trees, cypress simply die when exposed to sediment accumulation (Brown and Montz 1986).

For the initial study, trees of different ages (sizes) were examined. For any given environmental setting, it was anticipated that the oldest trees would exhibit the deepest root crowns. Assuming that the initial root-crown depth could be identified, a rate of sediment accumulation could be determined by comparing tree age with the depth of sediment over the root system.

The Atchafalaya Basin represents an area that has experienced extensive sediment accumulation over the last few centuries. Since 1930, the Corps of Engineers has collected data on sediment accumulation within the middle and lower portions of the basin along range lines running perpendicular to the Atchafalaya River. These transects indicate areas where sediment has accumulated from Atchafalaya River overbank deposits. The Indian Bayou North area straddles the Corps' elevation Range 5, which runs along the east-west pipeline/access road that goes through the middle of Sections 19, 20, 21, 22, and 23 of Township 7S, Range 7E. Range 6 crosses the Indian Bayou South area, crossing the Atchafalaya River near the mouth of Indian Bayou. The Corps' elevation study of 1951 indicates a maximum of 1 ft of sediment accumulation just west of Big Offa Bayou (mislabeled "Indian Bayou" on the Corps' cross section) between 1930 and 1950 and virtually no sedimentation for most of the study area during that period (Latimer and Schweizer 1951:2:Plates B57, B58). Within the upper Atchafalaya Basin, which includes the present study area, most sedimentation probably occurred prior to installation of the east and west basin guide levees during the 1930s. Subsequent to construction of the levees, sedimentation has been most extensive in the lower part of the basin where Grand Lake and other open water areas have filled in.

Within the study area, water-tolerant vegetation has dominated the areas of lower elevation from the mid nineteenth century until the present. In the present backswamp areas, cypress are still common and tree sizes range from seedlings to old-growth examples that are over one meter in diameter.

Summary of Phase I Findings

In conjunction with both the geological research and the archaeological survey, a pedestrian survey was conducted to identify areas of cypress growth. The preferred locales for study were wetland areas that displayed a relatively uniform natural setting and contained a wide range of cypress tree sizes. Although cypress were observed throughout the study area, very few concentrations were noted and only a handful of obvious old-growth examples were found. The original plan was to collect data from both the Indian Bayou North (CEI) and Indian Bayou South (ESI) study areas. However, no old-growth specimens were found within the South area and the focus of the study was therefore shifted to the North where cypress were more abundant. Cypress specimens occurred in a wide range of tree sizes at two locales within the Indian Bayou North study area: (1) along Little Fordoche Bayou and (2) along Big Offa Bayou (Figures 8-2 through 8-4).

Cypress Trees

Increment-core samples and root-depth data were collected from 20 living trees in these two locales (Figures 8-5 and 8-6). At least two increment-core samples were recovered from each tree. Trees ranged in age from about 80 years old to 1,600 years old (Table 8-1). For each cored tree, root depths were also recorded by systematically probing around the base of each tree with a 6-ft-long metal probe (Table 8-2; see Figure 8-5). Root growth patterns were also revealed by hand excavation at the base of selected trees (Figure 8-7 and Table 8-3). The maximum depth of the hand excavations was 1.5 meters. To avoid tree damage, excavation was halted when too many large roots were encountered, and to continue digging would have required removal (cutting) of the roots. At the bottom of each hand excavation, additional probing was performed in an attempt to identify deeper root crowns. For smaller (younger) trees, the depth of the primary root crown was easier to determine because the root systems were shallow. For older trees, roots varied in depth and it was difficult to identify the original root crown by probing or excavation for two reasons: (1) in

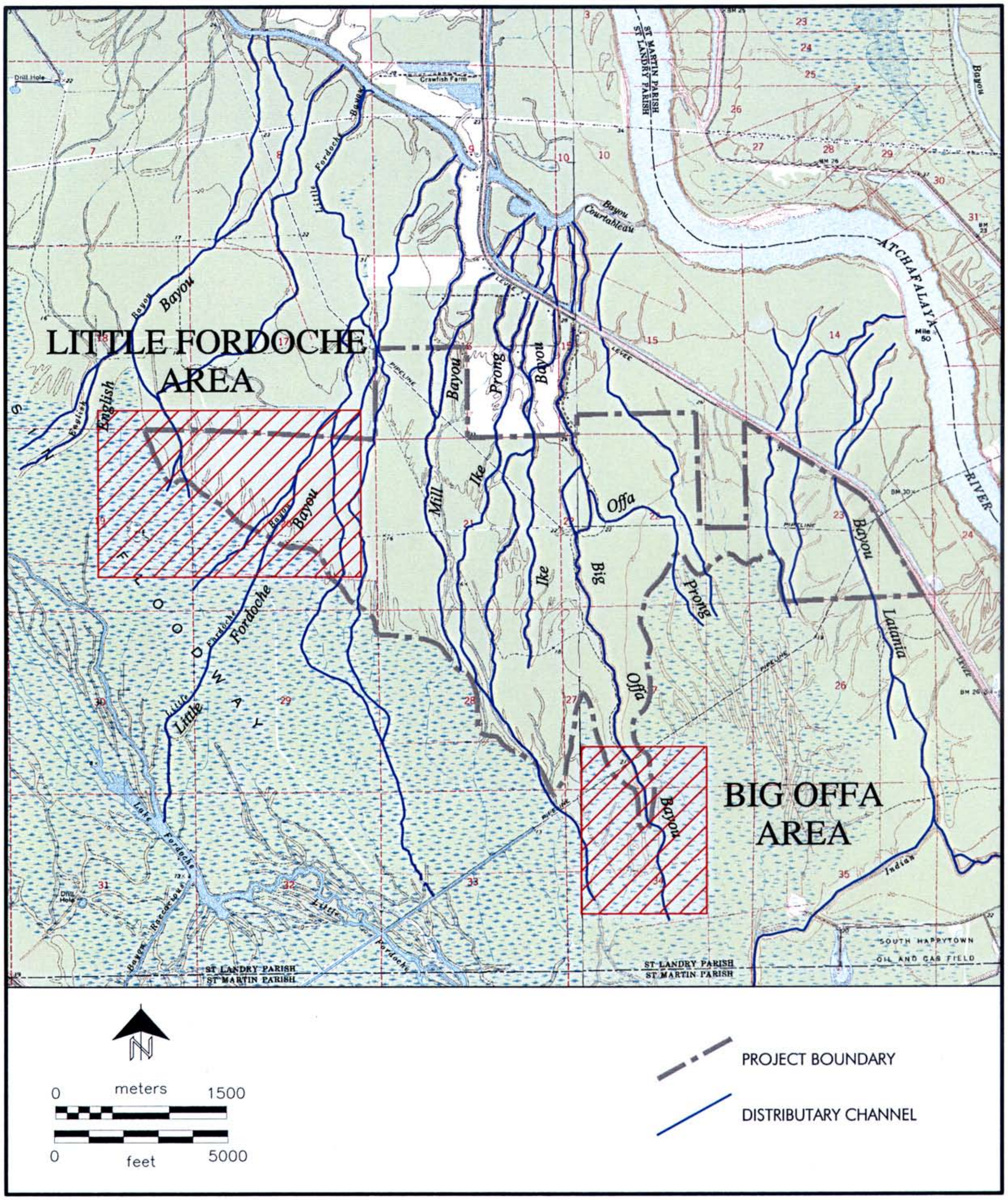

Figure 8-2. **The Little Bayou Fordoche and Big Offa Bayou locations within the Indian Bayou North project area. These areas contained a wide range of old-growth cypress trees that were available for study (USGS 1969, 1970)**

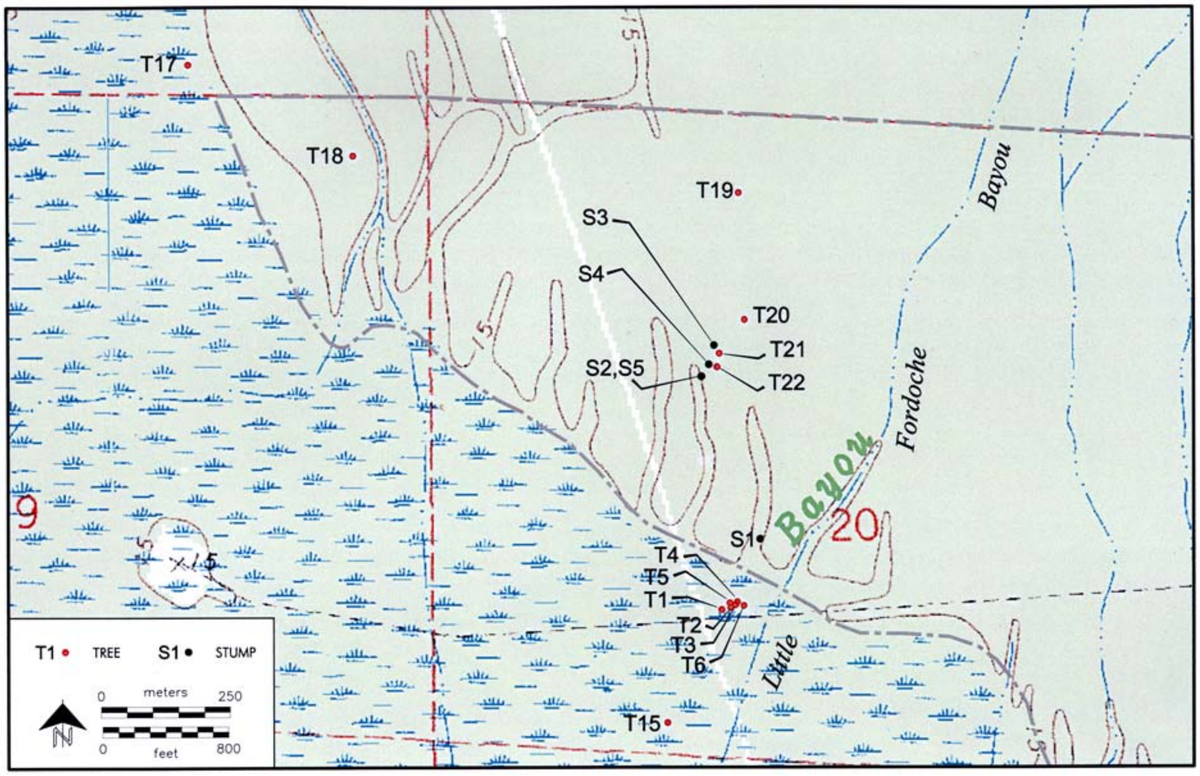

Figure 8-3. Detail map of the Little Bayou Fordoche location, showing the distribution of individual cypress trees and stumps examined during the present study (USGS 1969, 1970).

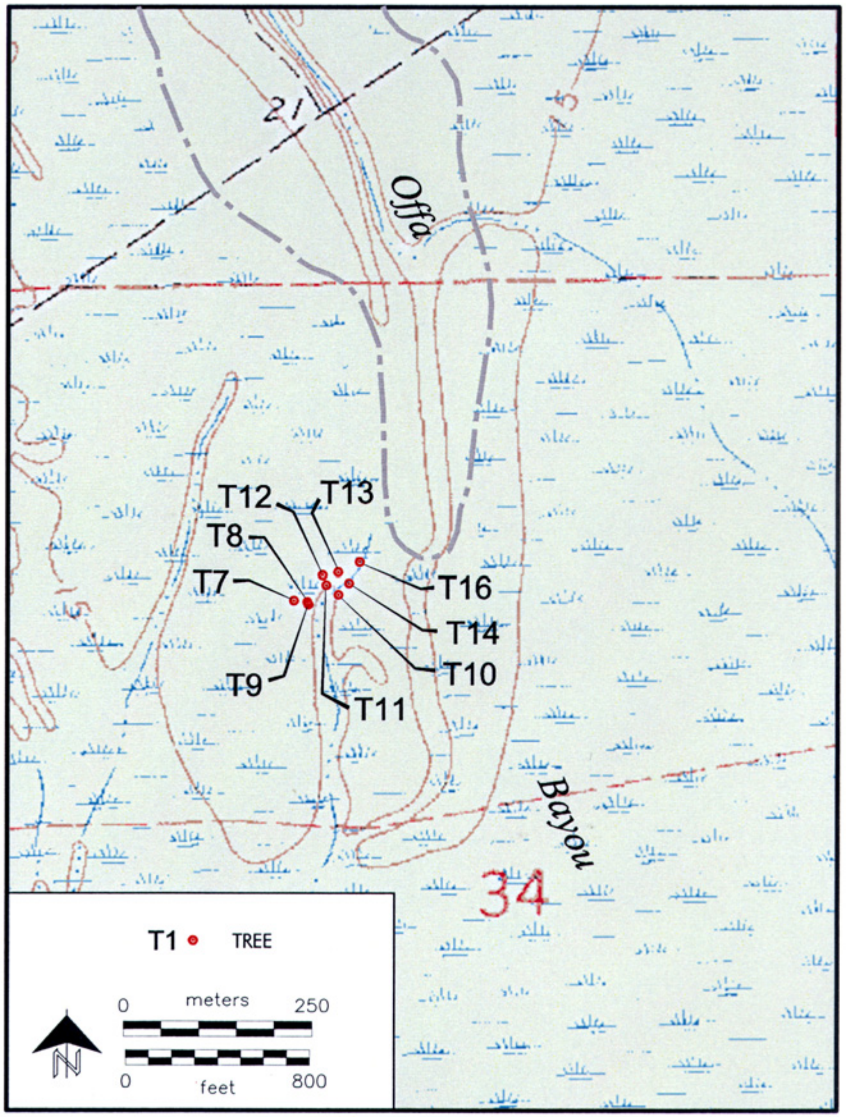

Figure 8-4. Detail map of the Big Offa Bayou location, showing the distribution of individual cypress trees examined during the present study (USGS 1969).

Figure 8-5. **Field technician measuring cypress root depths with a 6-ft-long metal probe. View to the south. Date: 9/5/03.**

Figure 8-6. Extracting core from an old-growth cypress tree estimated to be 1,600 years old. View to the north. Date: 9/26/03.

Table 8-1. Cypress Tree Age Data for the Indian Bayou North Project Area.

CEI ID #	DATE SAMPLED	SPECIES	LOCATION	FD ID #	TAG #	DIAM (cm)	CORE #	INNER RING DATE	PITH	OUTER RING	BARK	CORE HT (M)	AZIMUTH	CORE LNTH (mm)	NO. RINGS	AVE RG WDTH	EST YRS	EST PTH YR	EST TOT AGE	AVG. AGE	BEST AGE EST.	COMMENTS
1	9/5/03	TADI	30 25 42.5N 91 46 46.5W	01A	279	88.0	01A	1861	NO	2003	YES	3.17	101	47	143	0.3287	1195.72	665	1337		1337	first large tree found
1	9/5/03	TADI	30 25 42.5N 91 46 46.5W	01B	279	88.0	01B	1858	NO	2003	YES	3.17	196	57	146	0.3904	981.02	877	1125		1337	
1	9/5/03	TADI	30 25 42.5N 91 46 46.5W	01C	279	88.0	01C	1863	NO	2003	YES	3.62	196	54	141	0.3830	1007.89	855	1147	1203	1337	
2	9/5/03	TADI	30 25 42.8N 91 46 45.6W	02A	280	67.5	02A	1882	NO	2003	YES	3.43	50	304	122	2.4918	13.44	1869	133		136	
2	9/5/03	TADI	30 25 42.8N 91 46 45.6W	02B	280	67.5	02B	1875	NO	2003	YES	3.40	334	315	129	2.4419	9.21	1866	136	135	136	
3	9/5/03	TADI	30 25 43.3N 91 46 45.4W	03A	281	66.7	03A	1869	NO	2003	YES	1.66	98	311	135	2.3037	9.77	1859	143		153	
3	9/5/03	TADI	30 25 43.3N 91 46 45.4W	03B	281	63.6	03B	1853	YES	2003	YES	1.66	349	310	151	2.0530	3.90	1849	153	148	153	
4	9/5/03	TADI	30 25 43.5N 91 46 45.4W	04A	282	45.5	04A	1940	NO	2003	YES	1.75	343	169	64	2.6406	22.15	1918	84		84	
4	9/5/03	TADI	30 25 43.5N 91 46 45.4W	04B	282	41.8	04B	1945	NO	2003	YES	1.95	211	158	59	2.6780	19.04	1926	76	80	84	
5	9/5/03	TADI	30 25 43.4N 91 46 45.4W	05A	283	51.9	05A	1919	YES	2003	YES	1.57	267	249	85	2.9294	3.58	1915	87		95	
5	9/5/03	TADI	30 25 43.4N 91 46 45.4W	05B	283	49.0	05B	1924	NO	2003	YES	1.73	100	203	80	2.5375	16.55	1907	95	91	95	
6	9/5/03	TADI	30 25 42.8N 91 46 44.2W	06A	284	57.8	06A	1900	NO	2003	YES	2.58	110	274	104	2.6346	5.69	1894	108		421	
6	9/5/03	TADI	30 25 42.8N 91 46 44.2W	06B	284	52.3	06B	1902	NO	2003	YES	2.92	248	63	102	0.6176	321.38	1581	421	265	421	
6	9/5/03	TADI	30 25 42.8N 91 46 44.2W	06C	284	in buttress	06C	1918	NO	2003	YES	0.50	.	462	86	5.3721	.	.	#VALUE!		421	
15	9/5/03	TADI	30 25 35.4N 91 46 50.1W	07A	285	123.2	07A	1793	NO	2003	YES	1.79	203	102	211	0.4834	1063.27	730	1272	1272	1272	Little Bayou Fordoche; south of road
7	9/5/03	TADI	30 24 17.8N 91 44 45.4W	08A	286	97.0	08A	1922	NO	2003	YES	1.60	14	166	82	2.0244	157.58	1764	238		418	leaning old tree; Big Bayou Offa
7	9/5/03	TADI	30 24 17.8N 91 44 45.4W	08B	286	97.5	08B	1860	NO	2003	YES	1.68	319	167	144	1.1597	276.36	1584	418	328	418	
8	9/5/03	TADI	30 24 16.7N 91 44 45.6W	09A	287	66.6	09A	1918	NO	2003	YES	1.77	0	290	86	3.3721	12.75	1905	97		106	
8	9/5/03	TADI	30 24 16.7N 91 44 45.6W	09B	287	66.9	09B	1922	NO	2003	YES	1.77	238	255	82	3.1098	25.56	1896	106	101	106	
9	9/5/03	TADI	30 24 17.2N 91 44 45.0W	10A	288	62.6	10A	1938	NO	2003	YES	1.20	197	86	66	1.3030	174.21	1764	238		238	
9	9/5/03	TADI	30 24 17.2N 91 44 45.0W	10B	288	62.0	10B	1811	NO	2003	YES	1.20	29	267	193	1.3834	31.08	1780	222		238	
9	9/5/03	TADI	30 24 17.2N 91 44 45.0W	10C	288	60.4	10C	1805	NO	2003	YES	1.36	38	257	199	1.2915	34.84	1770	232	231	238	
10	9/5/03	TADI	30 24 17.9N 91 44 45.4W	11A	289	69.4	11A	1913	NO	2003	YES	1.59	43	329	91	3.6154	4.98	1908	94		154	
10	9/5/03	TADI	30 24 17.9N 91 44 45.4W	11B	289	70.1	11B	1871	NO	2003	YES	1.56	183	298	133	2.2406	23.43	1848	154	124	154	
11	9/5/03	TADI	30 24 17.7N 91 44 44.4W	12A	290	55.5	12A	1913	NO	2003	YES	1.63	294	271	91	2.9780	2.18	1911	91		98	
11	9/5/03	TADI	30 24 17.7N 91 44 44.4W	12B	290	57.7	12B	1913	NO	2003	YES	1.60	131	263	91	2.8901	8.82	1904	98	95	98	
12	9/5/03	TADI	30 24 17.9N 91 44 44.2W	13A	291	54.6	13A	1815	YES	2003	YES	1.35	60	236	189	1.2487	29.63	1785	217		217	
12	9/5/03	TADI	30 24 17.9N 91 44 44.2W	13B	291	55.9	13B	1823	NO	2003	YES	1.26	283	239	181	1.3204	30.67	1792	210	213	217	
13	9/5/03	TADI	30 24 17.8N 91 44 44.3W	14A	292	46.1	14A	1869	NO	2003	YES	1.00	5	182	135	1.3481	35.98	1833	169		169	tree with deep root system
13	9/5/03	TADI	30 24 17.8N 91 44 44.3W	14B	292	45.0	14B	1870	NO	2003	YES	1.05	278	215	134	1.6045	6.23	1864	138	154	169	
16	9/5/03	TADI	30 24 18.6N 91 44 42.6W	15A	293	82.2	15A	1835	NO	2003	YES	1.57	265	329	169	1.9467	42.12	1793	209		210	
16	9/5/03	TADI	30 24 18.6N 91 44 42.6W	15B	293	81.6	15B	1821	YES	2003	YES	1.60	75	352	183	1.9235	29.11	1792	210	210	210	
14	9/5/03	TADI	30 24 17.8N 91 44 43.4W	16A	294	100.0	16A	1300	NO	2003	YES	1.00	55	357	704	0.5071	281.99	1018	984		984	big old tree; shallow roots
14	9/5/03	TADI	30 24 17.8N 91 44 43.4W	16B	294	100.0	16B	1366	NO	2003	YES	1.12	323	328	638	0.5141	334.56	1031	971		984	
14	9/5/03	TADI	30 24 17.8N 91 44 43.4W	16C	294	100.0	16C	1400	NO	2003	YES	1.10		474	604	0.7848	33.13	1367	635	863	984	
17-A	9/5/03	TADI	30 24 19.4N 91 42 30.2W	17A	295	63.1	17A	1909	NO	2003	YES	1.10	94	208	95	2.1895	49.10	1860	142		142	located along Indian Bayou; no other data collected
17-A	9/5/03	TADI	30 24 19.4N 91 42 30.2W	17B	295	63.1	17B	1908	NO	2003	YES	1.10	307	244	96	2.5417	28.13	1880	122	132	142	located along Indian Bayou; no other data collected
20	9/26/03	TADI	30'26"0.14N 91'46"44.3W	25	ns	140.6	25A	1921		2003	YES	115	94	95	82	1.1585	704.39	1217	787			hollow tree
20	9/26/03	TADI	30'26"0.14N 91'46"44.3W	25	ns	140.6	25B	1957		2003	YES	96	8	123	46	2.6739	1550.87	406	1598			
20	9/26/03	TADI	30'26"0.14N 91'46"44.3W	25	ns	140.6	25C	1925		2003	YES	88	340	180	78	2.3077	1206.92	718	1286			
20	9/26/03	TADI	30'26"0.14N 91'46"44.3W	25	ns	140.6	25D	1933		2003	YES	98	256	110	70	1.5714	931.857	1001	1003	1169	1598	
21	9/26/03	TADI	30'25"58.6N 91'46"46.2W	24	ns	98.0	24A	1870		2003	YES	20 cm below soil surface	197	115	133	0.8647	324.248	1546	458			hollow tree; deep roots; small excavation
21	9/26/03	TADI	30'25"58.6N 91'46"46.2W	24	ns	98.0	24B	1850		2003	YES	0 - at soil surface	208	60	153	0.3922	168.628	1681	323	391	458	
21	9/26/03	TADI	30'25"58.6N 91'46"46.2W	24	ns	root A	24C	1987	NO	2003	YES				16							root
21	9/26/03	TADI	30'25"58.6N 91'46"46.2W	24	ns	root B	24D	1960	NO	2003	YES				43							root
21	9/26/03	TADI	30'25"58.6N 91'46"46.2W	24	ns	root	24E	1982	NO	2003	YES				21							root
21	9/26/03	TADI	30'25"58.6N 91'46"46.2W	24	ns	root	24F	na		2003	YES											root
22	9/26/03	TADI	30'25"57.5N 91'46"46.3W	23	ns	94.0	23A	1474	NO	2003	YES	110	345	435	529	0.8223	28.7807	1445	559			solid tree; shallow roots exposed by excavation
22	9/26/03	TADI	30'25"57.5N 91'46"46.3W	23	ns	94.0	23B	badly broken	NO	2003	YES	108	350	na	na	na						
22	9/26/03	TADI	30'25"57.5N 91'46"46.3W	23	ns	94.0	23C	1474	NO	2003	YES	111	100	357	529	0.6749	76.259	1398	606			
22	9/26/03	TADI	30'25"57.5N 91'46"46.3W	23	ns	94.0	23D	1600	NO	2003	YES	110	160	390	403	0.9677	77.4194	1523	481			
22	9/26/03	TADI	30'25"57.5N 91'46"46.3W	23	ns	94.0	23E	1514	NO	2003	YES	110	240	413	489	0.8446	48.1411	1466	538	546	606	
22	9/26/03	TADI	30'25"57.5N 91'46"46.3W	23	ns	root A	23F	1937	YES	2003	YES				66							root
22	9/26/03	TADI	30'25"57.5N 91'46"46.3W	23	ns	root F	23G	1946		2003	YES				57							root
22	9/26/03	TADI	30'25"57.5N 91'46"46.3W	23	ns	root									0							root

Table 8-2. Cypress Root and Age Summary for the Indian Bayou North Project Area.

CEI ID #	DATE SAMPLED	LOCATION	LAT-LONG	EST. BUTT SWELL HGT. (M)	DIAM TOP BUTT SWELL (M)	DIAM. AT GROUND (M)	BEST AGE EST. (YEARS BP)	AVG. CORE AGE (YEARS BP)	AVG. TREE ROOT DEPTH	COMMENTS	DIAM AT 1.5 M ABOVE GROUND
1	9/5/03	Indian Bayou North Area - Sec. 20	30 25 42.5N 91 46 46.5W	3.17	0.88	1.77	1337	1203	1.93	excavation at base of tree	1.36
2	9/5/03	Indian Bayou North Area - Sec. 20	30 25 42.8N 91 46 45.6W	3.40	0.68	1.61	136	135	0.81		1.09
3	9/5/03	Indian Bayou North Area - Sec. 20	30 25 43.3N 91 46 45.4W	1.66	0.67	1.15	153	148	0.61	excavation at base of tree	0.71
4	9/5/03	Indian Bayou North Area - Sec. 20	30 25 43.5N 91 46 45.4W	1.95	0.42	0.62	84	80	0.57		0.57
5	9/5/03	Indian Bayou North Area - Sec. 20	30 25 43.4N 91 46 45.4W	1.73	0.49	1.00	95	91	0.41		0.55
6	9/5/03	Indian Bayou North Area - Sec. 20	30 25 42.8N 91 46 44.2W	2.58	0.52	1.45	421	265	0.65		0.84
7	9/5/03	Indian Bayou North Area - Sec. 34	30 24 17.8N 91 44 45.4W	1.60	0.97	2.29	418	328	0.7	excavation at base of tree	1.03
8	9/5/03	Indian Bayou North Area - Sec. 34	30 24 16.7N 91 44 45.6W	1.77	0.67	1.35	106	101	0.46		0.69
9	9/5/03	Indian Bayou North Area - Sec. 34	30 24 17.2N 91 44 45.0W	1.20	0.62	1.12	238	231	0.31		0.60
10	9/5/03	Indian Bayou North Area - Sec. 34	30 24 17.9N 91 44 45.4W	1.56	0.70	1.38	154	124	0.36		0.70
11	9/5/03	Indian Bayou North Area - Sec. 34	30 24 17.7N 91 44 44.4W	1.60	0.58	1.07	98	95	0.42		0.59
12	9/5/03	Indian Bayou North Area - Sec. 34	30 24 17.9N 91 44 44.2W	1.26	0.56	1.09	217	213	0.43		0.54
13	9/5/03	Indian Bayou North Area - Sec. 34	30 24 17.8N 91 44 44.3W	1.00	0.46	0.58	169	154	1.43	excavation at base of tree	0.39
14	9/5/03	Indian Bayou North Area - Sec. 34	30 24 17.8N 91 44 43.4W	1.00	1.00	1.40	984	863	0.4	excavation at base of tree	1.07
15	9/5/03	Indian Bayou North Area - Sec. 20	30 25 35.4N 91 46 50.1W	1.79	1.23	1.94	1272	1272	1.99	excavation at base of tree	-
16	9/5/03	Indian Bayou North Area - Sec. 34	30 24 18.6N 91 44 42.6W	1.57	0.82	1.53	210	210	0.52		-
17-A	9/5/03	Indian Bayou South Area - Sec. 36	30 24 19.4N 91 42 30.2W	1.10	0.63	-	142	132	ND	Indian Bayou south area; no root data collected	-
17-B	9/12/03	Indian Bayou North Area - Sec. 19	-	-	-	-	-	-	ND	no data collected; hollow old growth tree	-
18	9/12/03	Indian Bayou North Area - Sec. 19	-	-	-	-	-	-	ND	no data collected; hollow old growth tree	-
19	9/12/03	Indian Bayou North Area - Sec. 20	-	-	-	-	-	-	ND	no data collected; hollow old growth tree	-
20	9/26/03	Indian Bayou North Area - Sec. 20	30'26"0.14N 91'46"44.3W	0.88	1.41	-	1598	1169	ND		-
21	9/26/03	Indian Bayou North Area - Sec. 20	30'25"58.6N 91'46"46.2W		0.98	-	458	391	0.23	excavation at base of tree	-
22	9/26/03	Indian Bayou North Area - Sec. 20	30'25"57.5N 91'46"46.3W	1.1	0.94	-	606	546	2	excavation at base of tree	-

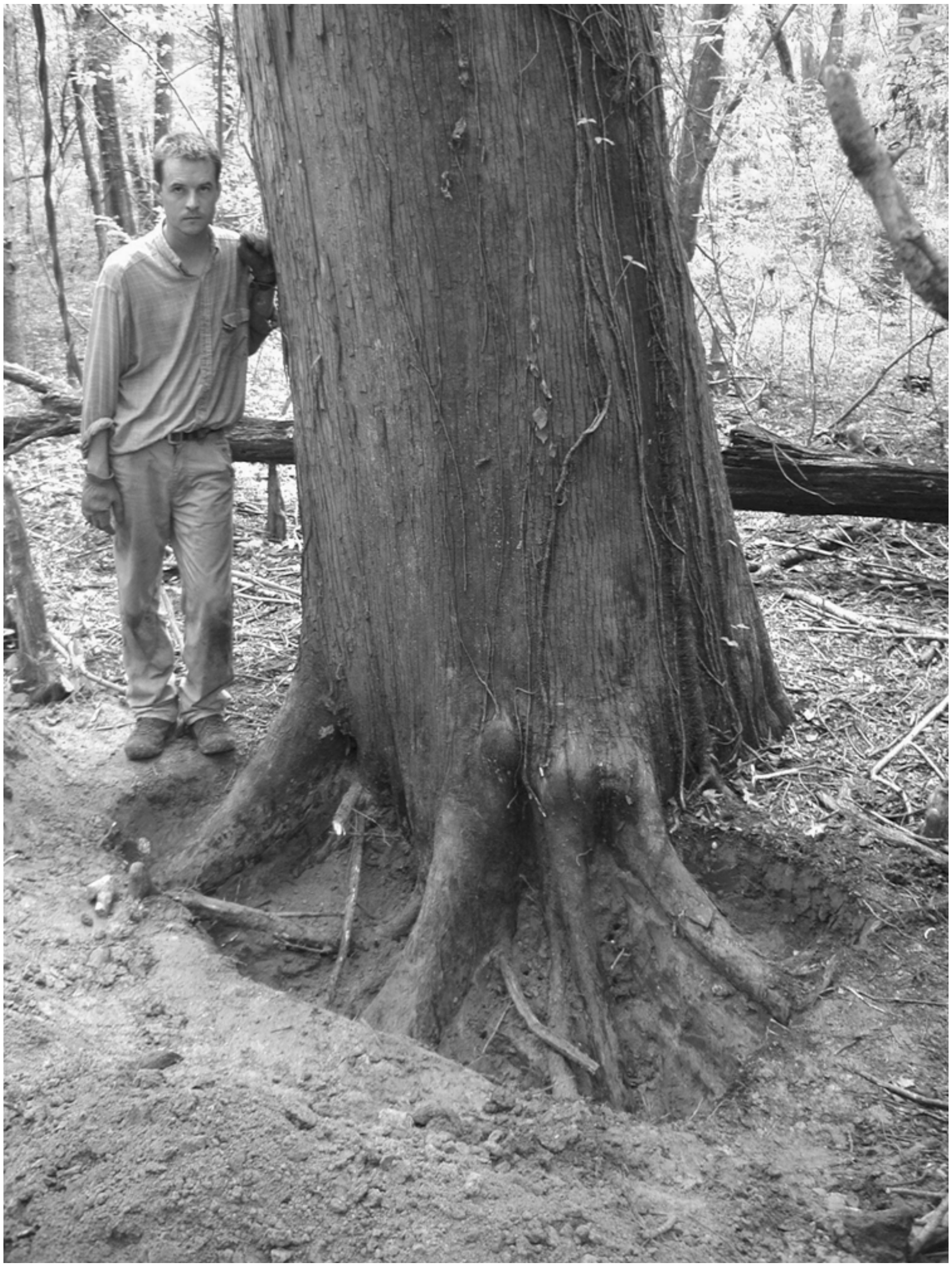

Figure 8-7. Partially exposed shallow root crown from a ca. 980-year-old tree. View to the east. Date: 8/26/03.

Table 8-3. Summary of Tree and Stump Excavation Depths.

CEI TREE NO.	EXCAVATION DEPTH	EXCAVATION UNIT SIZE
1	0.7 m	1.5 X .5 m
3	0.7 m	1 x 1 m
7	0.65 m	1.5 x .8 m
13	1.5 m	1 x .8 m
14	0.6 m	1.5 x .8 m
15	0.8 m	1 x .7 m
21	0.6 m	1 x .7 m
22	0.6 m	1 x 1 m
Stump 1	1.5 m	1.5 x 1 m

some cases the root density was such that probing and/or excavation failed to reach below the depth of the first major root system encountered, or (2) the first root crown identified was so deep that the probe was not long enough to determine whether additional root crowns existed below. Initial probing and excavation indicated that, in addition to obvious root crowns, adventitious root horizons (root splays) were also found. Obvious secondary (younger) root crowns were observed at or just below the surface on several trees that were several hundred years old. As a result of this finding, it is clear that from the specimens examined for this study that root depth is not always a reflection of tree age. This is particularly true for older trees. For cypress trees older than 100 years, root depths varied from just below the surface to at least two meters below surface. Preliminary research indicates that crevasse accumulation, in excess of three meters in some areas, has occurred within the last 500 years.

Initial observations suggest three potential root patterns for older (i.e., 100+ year old) trees:

Pattern A. The original root crown (i.e., primary horizontal root splay that formed at the root/stem interface in seedlings) remains intact and only a few secondary (adventitious) roots formed above the original root crown; as a result of sediment deposition, the original root crown may be buried 1-2 meters or more below ground (Figure 8-8).

Pattern B. As sediment accumulated, multiple (secondary) adventitious root horizons developed, each one starting near the ground surface and some forming large root crowns; the factors that stimulate formation of multiple root horizons are unknown; all root horizons (from earliest to most recent) remain intact and viable (Figure 8-9).

Pattern C. As sediment accumulated, multiple (secondary) adventitious root horizons developed, each one forming near the ground surface; the factors that stimulate formation of multiple horizons are unknown; as each new root horizon developed, the lower root crown was absorbed or perhaps rotted away and/or deep portions of the trunk rotted away, leaving only a shallow bole with a single root crown just below the surface.

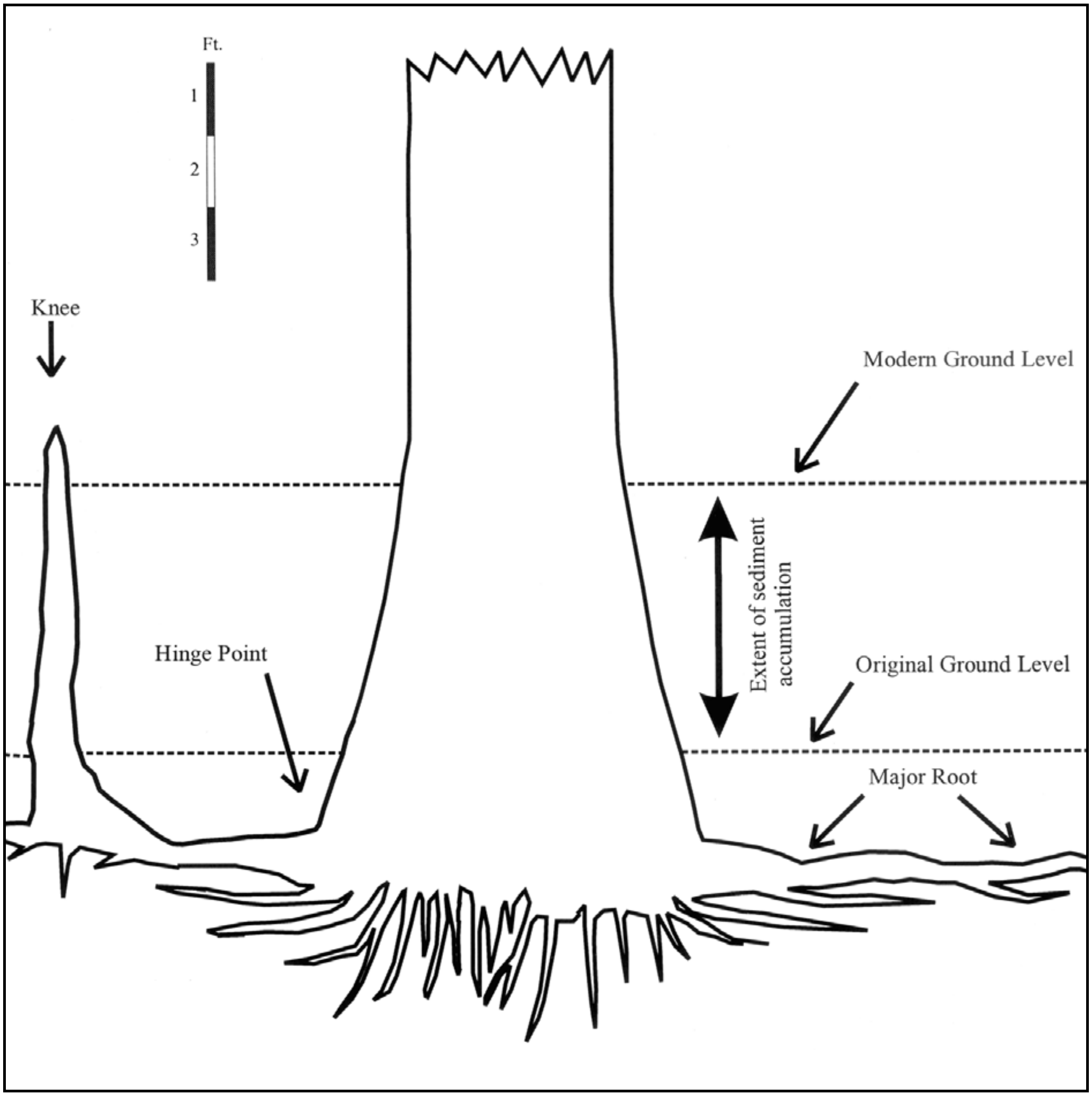

Figure 8-8. Side view of cypress tree, showing typical butt swell and root-splay system after accumulation of sediment.

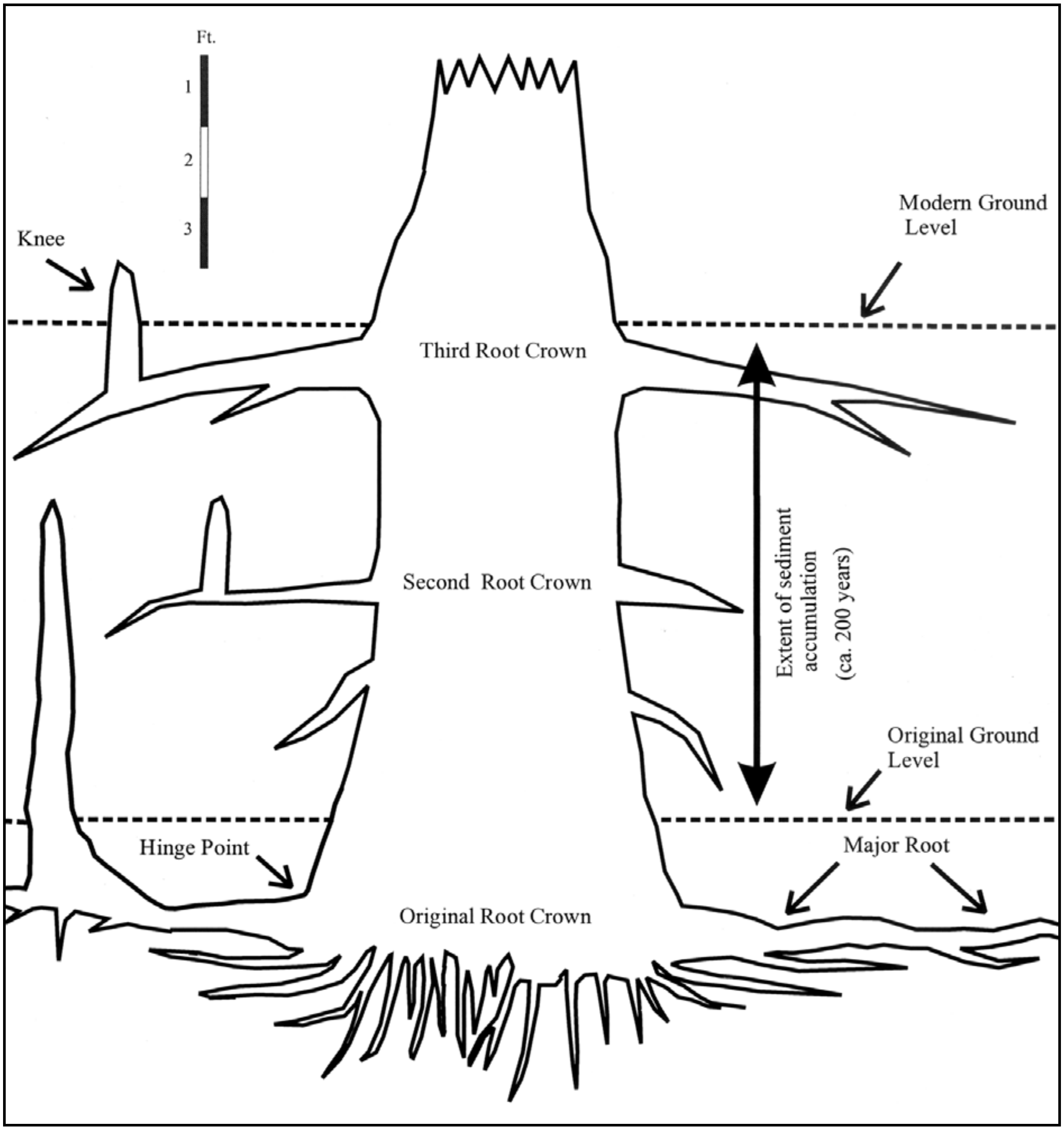

Figure 8-9. **Side view of cypress tree, showing typical butt swell and root-splay system after long term accumulation of sediment.**

Root response to sediment accumulation is the real puzzle that has not yet been solved. For younger trees (less than 100 years old) the root crown is shallow and the root system most closely resembled Pattern A. Root depths were less than one meter for all trees less than 100 years old. However, it is possible that additional root crowns may be present for trees in areas where rapid sediment accumulation has occurred over the last 100 or so years. Lower root mats would not be detectable through simple probing if the surface root mat is very dense. Most younger trees exhibited classic cypress butt swells with ground-level diameters that were two to three times greater than the bole diameter above the butt swell.

For older trees, the picture is not as clear. Some older trees exhibited deeply buried root systems (Pattern A) that presumably represent the original root splay (see Table 8-2). Examples of this pattern were found on trees as young as 95 years and the oldest tree was estimated to be 1272 years. For the older trees in particular, the identification of Pattern A is not definitive, particularly since sediment accumulation may have exceeded two meters in this area over the last two centuries. It is possible that the identified root crown, although deeply buried, may not be the original root splay; only deeper excavation can provide definitive evidence for this identification. Older cypress trees also exhibited root patterns with multiple root splays (Pattern B). Notable examples of this pattern occurred on trees ranging in age from 328 years to 863 years (see Tables 8-1 and 8-2).

From the small sample of trees examined in this investigation, there is no visible correlation between tree age and root pattern. It should be pointed out that some trees identified as exhibiting Pattern B may actually be examples of Pattern C. The roots were so dense that investigators were unable to probe beneath the upper root crown; it is possible (and likely) that additional root crowns exist much deeper below the surface. Only deeper excavations will determine which pattern is characteristic of these older trees.

Cypress Stumps

Throughout the wetter portions of the study area, obvious logged cypress stumps were observed. The larger stumps probably represent cypress that were cut during the late nineteenth or early twentieth century when industrial logging swept through the Atchafalaya Basin. In an attempt collect additional data on root depth and sedimentation, the base of one large stump was exposed by hand excavation (Figure 8-10). This excavation revealed what appears to be a basal root crown about 1.5 meters below the surface. Only a few ephemeral roots were observed above the primary root crown. This stump exemplifies Pattern A described above. Several additional stumps were examined and wood samples collected from them. However, no additional stump excavations were attempted.

During backhoe excavations conducted by Earth Search, Inc., (ESI) in the Indian Bayou South study area, an approximately three-meter long upright cypress stump was found (Figure 8-11). The root growth pattern from this stump indicates long-term sediment accumulation with multiple root crown development (Pattern B). A section of this stump was recovered but not analyzed. The lower two meters of the stump exhibited a strikingly consistent diameter, suggesting that either the butt swell expanded to keep pace with sedimentation, creating a consistent trunk width, or that sedimentation was too rapid to permit the formation of a typical butt swell that is so common for trees in bankline or swamp settings.

As the ESI stump example indicates, some trees develop supplemental adventitious root horizons as sediment builds up around the tree. Within the study area, some of the oldest living trees examined have root crowns/horizons just below the surface. These examples represent either Pattern B or Pattern C described above. It is unclear whether older and deeper root horizons exist for these trees. Indirect evidence (i.e., the lack of a pronounced butt-swell above ground) suggests that much of the original tree base remains buried. Other trees seem to keep the original crown and send out only ephemeral roots as sediment accumulates around the base. Why do trees respond in different ways within the same setting? Root response may be triggered by a variety of factors, including sedimentation rate, amount of sunlight, depth of inundation, length of inundation, type of sediment being deposited, temperature, or a host of other mechanisms that we are simply unaware of. Very little research has been done in this area and the remaining field portion of the Indian Bayou project may provide some clues to this puzzle. For archaeology, the factors

Figure 8-10. Excavation at base of old-growth cypress stump. Unit is 1.5 m deep; probing revealed probable original root crown at depth of 2.7 to 3.0 m below surface. View to the east. Date: 8/27/03.

Figure 8-11. **Cypress stump recovered by Earth Search, Inc., The stump was completely buried, but still standing upright when found. Note the multiple root zones and relatively uniform diameter of bore.**

that trigger root splay development are important, but what is more important is the age of trees and their relationship to the original ground surface, as well as the age of subsequent root splays and their relationship to more recent ground levels as sedimentation progresses.

Cypress Buttress Formation

The formation of a buttressed stem or bole is believed to be a direct result of the hydrology of the site. Different types of buttressing are generally indicative of specific flood regimes, as is the presence and height of the cypress knees.

For most smaller trees (less than 80 cm diam) that were examined, buttressing is fairly pronounced. Some trees, however, exhibit little buttressing near the ground (e.g., Tree No. 13). One possible explanation is that buttressing is not as pronounced when sediment accumulation is rapid so that above-ground basal swelling can not keep up with the rate of sedimentation. If that is the case, then the buttresses for many old-growth trees are no longer visible because they are buried below ground. Several examples of old-growth cypress with only moderate butt swells were found during this investigation. Future research might provide data to indicate whether the buttress growth occurs both above and below ground. Assuming that the butt swelling occurs primarily above ground and given a sedimentation rate that keeps up with tree growth, the base diameter below ground might be the same or similar to that of the bole exposed above ground. It is also possible that the local hydrology (i.e., flood frequency, duration, and depth) and sedimentation rate both affect swelling in a presently undetermined way.

Summary of Findings for Phase I Cypress Research

For the Indian Bayou North project, twenty cypress trees were examined. Tree age estimates were determined through the analysis of at least two increment bore samples recovered from each tree. Trees ranged widely in both size (from 0.49 m. to 1.41 m. in diameter) and age (from 95 to 1272 years). Root systems were examined through a program of probing, supplemented by exposure of root splays through hand excavation at the base of selected trees. In addition to living trees, an excavation was also conducted at the base of a large old-growth cypress stump.

Although the initial field investigation provided some information on the correlation of tree ages to sediment accumulation, the utilized techniques are not ideal for examining areas of deep sediment accumulation. Determining root depth by probing and shallow excavation is useful for settings where less than two meters of sedimentation has occurred. For areas such as the Atchafalaya Basin where extensive sediment accumulation occurs over time, deeper excavation techniques are needed to expose the original root systems of cypress.

One striking characteristic of old growth cypress within the study area is their lack of a pronounced butt swell. It is postulated that where sedimentation occurs over a long period of time, the sedimentation either keeps pace with development of the butt swelling or perhaps the expanded portion at the base becomes buried. Pronounced bases were most evident on relatively young trees (i.e., those less than 150 years old) and least evident on the oldest trees (i.e., those over 500 years old). This difference may reflect changes in either the sedimentation rate or the hydrologic setting over the last two centuries.

The limited field testing program did highlight the utilization of several techniques that may prove useful for future investigations of cypress and the association of root systems to old land surfaces. The use of metal probes to determine root depths was productive. Another useful technique was the excavation of tree bases to expose root systems. The final technique that shows much promise is the collection of increment cores from tree roots. Cored roots displayed growth ring patterns that were comparable to those recovered from the boles. If roots can be dated, then trees with multiple root crowns have the potential to provide absolute dates for buried ground surfaces associated with individual root splays.

Phase II Cypress Program

Because cypress do not establish roots above ground, the date that sediment accumulation reached any particular elevation could be determined by aging the larger roots, assuming a rather steady rate of sediment accumulation. For trees with multiple root horizons, the larger roots at each root horizon (i.e., at various depths) could be dated through recovery of increment bore samples. For trees that exhibit a single, deeply buried root crown, the rate of sediment accumulation could be determined by comparing the ages of trees to the depths of the original root crowns. Given a wide range of tree ages, this methodology has the potential to date old land surfaces as far back as the oldest tree examined.

As part of the second phase investigation of the prehistoric mound site, a limited study will be conducted of cypress located in the near vicinity of the mound. The cypress investigation will include recovery of core samples, probing of root depths, and if possible, subsurface testing to expose root systems. The subsurface testing may involve limited use of a backhoe, followed by hand excavation in an effort to preserve tree roots and avoid damage to the tree. Excavations may also be conducted around the bases of old stumps if old-growth cypress stumps are found in close proximity to the mound site.

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS FOR THE INDIAN BAYOU NORTH PROJECT AREA

Richard A. Weinstein, George J. Castille, and Douglas C. Wells

Conclusions and Recommendations

The Phase I geological field investigations showed that all of the crevasse channels flowing through the project area, plus their associated natural-levee deposits, are of fairly recent age and not likely to contain any prehistoric or protohistoric aboriginal sites. In addition, the older sediments underlying historic natural-levee deposits within the study area appear to be backswamp deposits, and are poor candidates for human occupation. Although a few of the crevasse channels may be old enough to have supported historic aboriginal sites, this possibility is considered unlikely given the findings of the Phase I shovel-testing program. That program found no evidence of any historic activity (save for recent trash), whether aboriginal or Euro-American, along any of the high-probability landforms that were investigated. Such landforms are considered to be the likely features upon which historic aboriginal sites would have been established if such sites actually existed in the study area. Only locations outside the Indian Bayou North Project area, such as near the Bayou Fordoche Mounds (16SL34) and in the upper reaches of Little Fordoche Bayou, show the potential for buried prehistoric deposits.

Therefore, to compensate for this lack of archaeological sites within the project area, it is recommended that subsequent field research be conducted at a nearby prehistoric mound site that exists on Corps property just west of the present project area. This research can be conducted for a portion of the money still available under the existing delivery order, and it would provide a significant amount of data on a Corps-owned archaeological site about which very little presently is known.

Phase I seismic investigations were also conducted in an attempt to model very shallow (0 to –4 m) subsurface facies, and to determine the best methods for future investigations. It was found that seismic platform imaging of refracted data was the best and most cost-effective method for collecting subsurface data. In addition, it was recommended that tomographic methods, similar to those used to image human bodies in medical CAT scans (and commonly used by the oil and gas industry), would be very effective for modeling the upper two to four meters of subsurface. This is the region most prone to impact from construction, and of most concern to archaeologists.

The Phase I investigation of the area's cypress trees and cypress stumps yielded a preliminary set of highly useful data. The study showed that several old-growth trees are present in the project area, and that they can be used to help date the landforms upon which they are growing or upon which they once grew. They also can be used to help create an accurate cross-dated sequence that has applicability beyond the present project area. As with the research at the prehistoric mound site, this work also can be accomplished for a portion of the money still remaining in the existing delivery order.

Proposed Research at the Bayou Fordoche Mounds (16SL34)

CEI proposes to conduct the following investigations at the Bayou Fordoche Mounds in an effort to determine the site's true size and age. Basically, three tasks will be involved in this research:

Task 1. Produce a contour map of the site. Despite the fact that Jones and Shuman were conducting a mound-mapping project, high water at the time of their visit precluded them from making a contour map of the locale. Thus, CEI proposes to produce a detailed contour map of both Mounds A and B and any associated midden area(s) that are identified by means of the augering and probing described in Task 2.

Task 2. Conduct a systematic augering and/or probing program across the site area to determine the extent and depth of any associated midden deposits. It is envisioned that the auger borings/probes will be spaced at either 10- or 20-m intervals across the site area and will be of sufficient depth to locate the buried premound and premidden natural-levee deposits upon which the site developed. A concerted effort will be made to identify the maximum extent of midden deposits to the north, south, and west of the two mounds.

Task 3. Conduct a preliminary program of augering/probing atop the two mounds, to determine the actual thickness of each structure, whether they were built in one stage or multiple stages, and to uncover evidence of internal stratigraphy.

Task 4. Excavate a small number of 1-by-1-m-square test units in those locations identified by the augering/probing as being most conducive to providing useful stratigraphic and cultural data. It is estimated that at least two units will be dug either into or adjacent to the flanks of the two mounds, while one or two additional units will be placed in midden areas away from the mounds. All units will be dug by hand, with soil removed by natural strata (or 10-cm levels within natural strata if such strata are greater than 10 cm thick). All fill will be water screened through 1/4- and 1/8-inch wire mesh, and soil samples from selected proveniences will be collected for flotation. The four walls of each completed unit will be drawn and photographed.

Task 5. Analyze the material collected from the test units, including aboriginal ceramics and lithics, and floral and faunal remains. Hopefully, this will allow for an assessment of the age of the site and provide an understanding of at least some of the activities that once occurred there.

Phase II Cypress Program

Because cypress do not establish roots above ground, the date that sediment accumulation reached any particular elevation could be determined by aging the larger roots, assuming a rather steady rate of sediment accumulation. For trees with multiple root horizons, the larger roots at each root horizon (i.e., at various depths) could be dated through recovery of increment bore samples. For trees that exhibit a single, deeply buried root crown, the rate of sediment accumulation could be determined by comparing the ages of trees to the depths of the original root crowns. Given a wide range of tree ages, this methodology has the potential to date old land surfaces as far back as the oldest tree examined.

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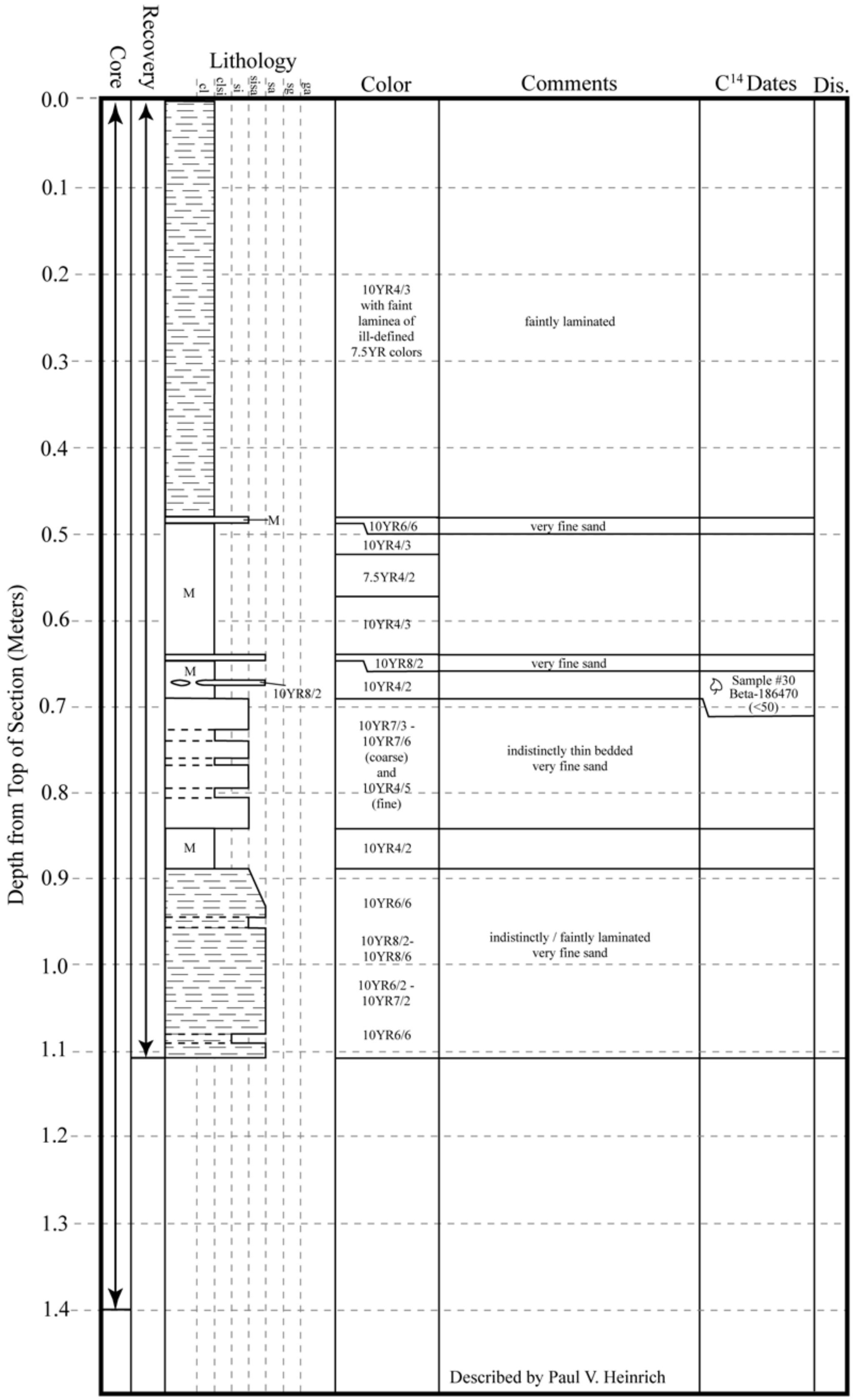
APPENDIX A

CORE LOGS FROM THE INDIAN BAYOU NORTH PROJECT AREA



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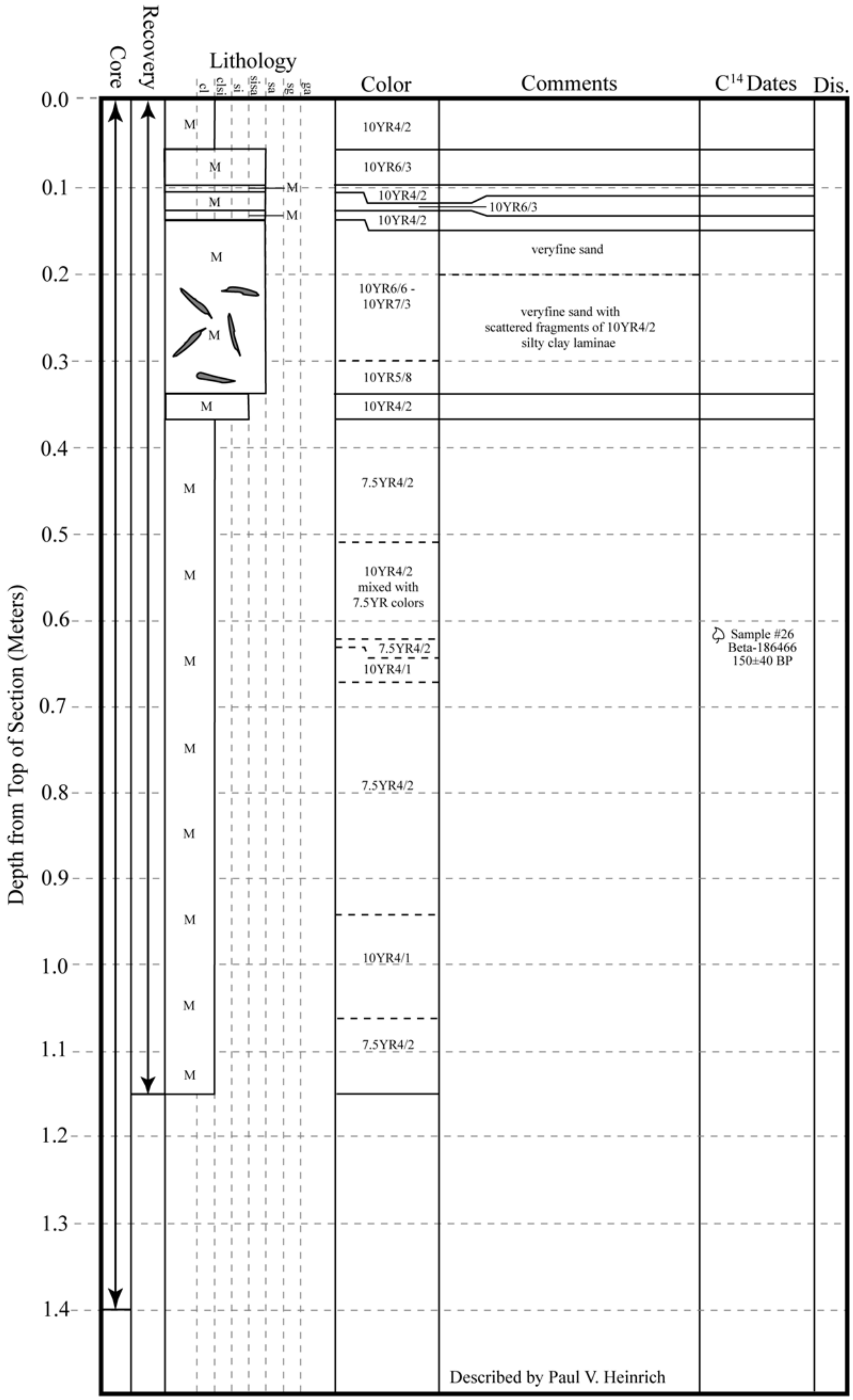

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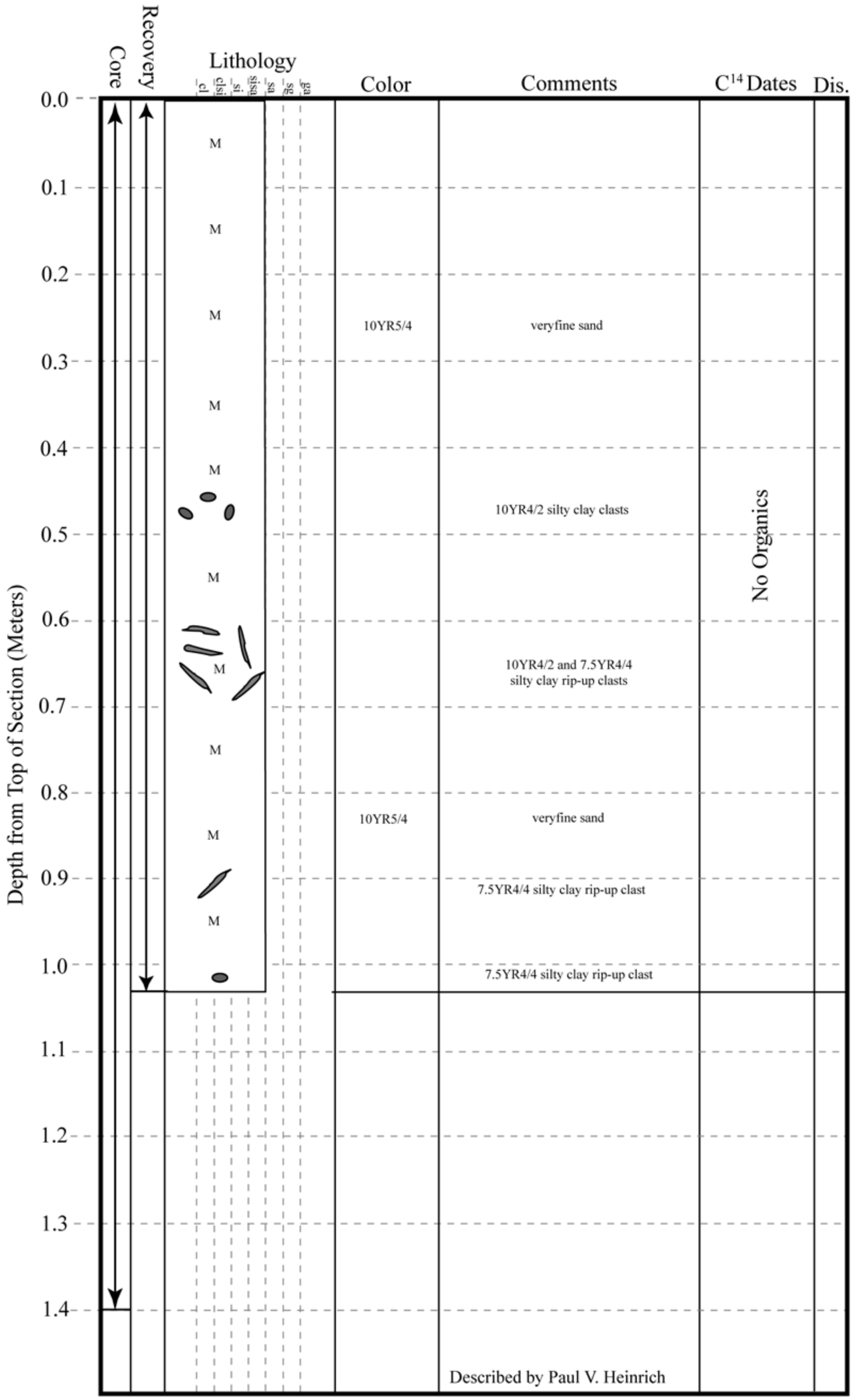
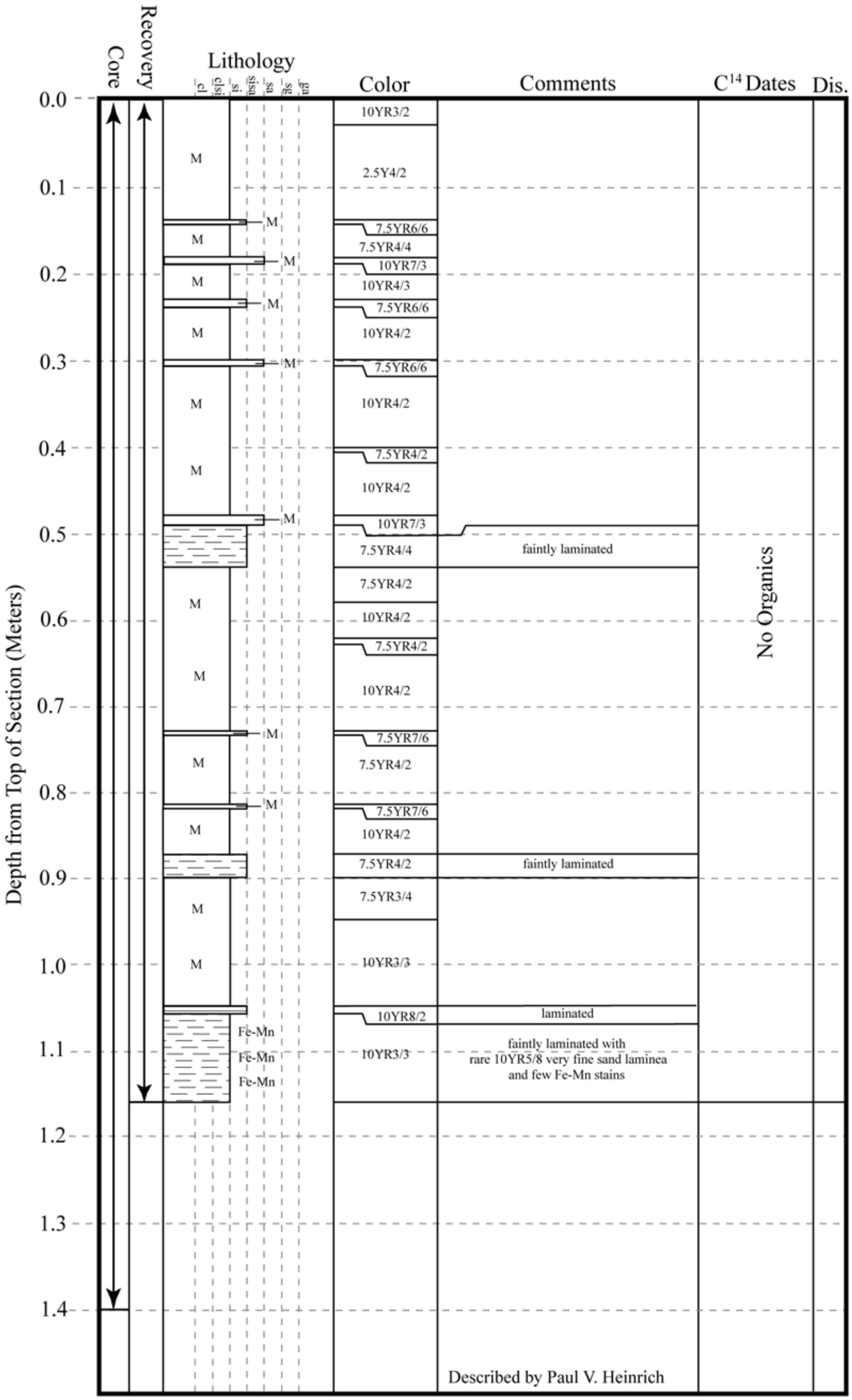
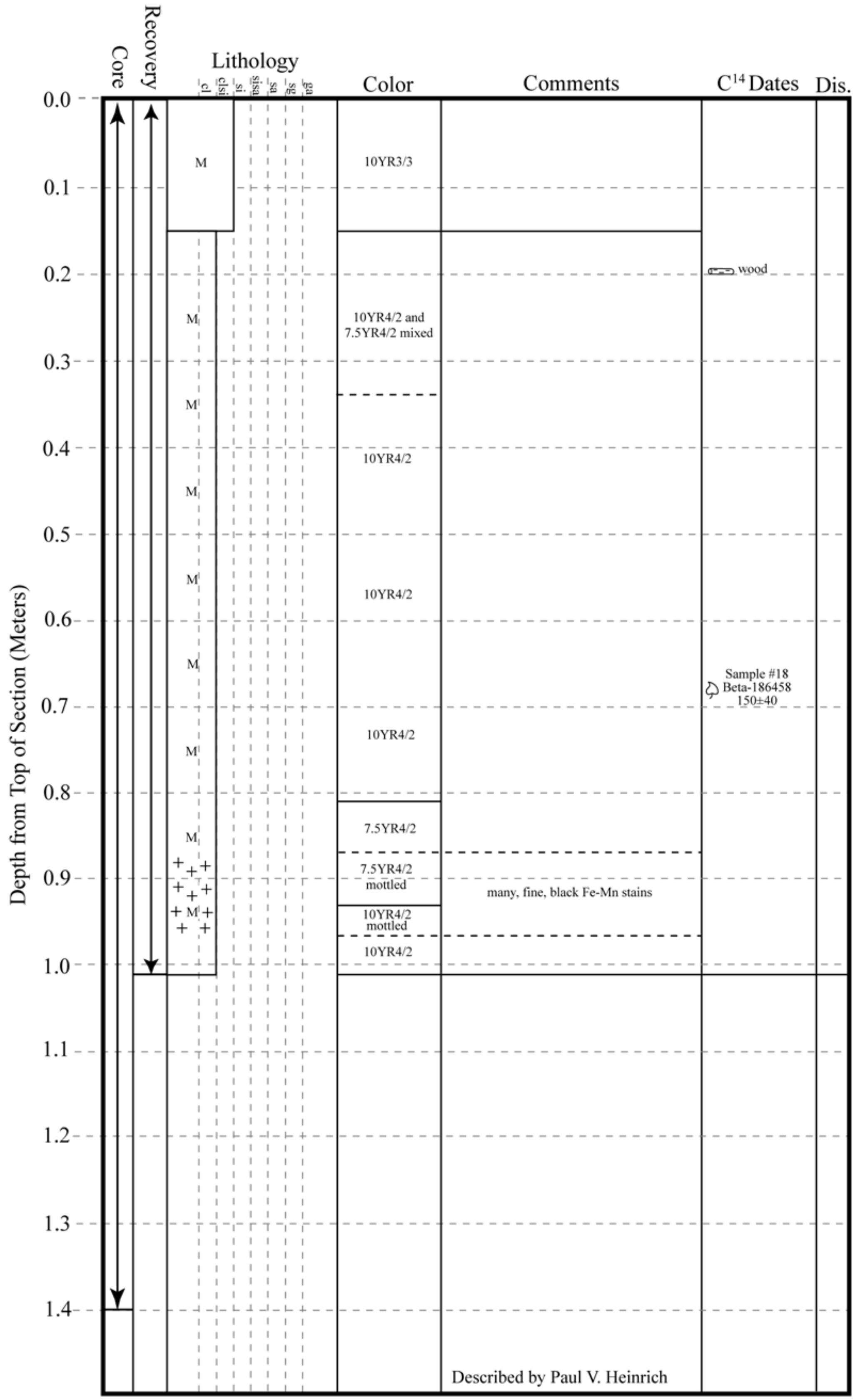


Boring 1-3, St. Landry Parish, Louisiana. Depth: 2.8-4.2 m, page 3 of 3.



Boring 2-1, St. Landry Parish, Louisiana. Depth: 0.0-1.4 m, page 1 of 4.



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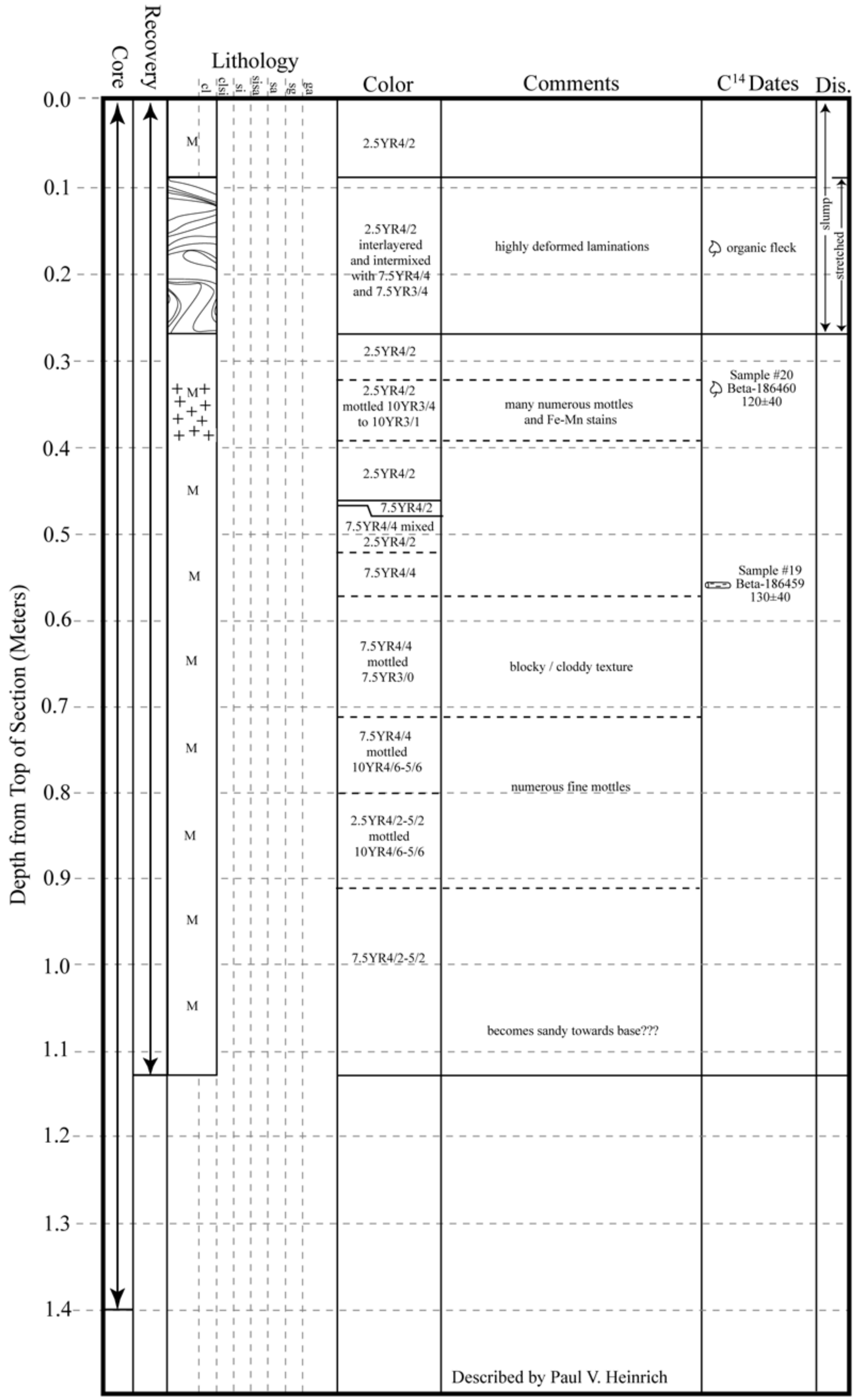
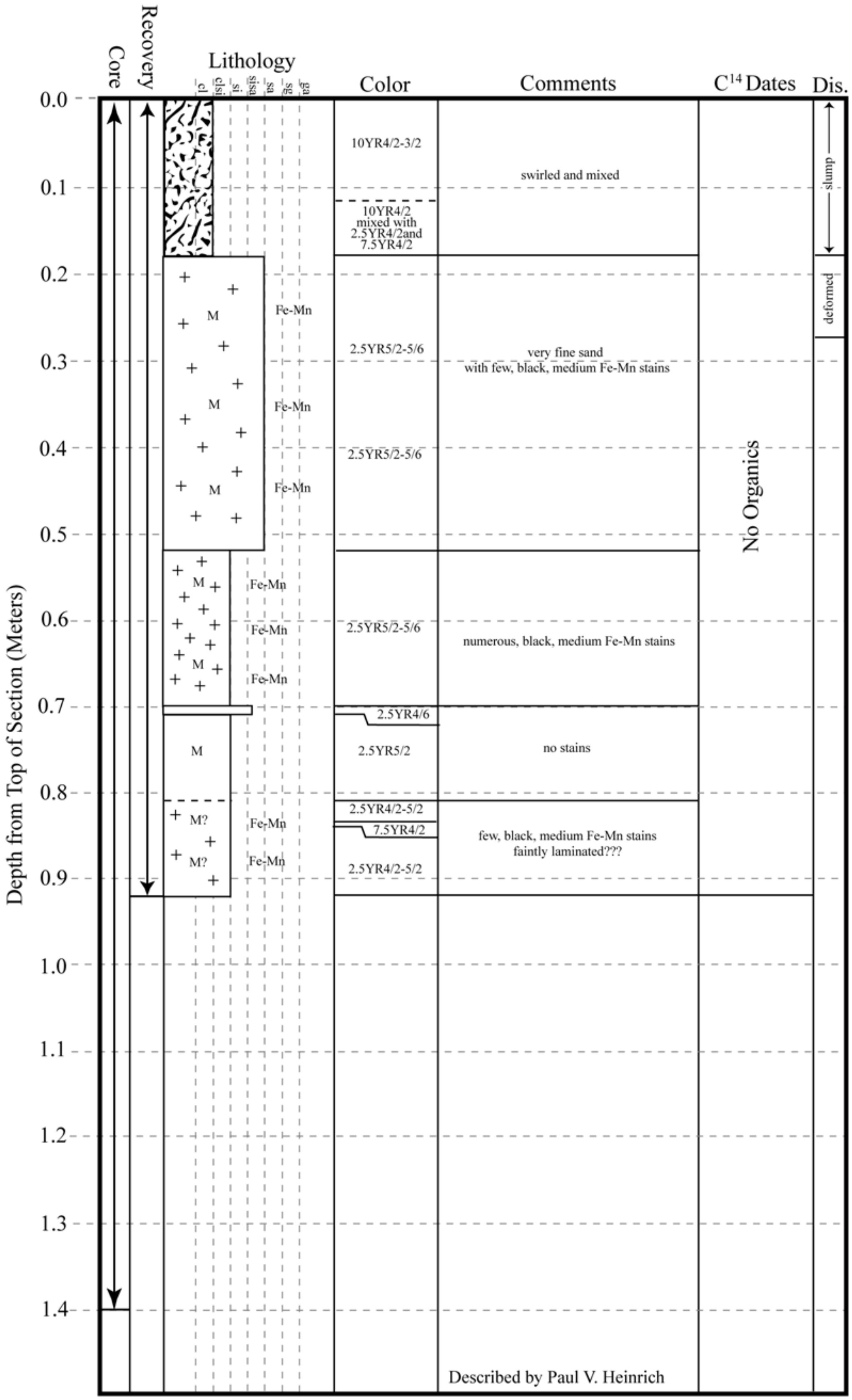
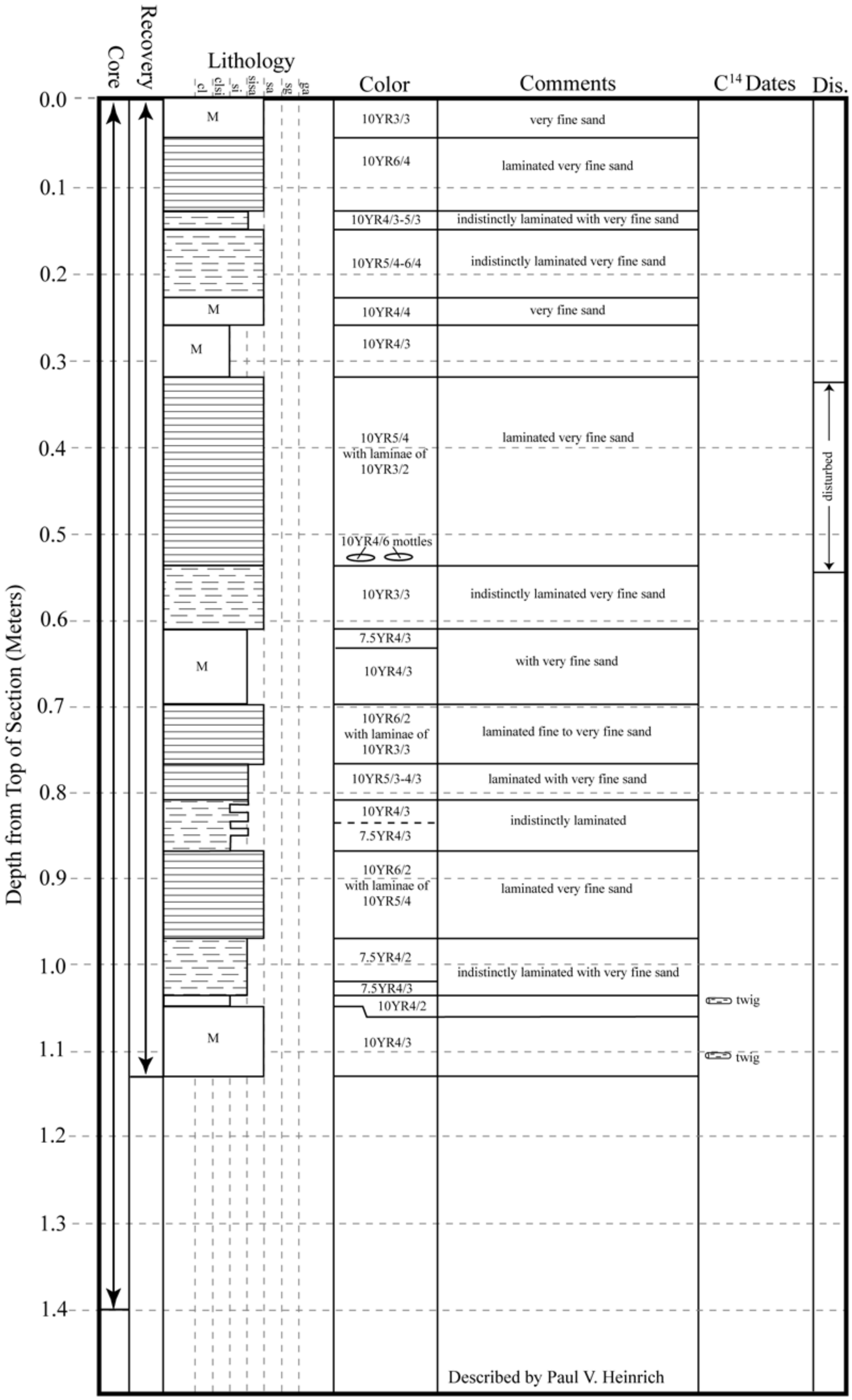


Boring 2-3, St. Landry Parish, Louisiana. Depth: 2.8-4.2 m, page 3 of 4.



Boring 2.4, St. Landry Parish, Louisiana. Depth: 4.2-5.6 m, page 4 of 4.



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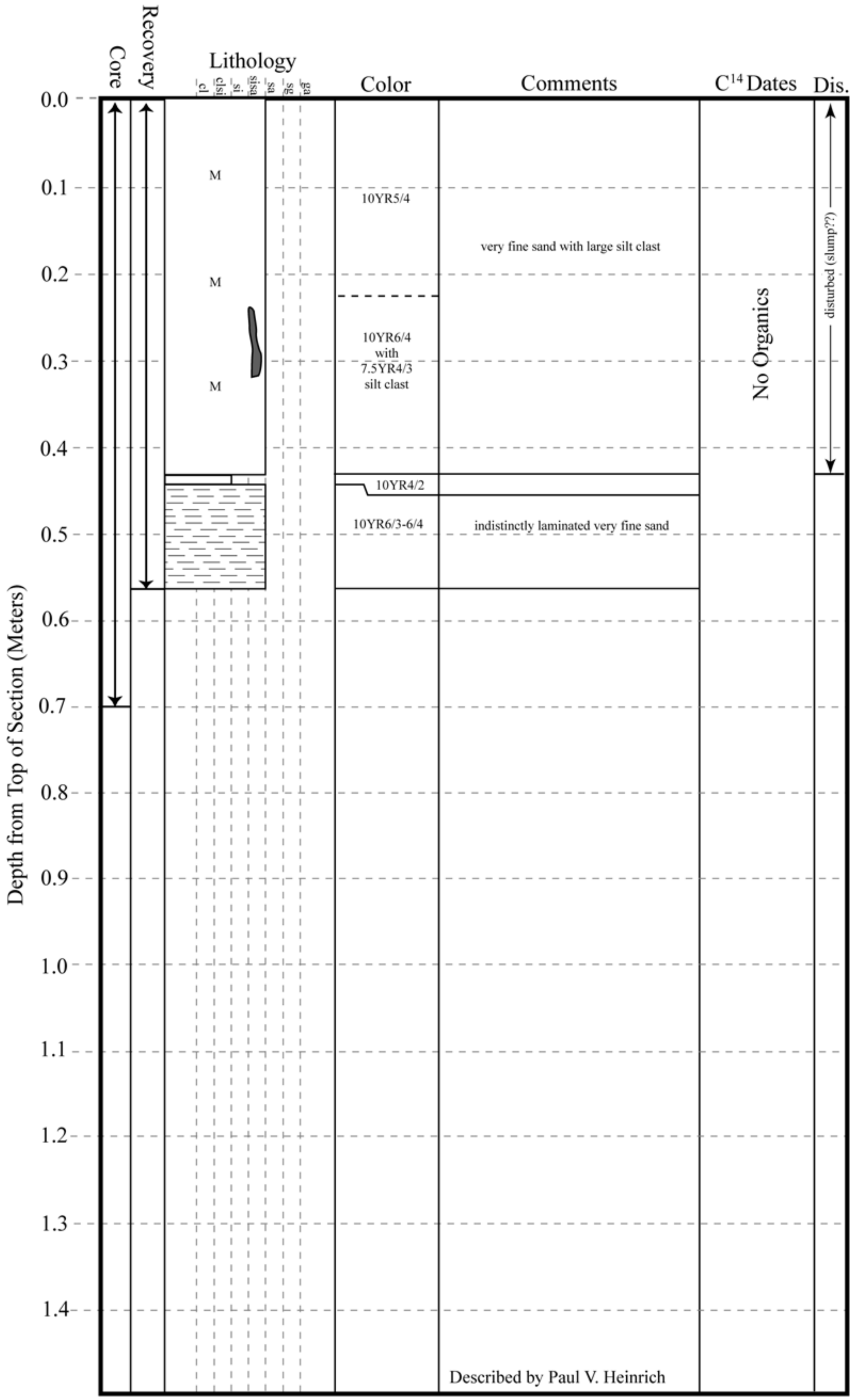

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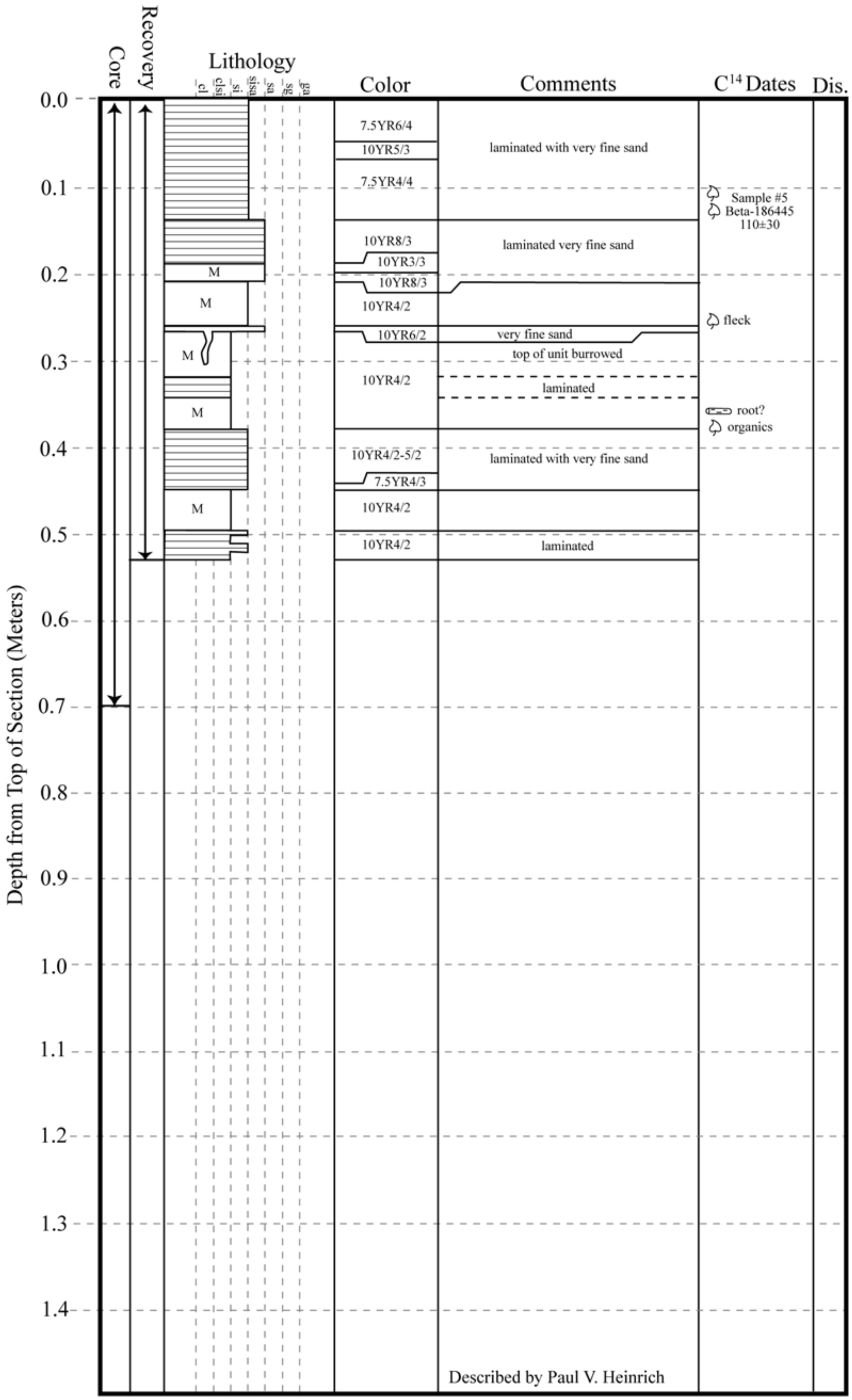

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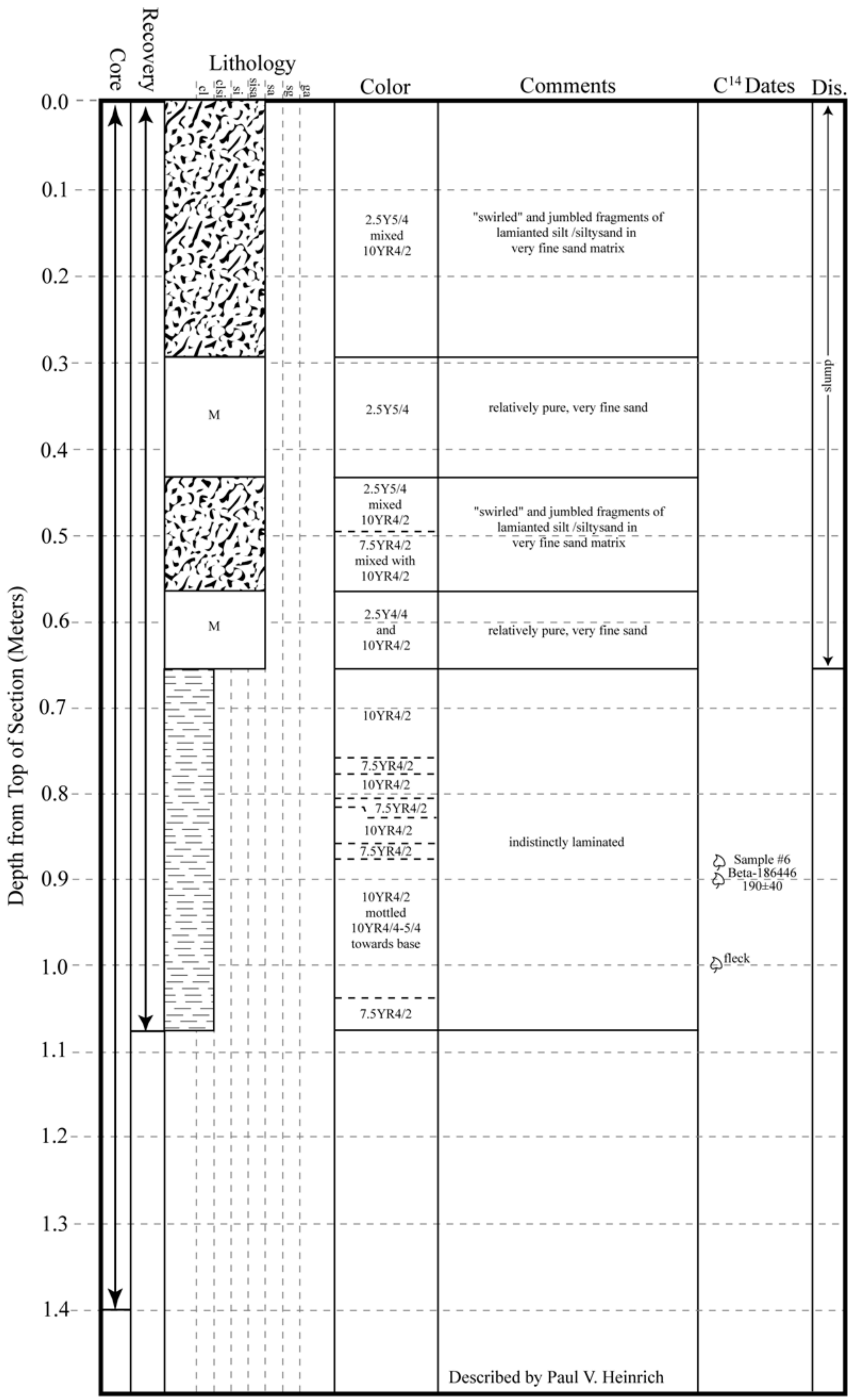
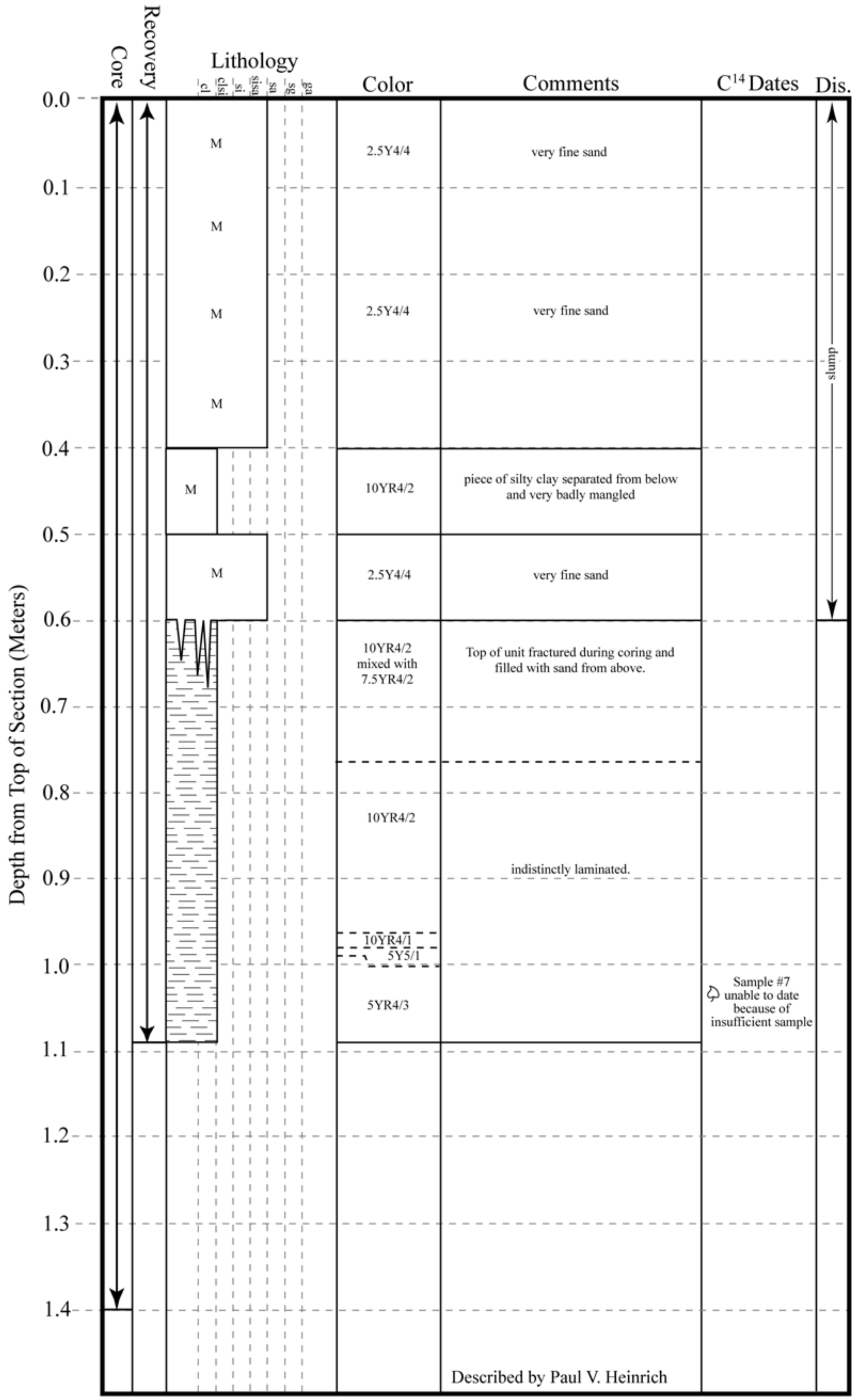
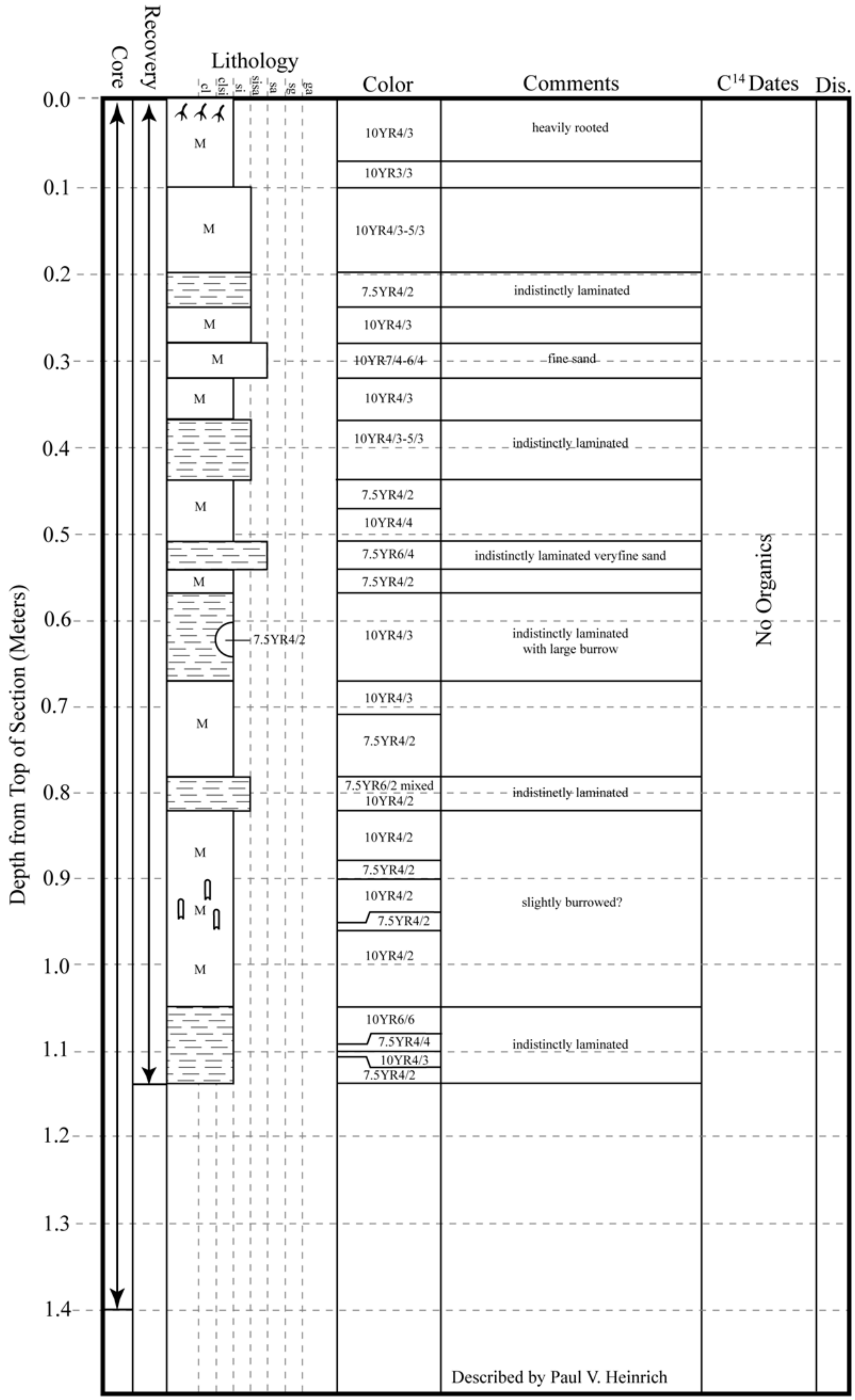


Boring 3-4, St. Landry Parish, Louisiana. Depth: 2.8-4.2 m, page 4 of 5.



Boring 3-5, St. Landry Parish, Louisiana. Depth: 4.2-5.6 m, page 5 of 5.



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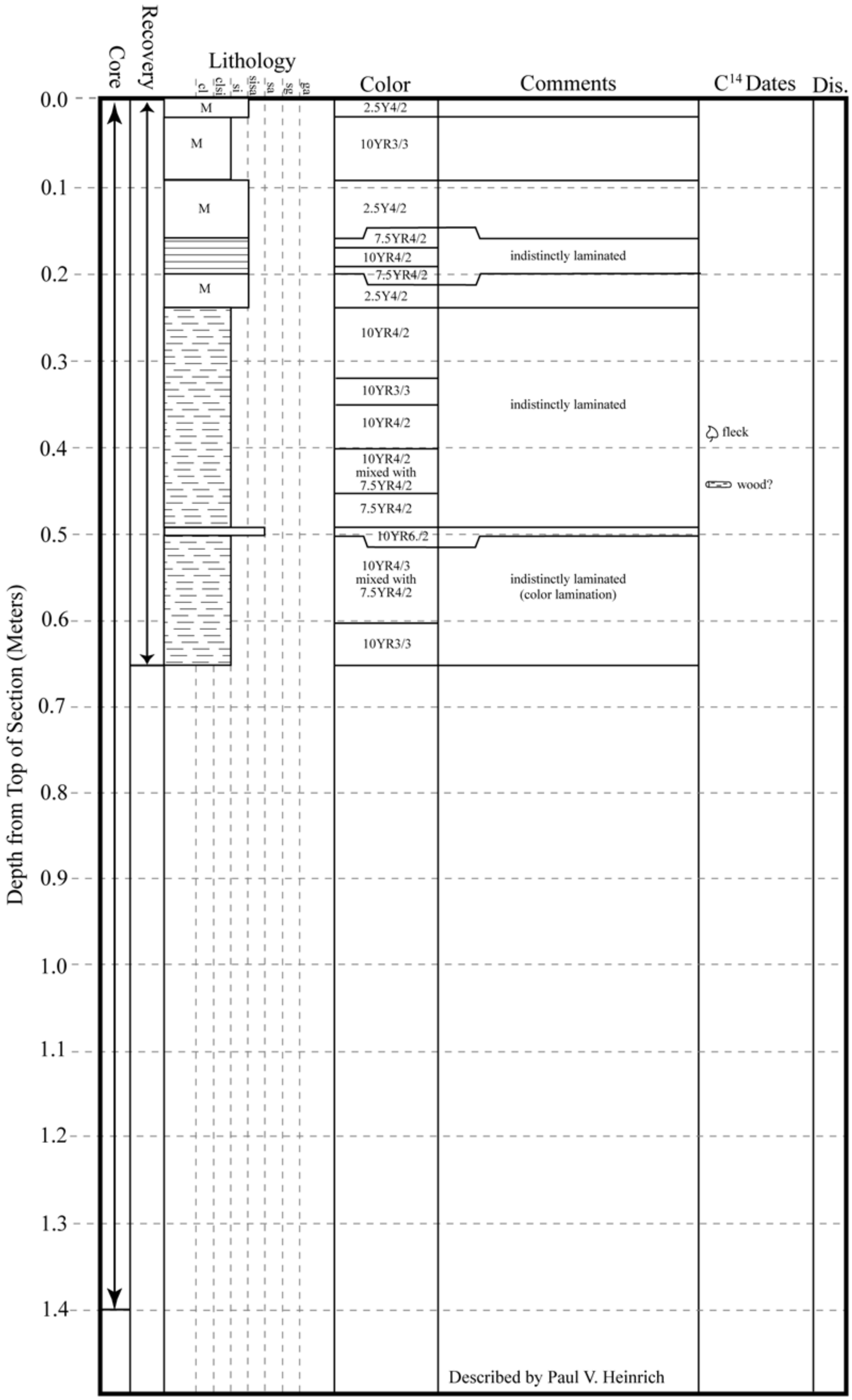
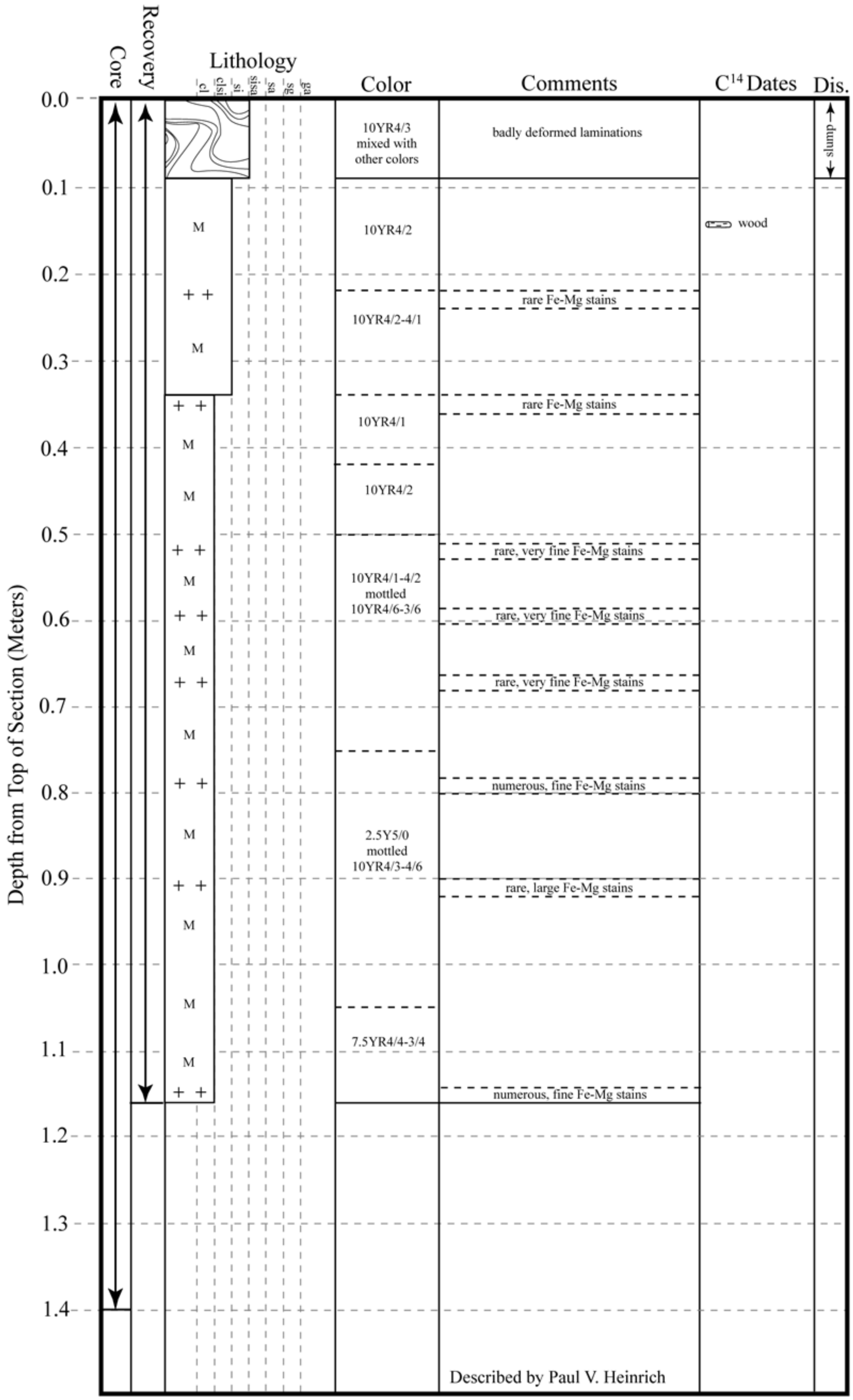


Boring 4-2, St. Landry Parish, Louisiana. Depth: 1.4-2.8 m, page 2 of 4.



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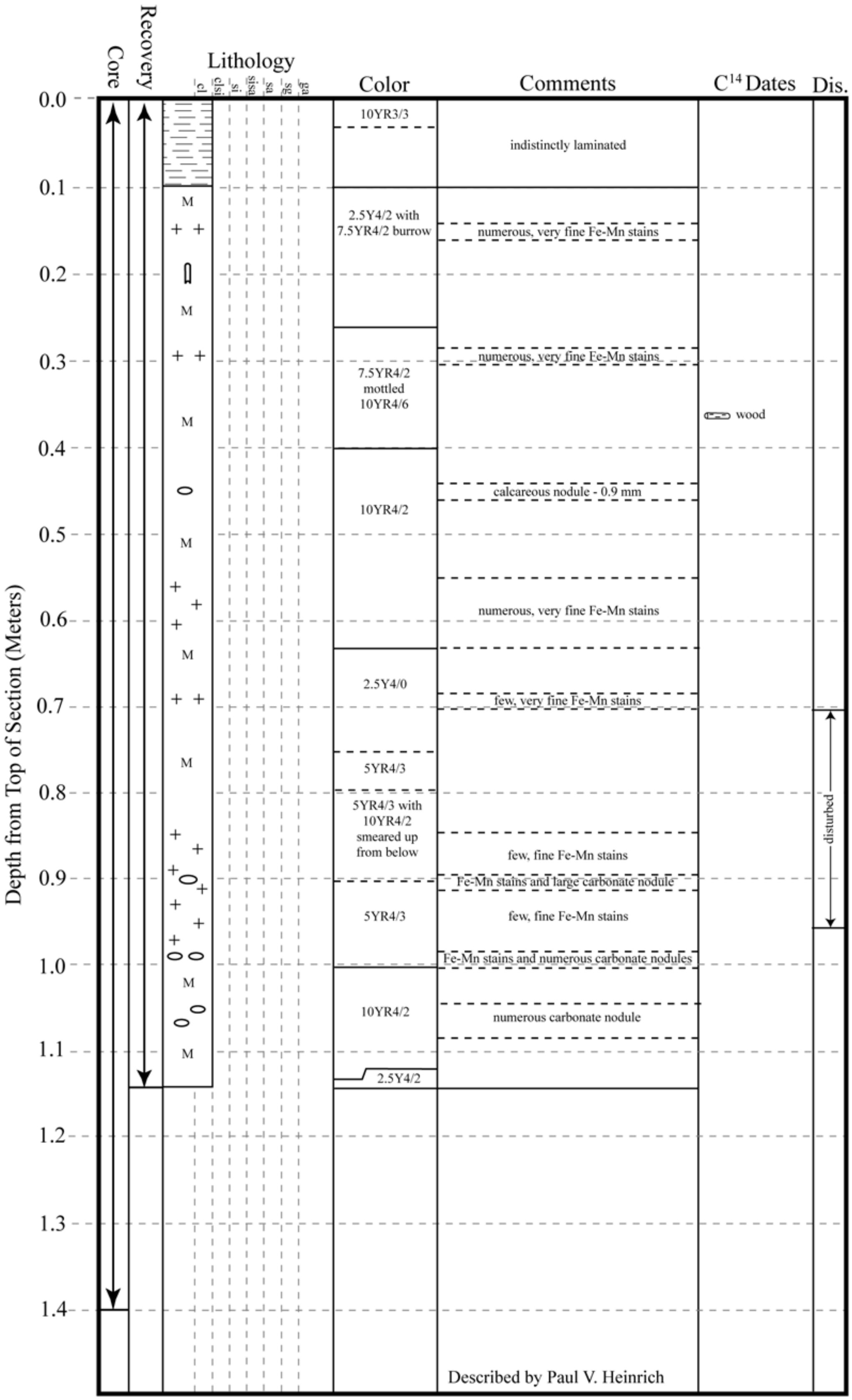
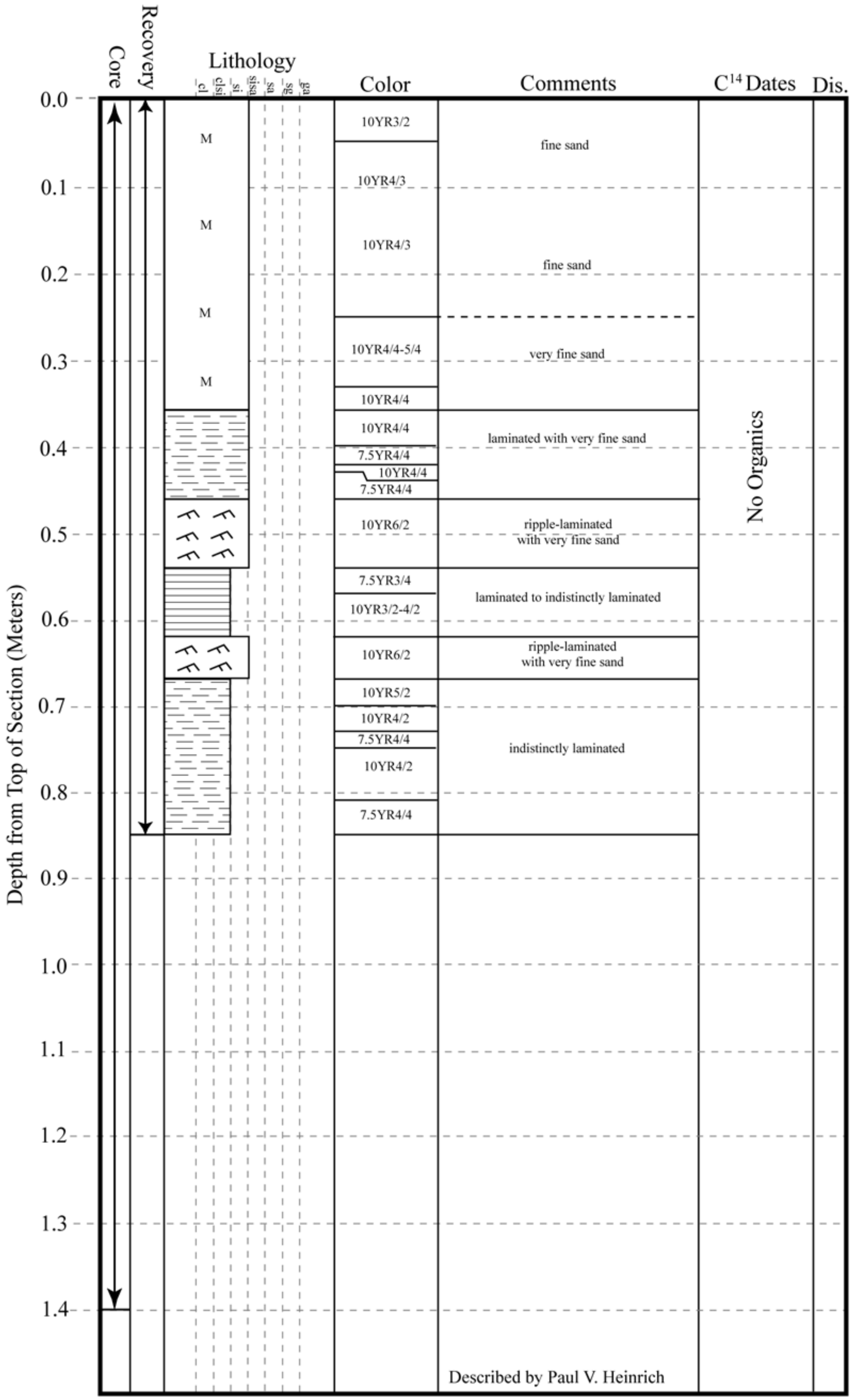
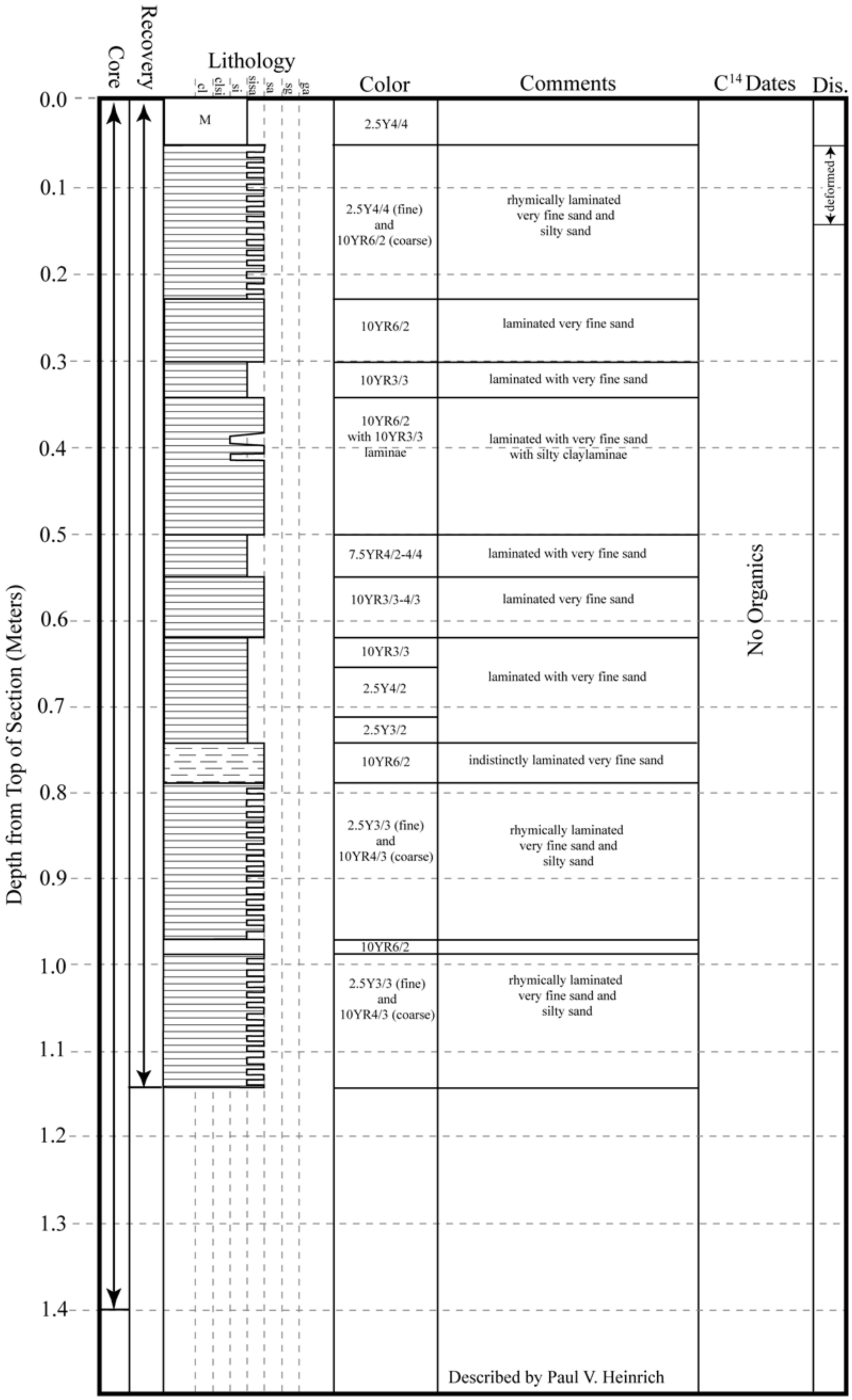


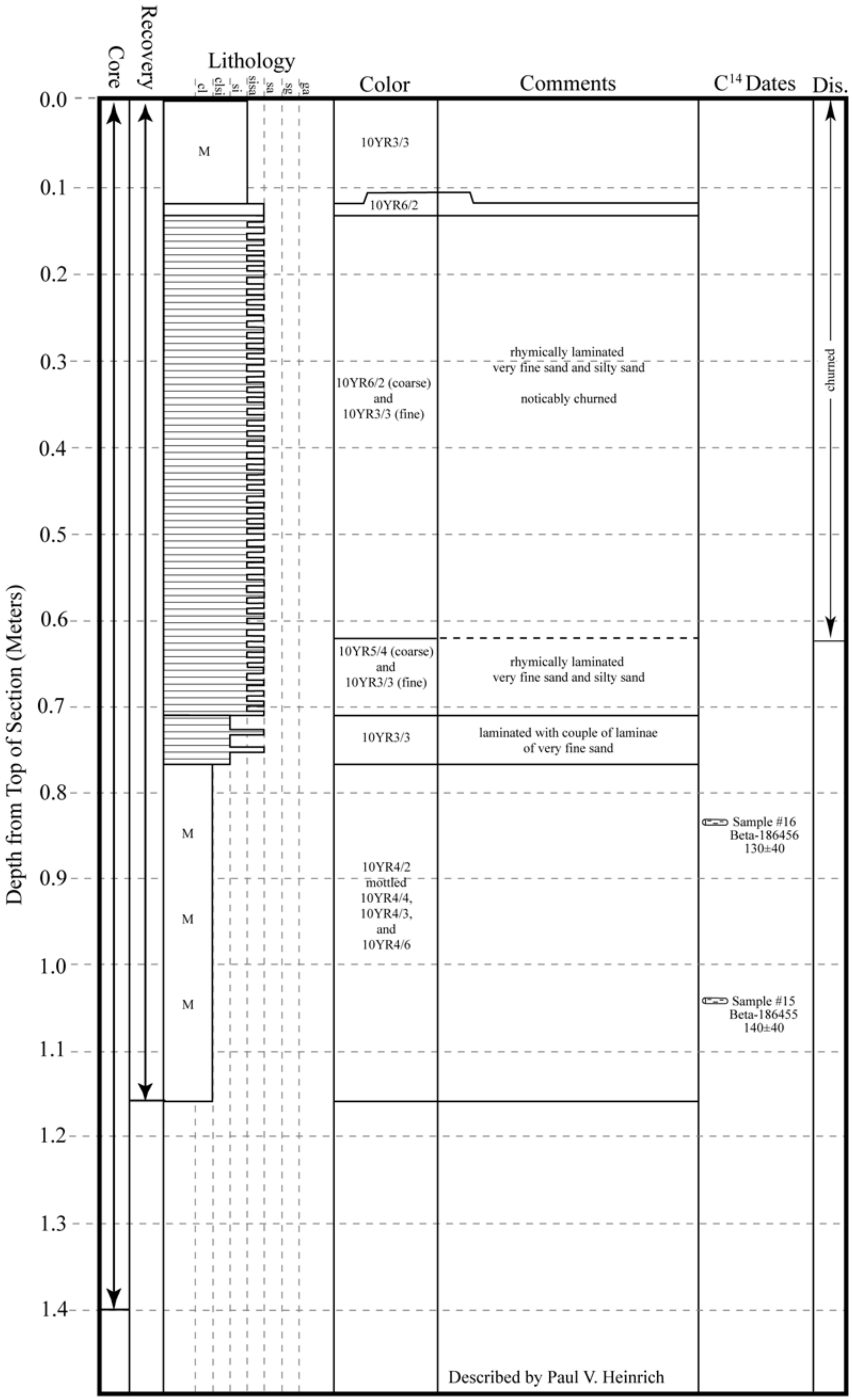
Boring 4-4, St. Landry Parish, Louisiana. Depth: 4.2-5.6 m, page 4 of 4.



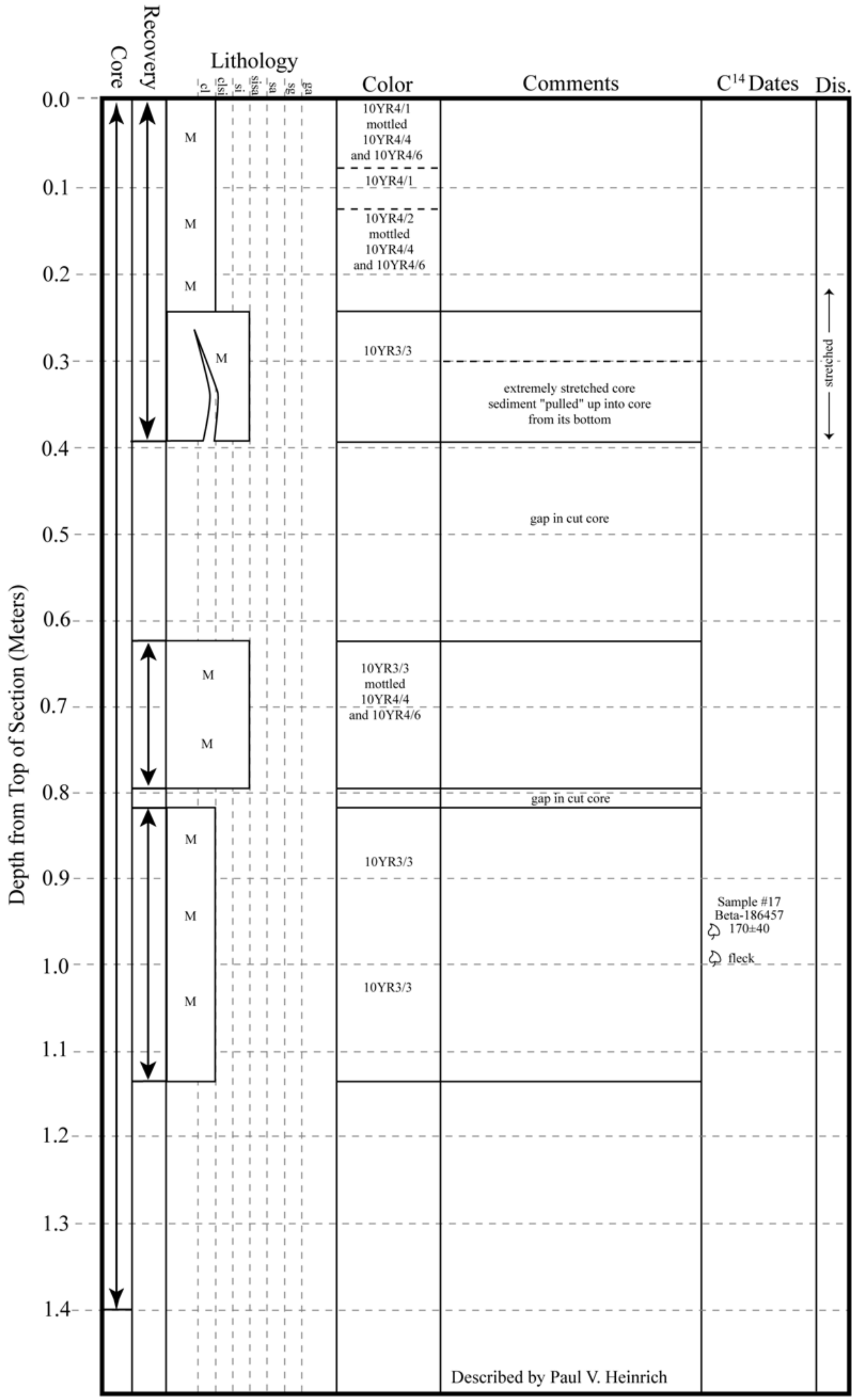
Boring 5-1, St. Landry Parish, Louisiana. Depth: 0.0-1.4 m, page 1 of 4.



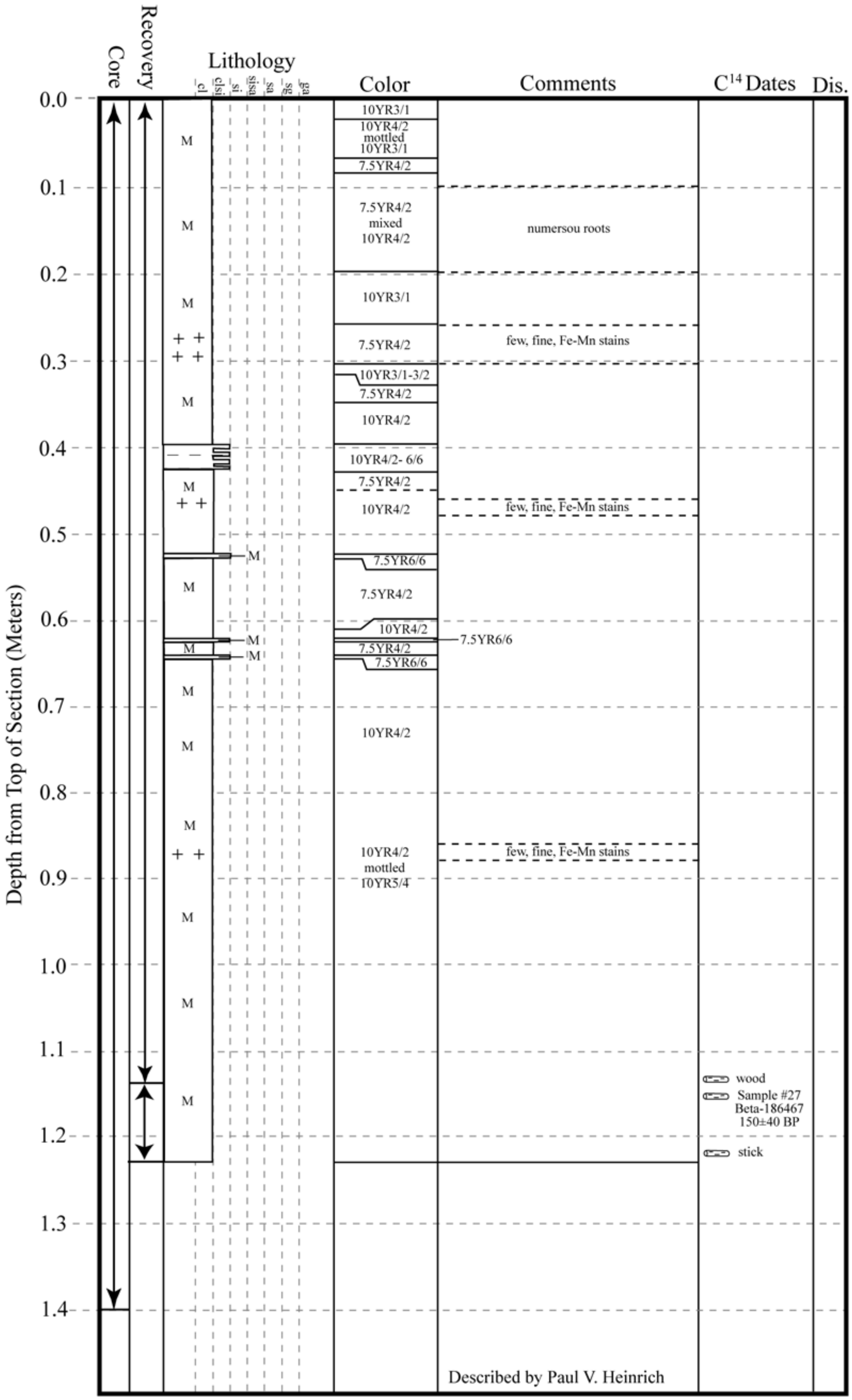
Boring 5-2, St. Landry Parish, Louisiana. Depth: 1.4-2.8 m, page 2 of 4.



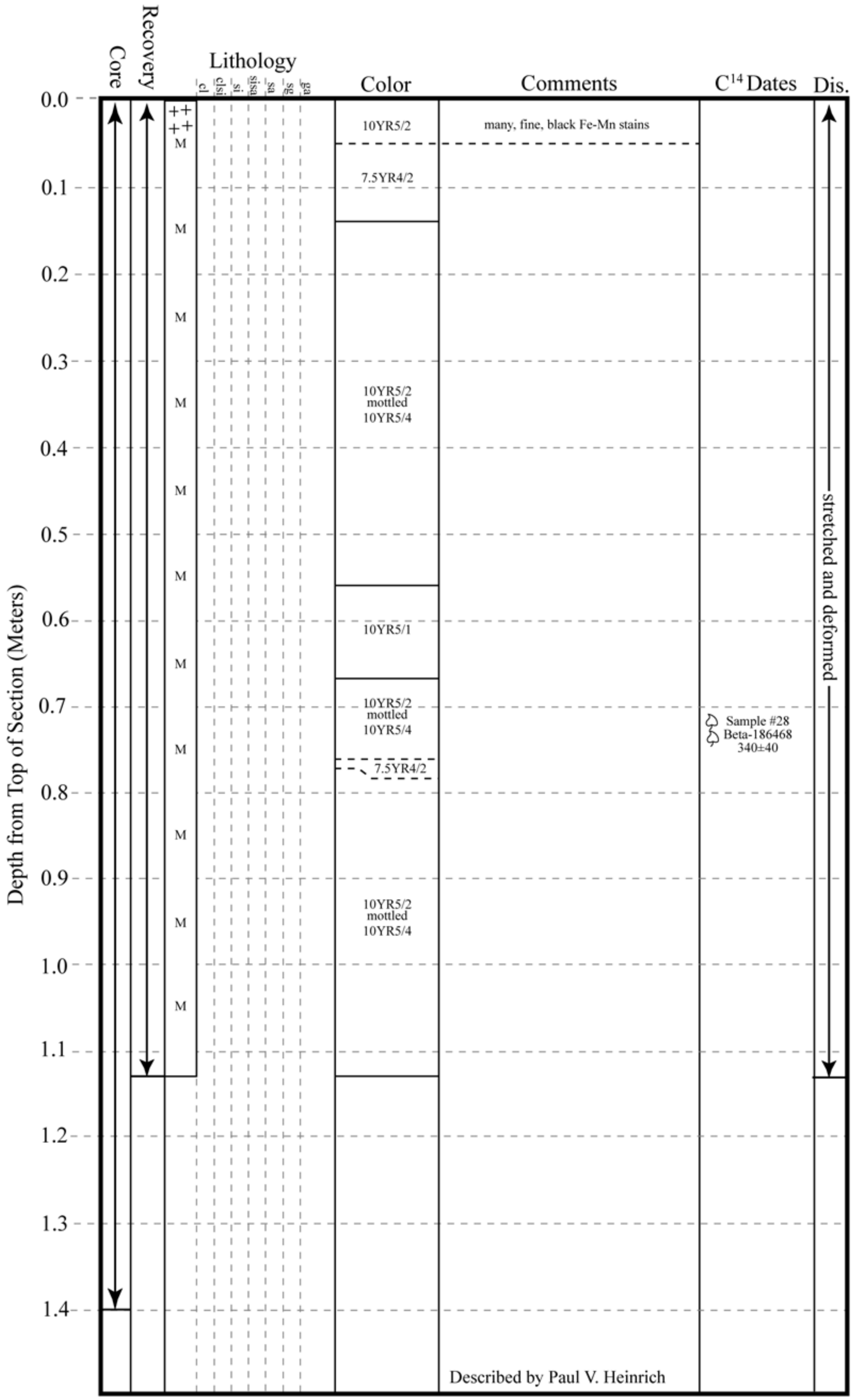
Boring 5-3, St. Landry Parish, Louisiana. Depth: 2.8-4.2 m, page 3 of 4.



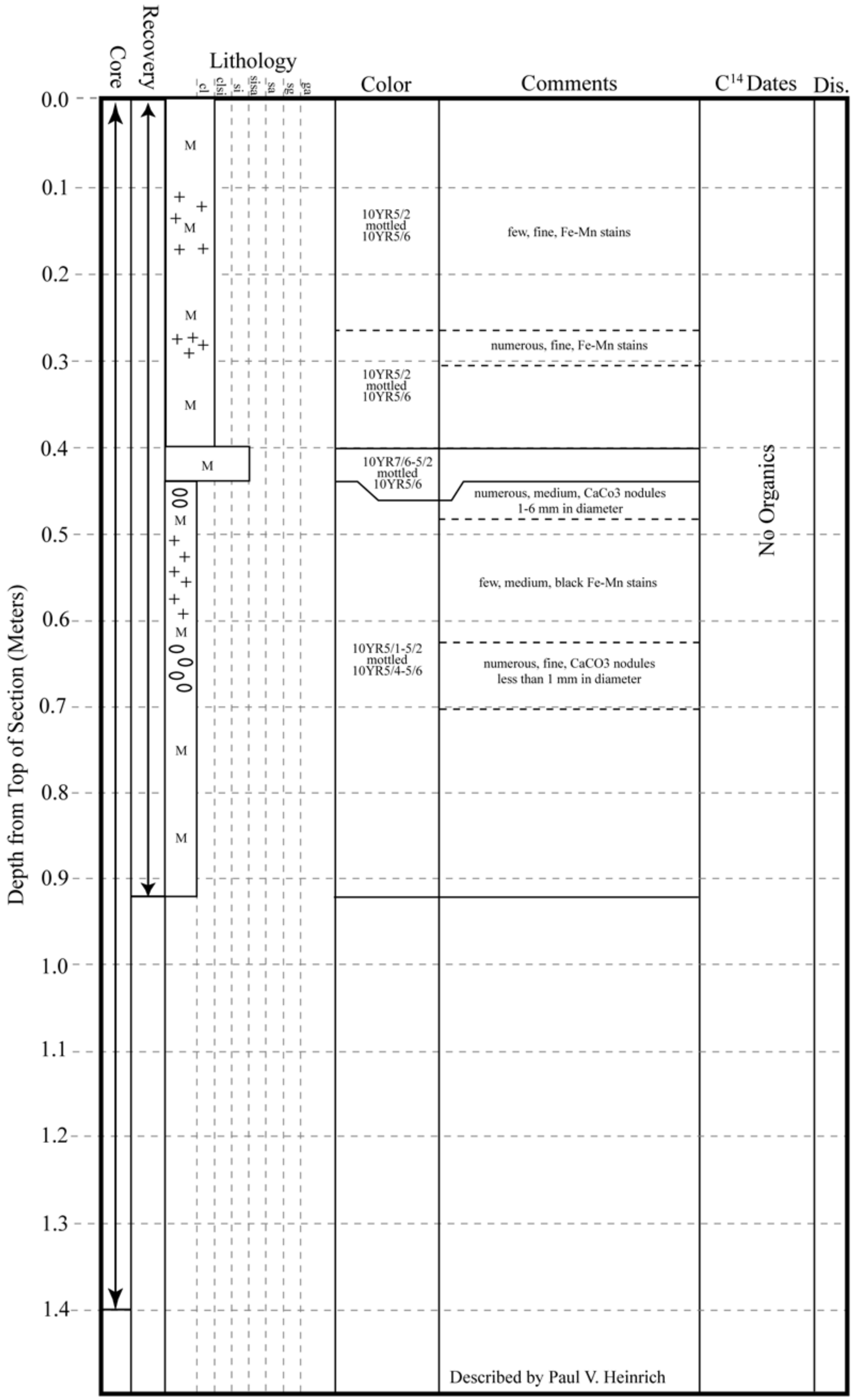
Boring 5-4, St. Landry Parish, Louisiana. Depth: 4.2-5.6 m, page 4 of 4.



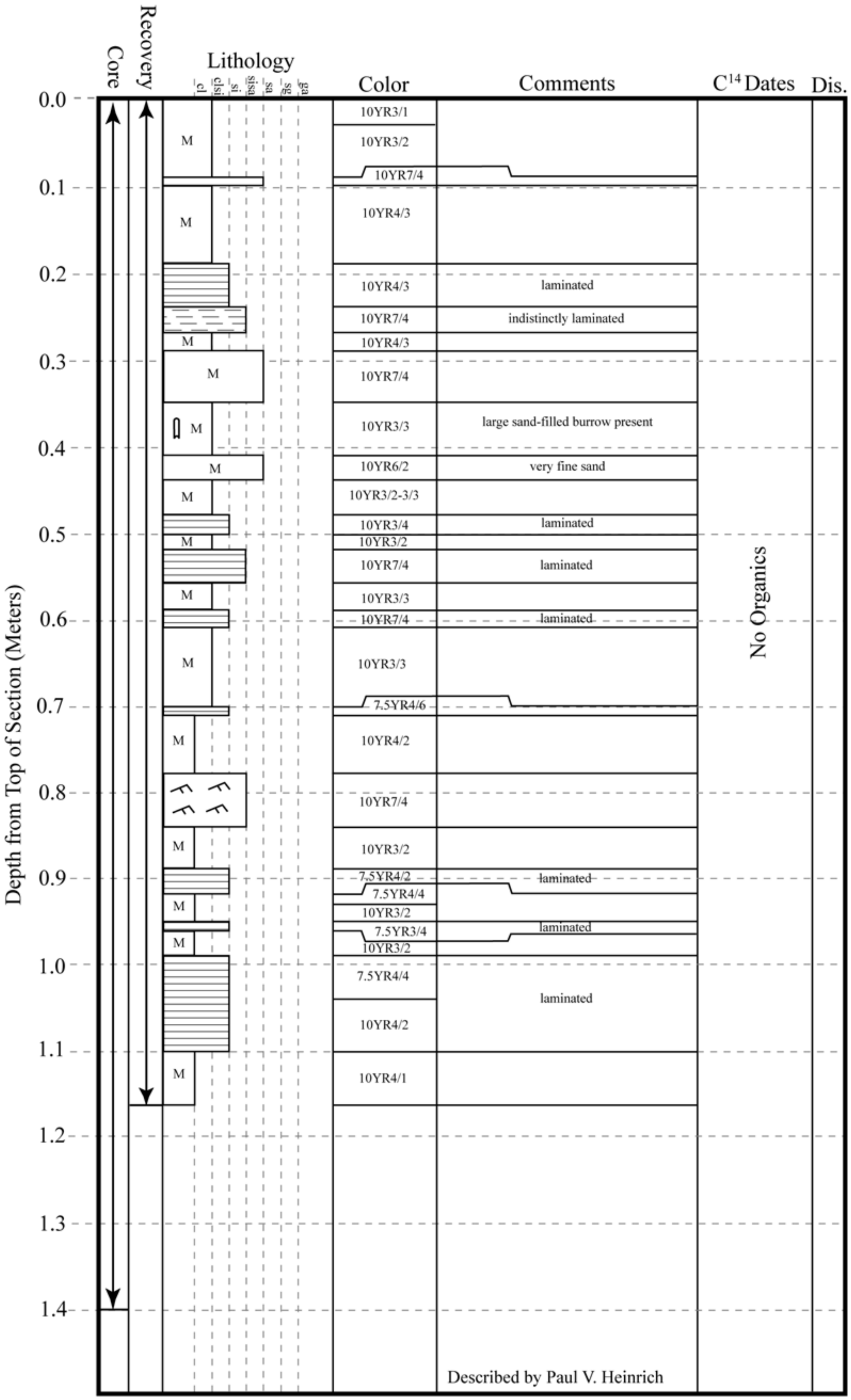
Boring 6-1, St. Landry Parish, Louisiana. Depth: 0.0-1.4 m, page 1 of 3.



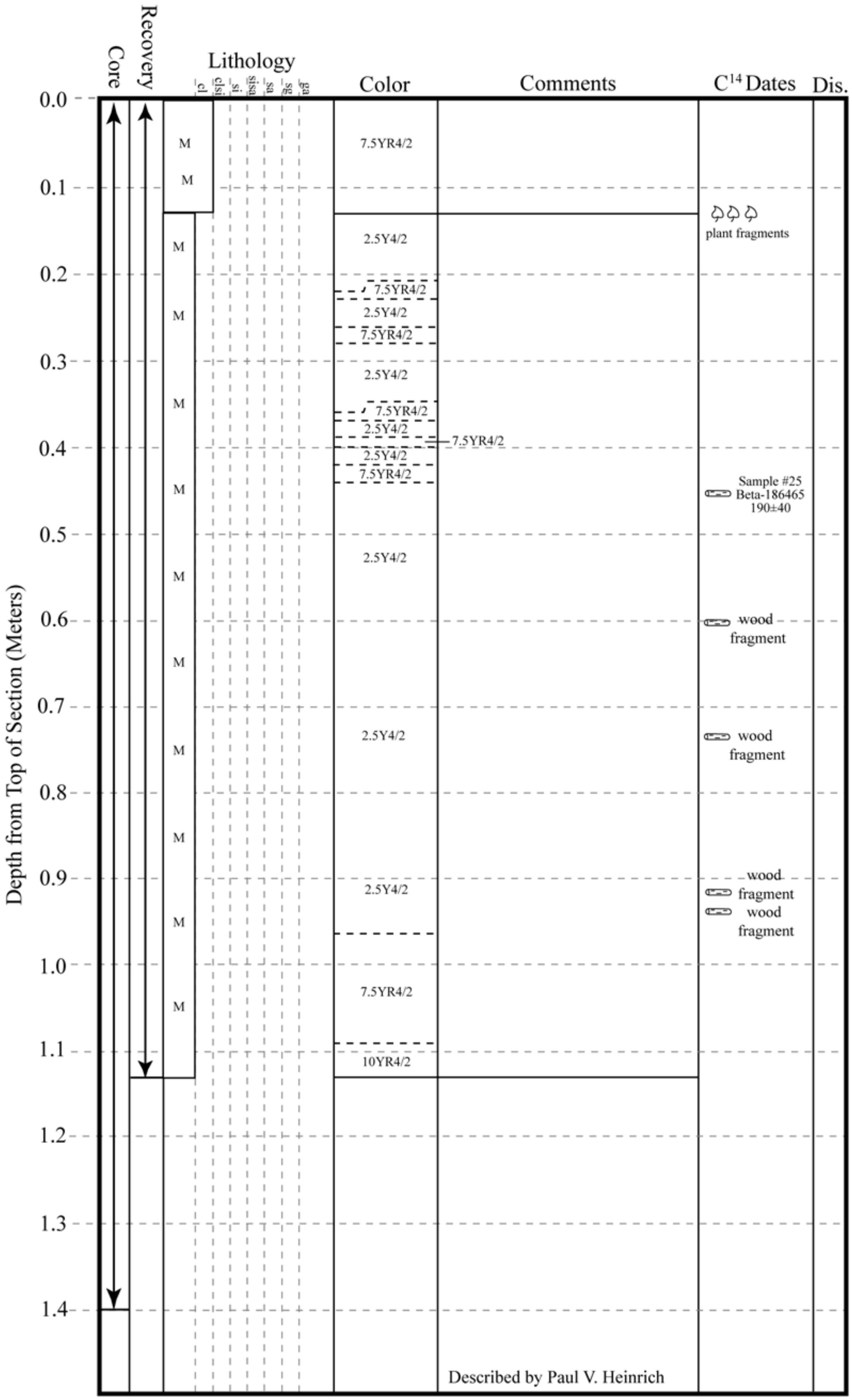
Boring 6-2, St. Landry Parish, Louisiana. Depth: 1.4-2.8 m, page 2 of 3.



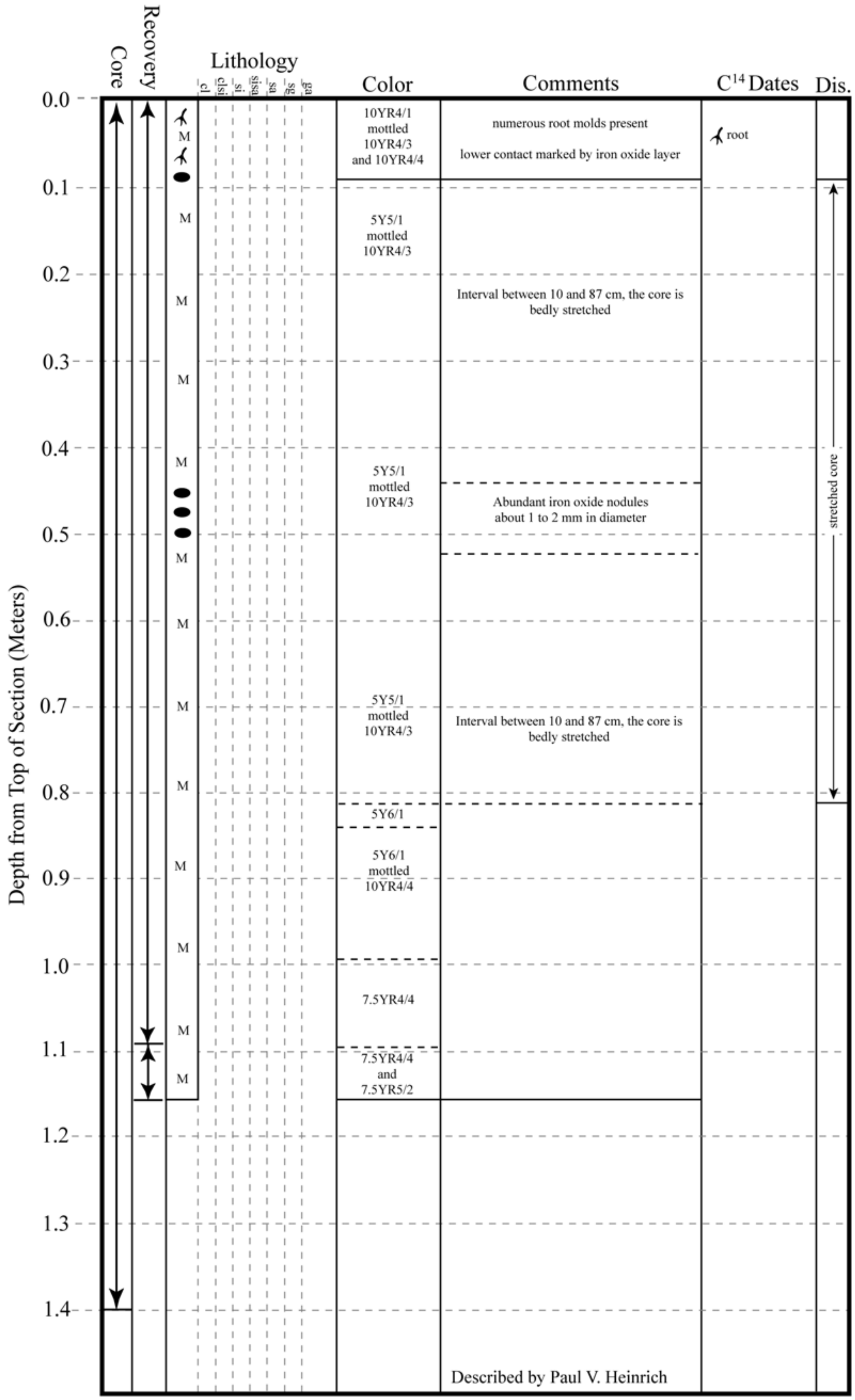
Boring 6-3, St. Landry Parish, Louisiana. Depth: 1.4-4.2 m, page 3 of 3.



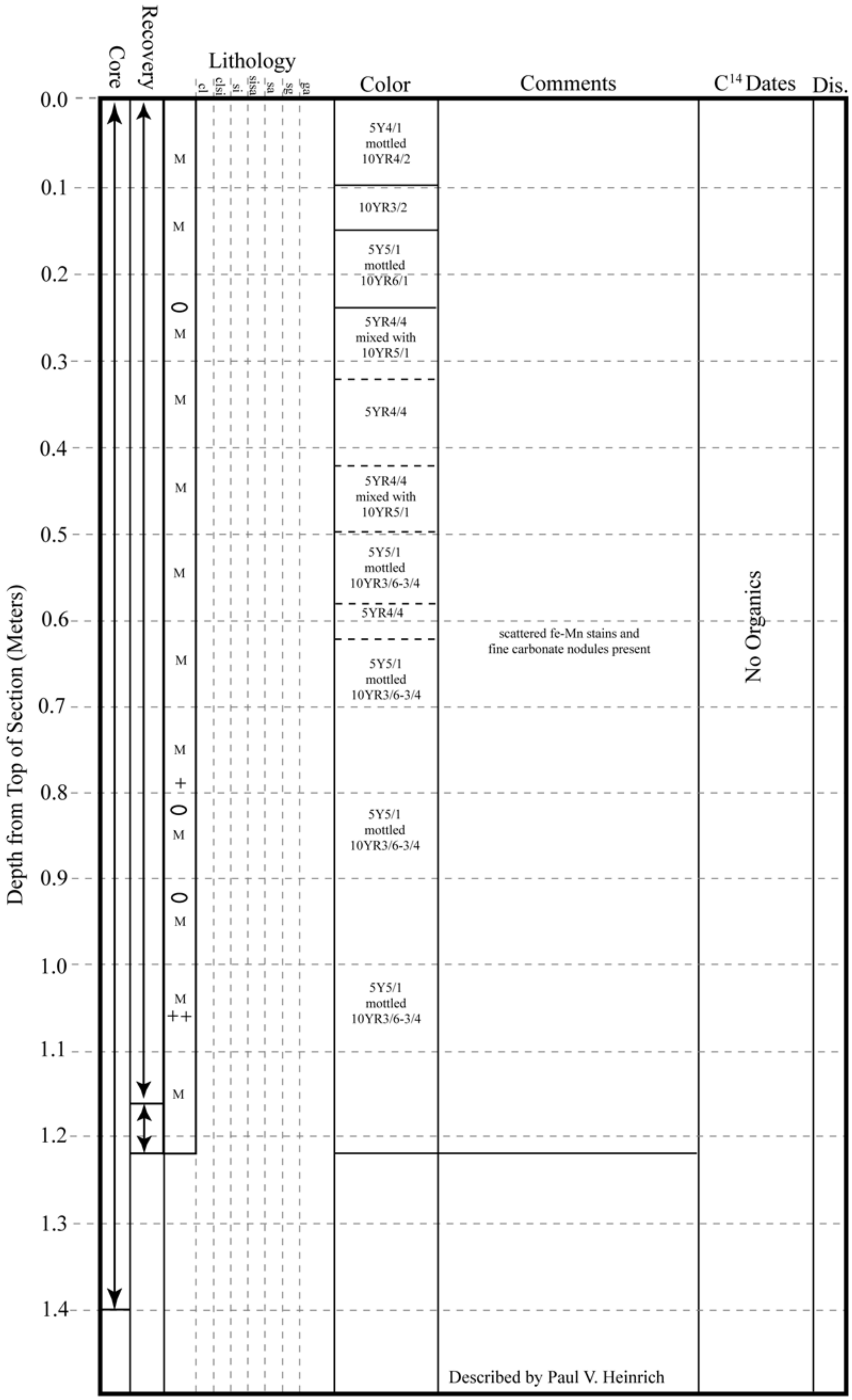
Boring 7-1, St. Landry Parish, Louisiana. Depth: 0.0-1.4 m, page 1 of 4.



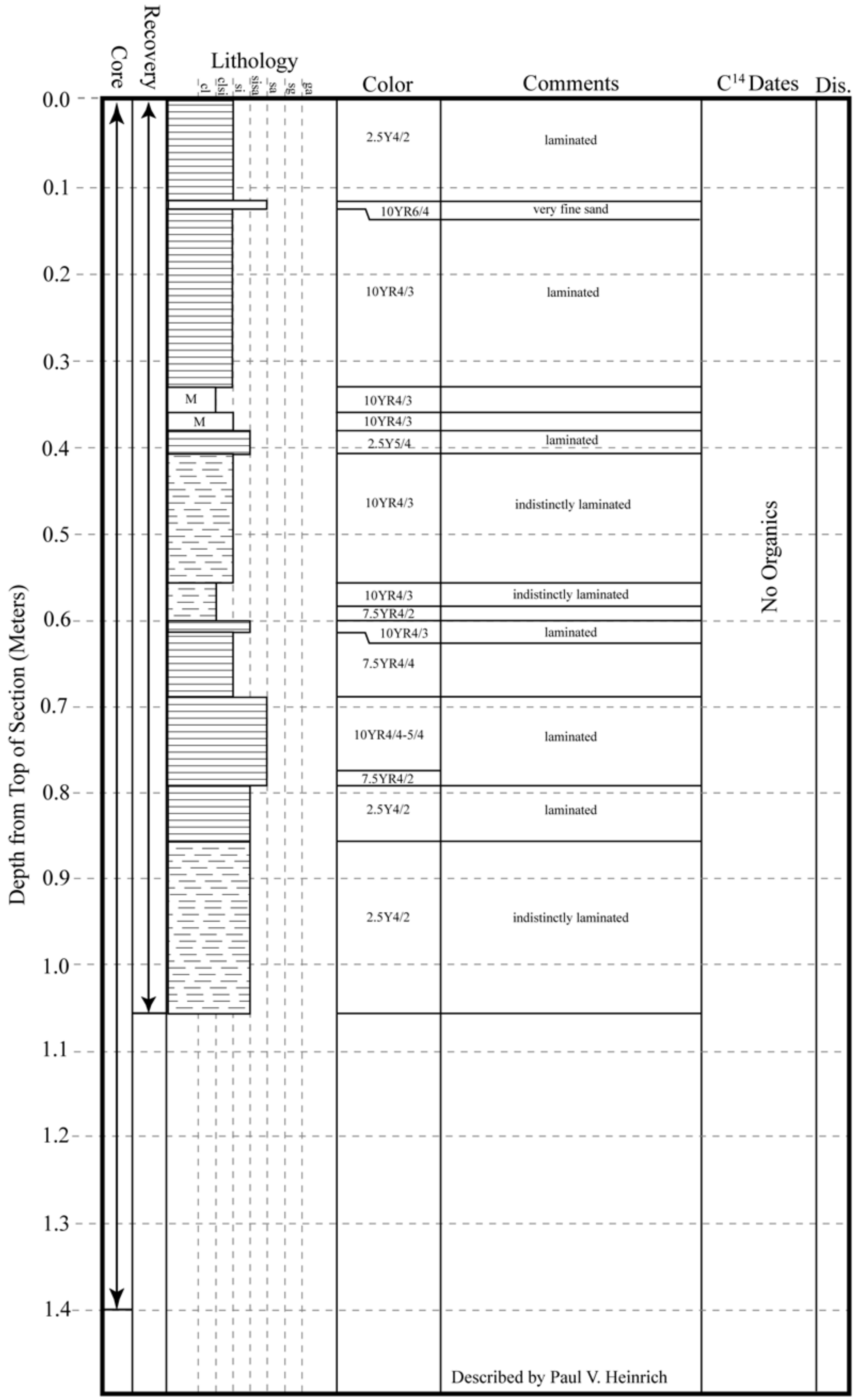
Boring 7-2, St. Landry Parish, Louisiana. Depth: 1.4-2.8 m, page 2 of 4.



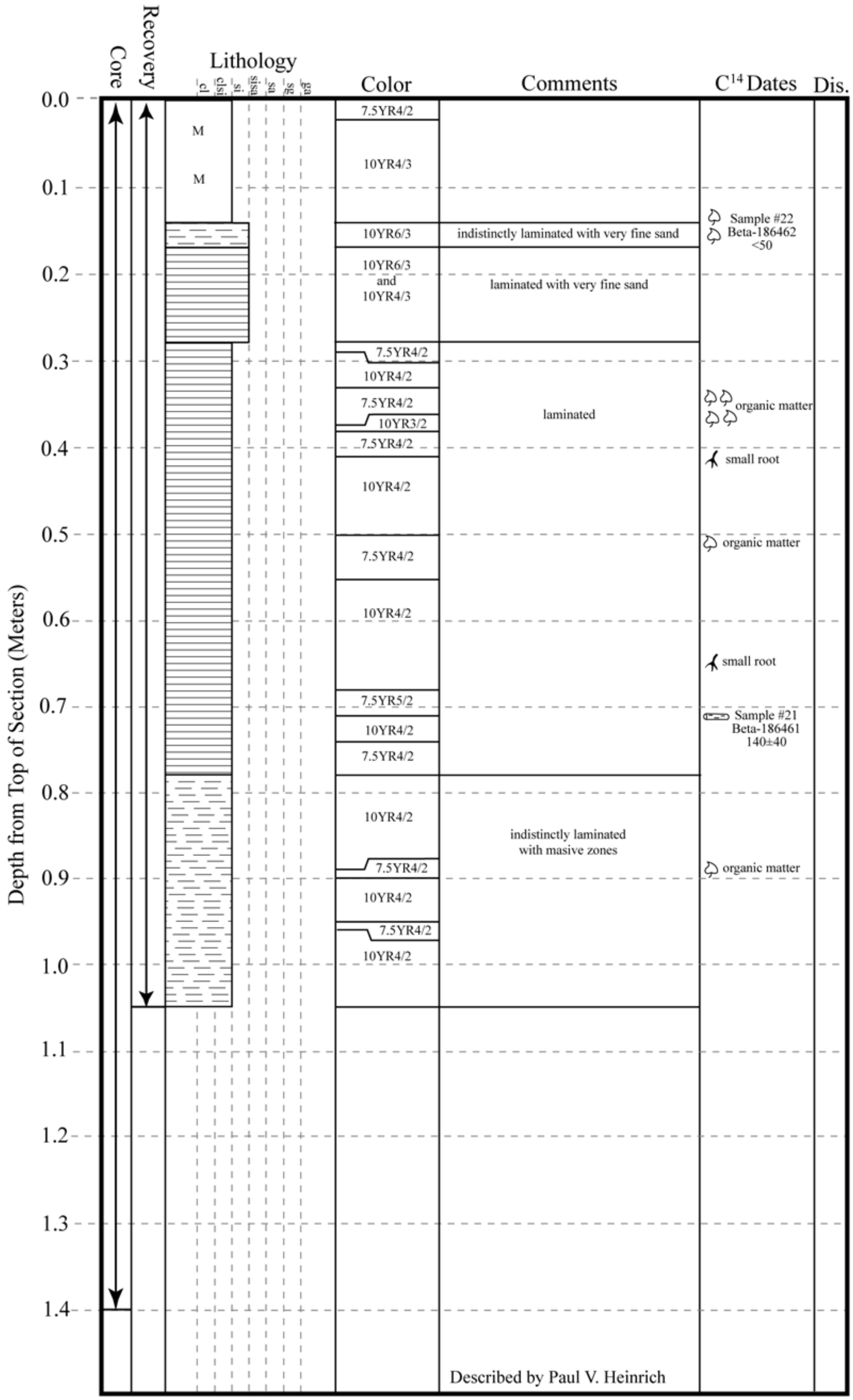
Boring 7-3, St. Landry Parish, Louisiana. Depth: 2.8-4.2 m, page 3 of 4.



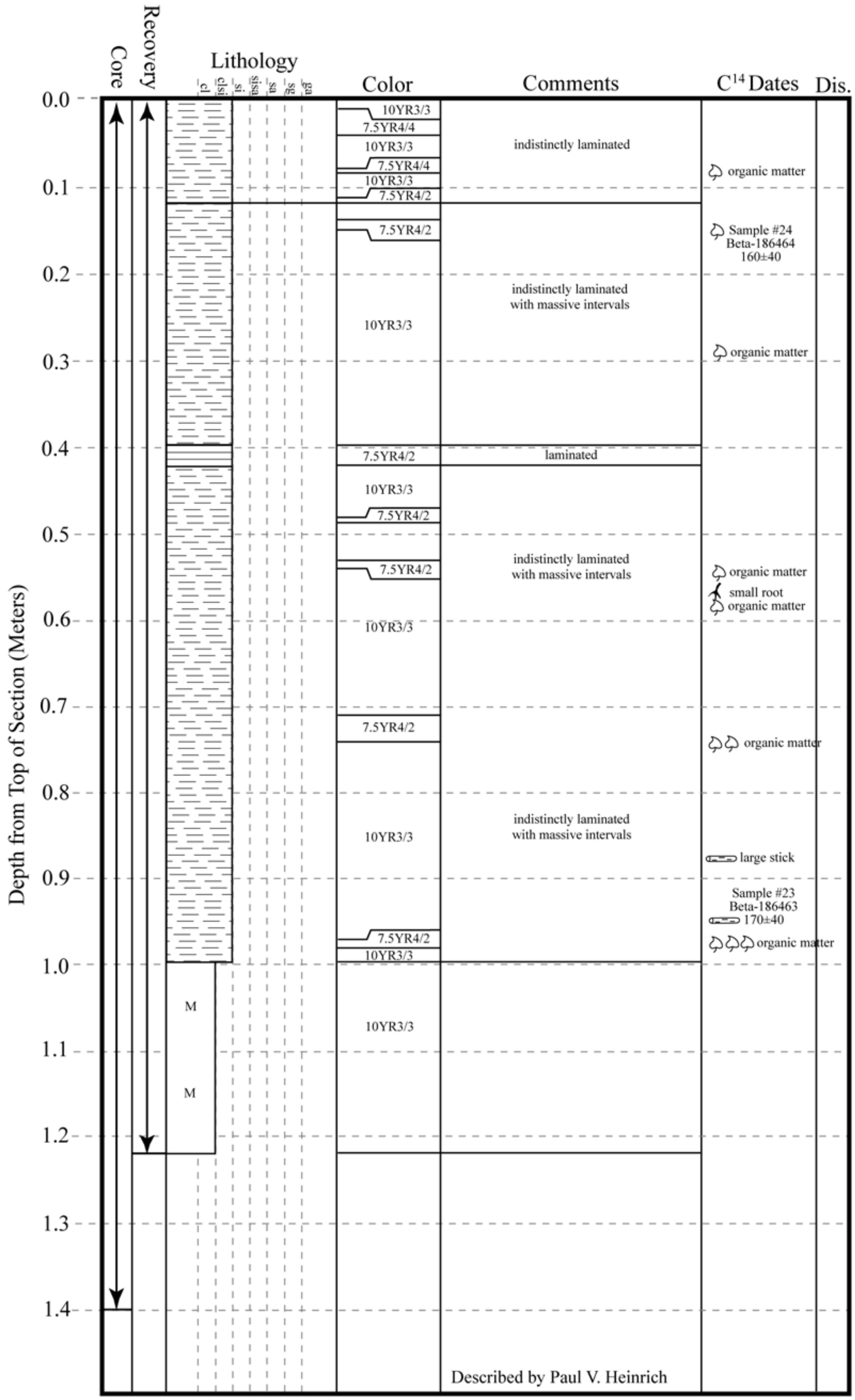
Boring 7-4, St. Landry Parish, Louisiana. Depth: 4.2-5.6 m, page 4 of 4.



Boring 8-1, St. Landry Parish, Louisiana. Depth: 0.0-1.4 m, page 1 of 4.



Boring 8-2, St. Landry Parish, Louisiana. Depth: 1.4-2.8 m, page 2 of 4.



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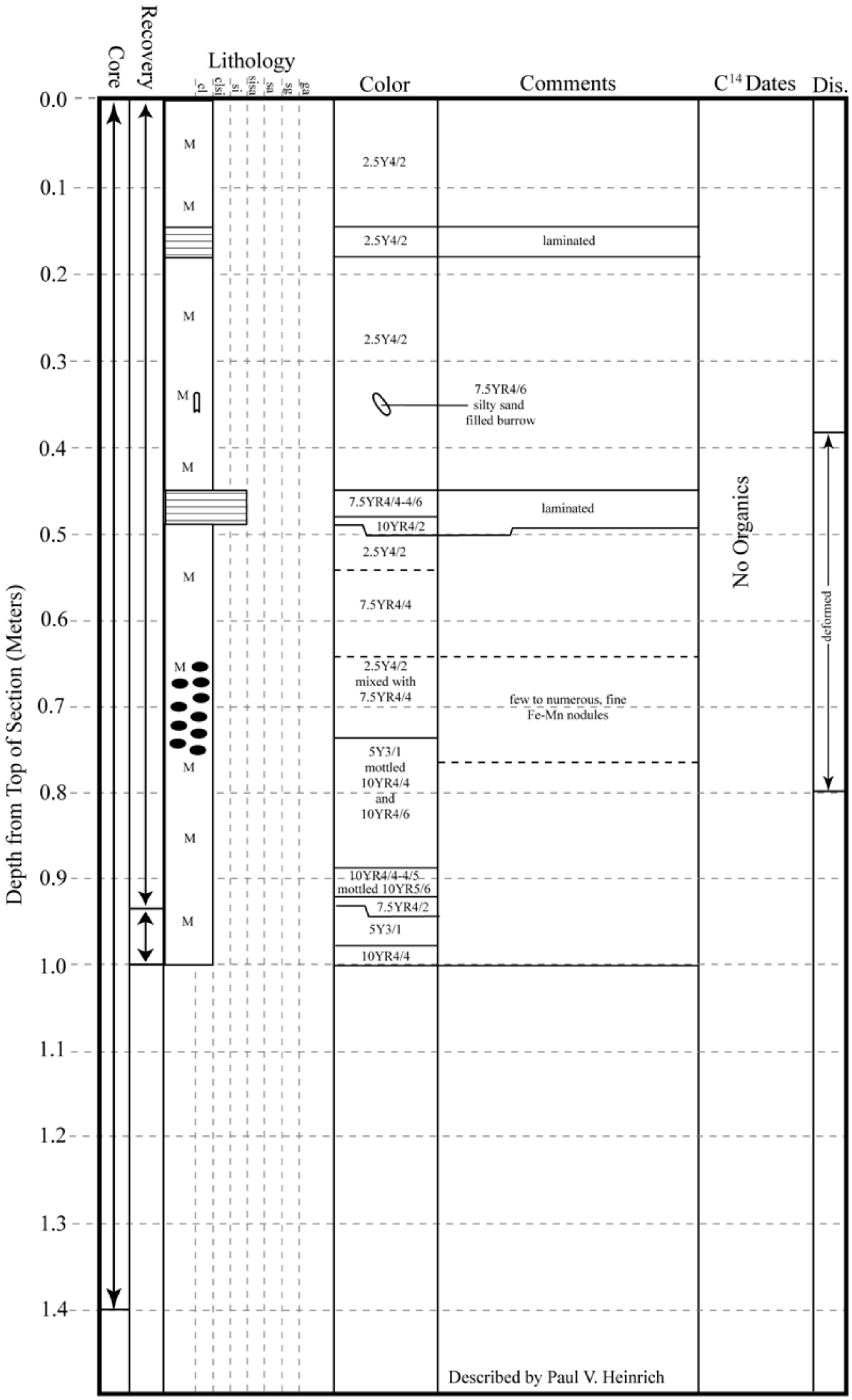
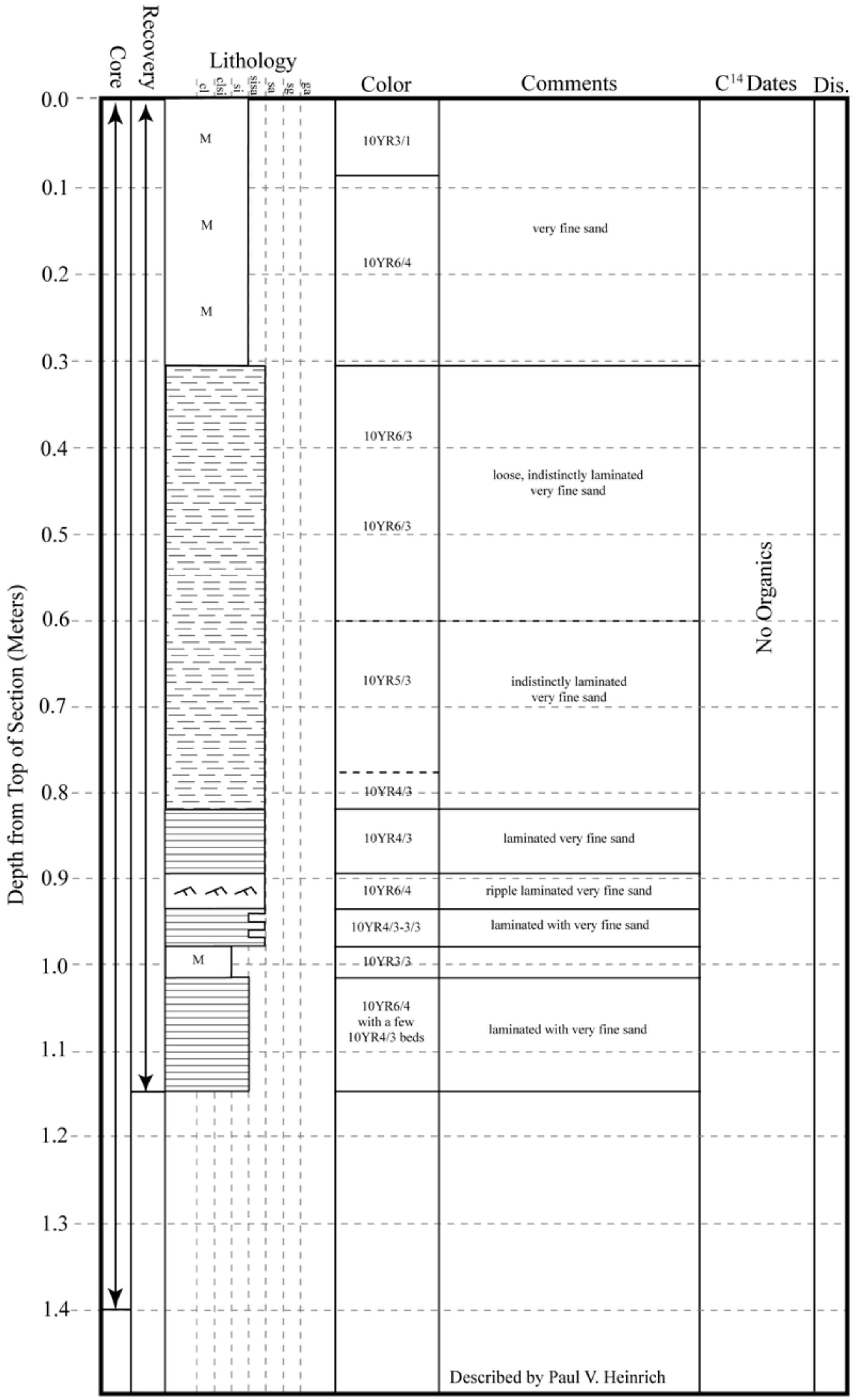
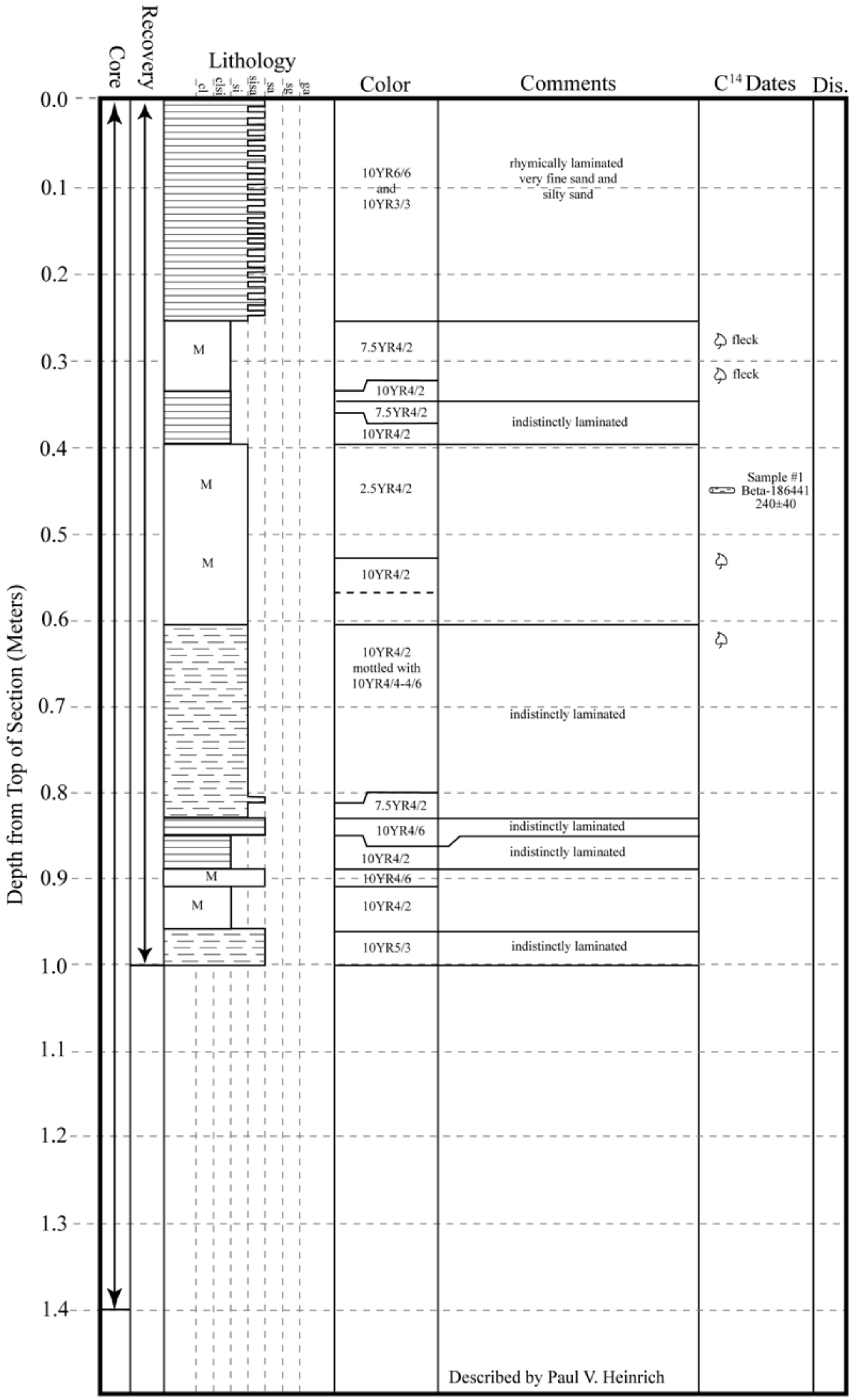


Boring 8-4, St. Landry Parish, Louisiana. Depth: 4.2-5.6 m, page 4 of 4.



Boring 9-1, St. Landry Parish, Louisiana. Depth: 0.0-1.4 m, page 1 of 5.



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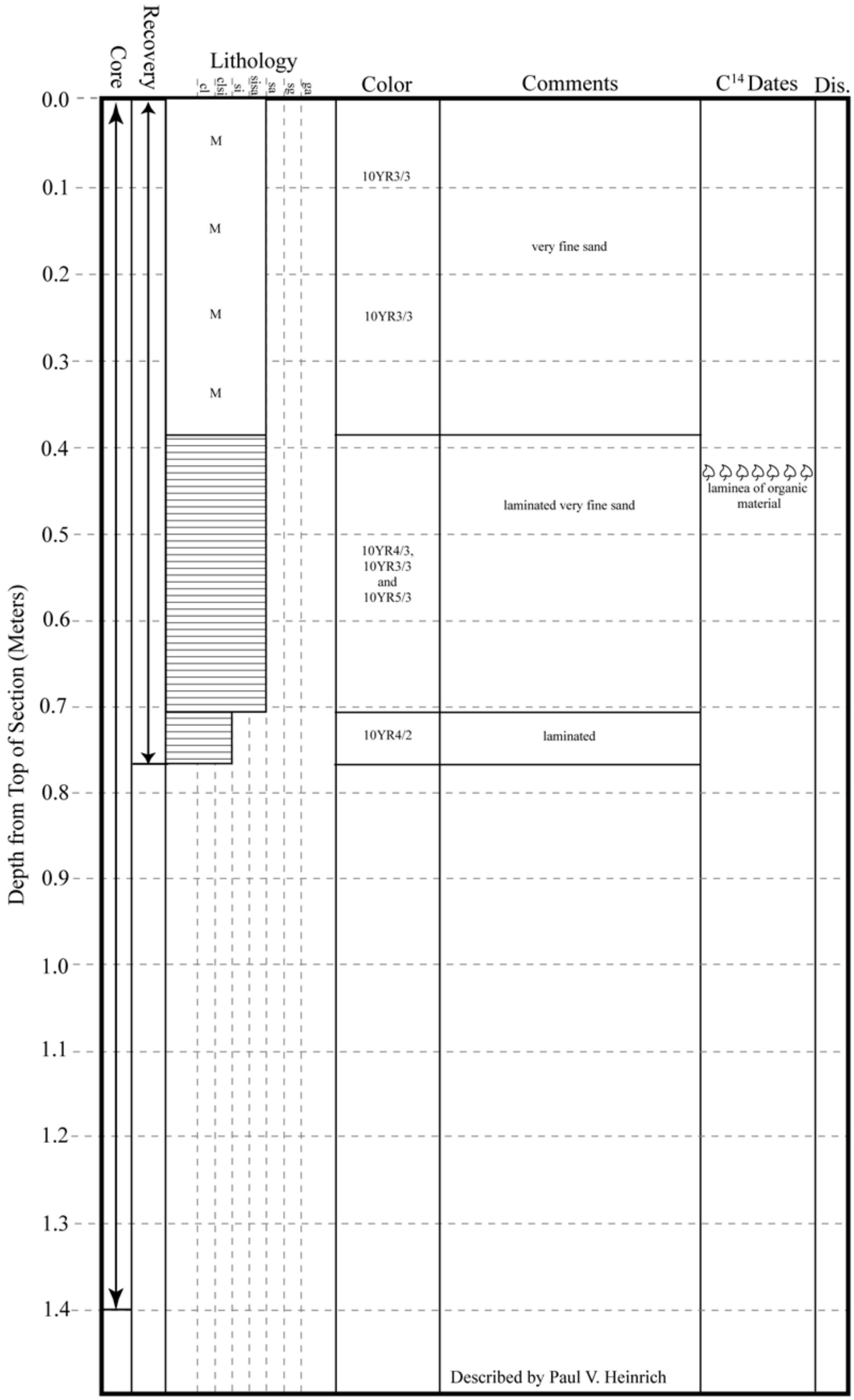
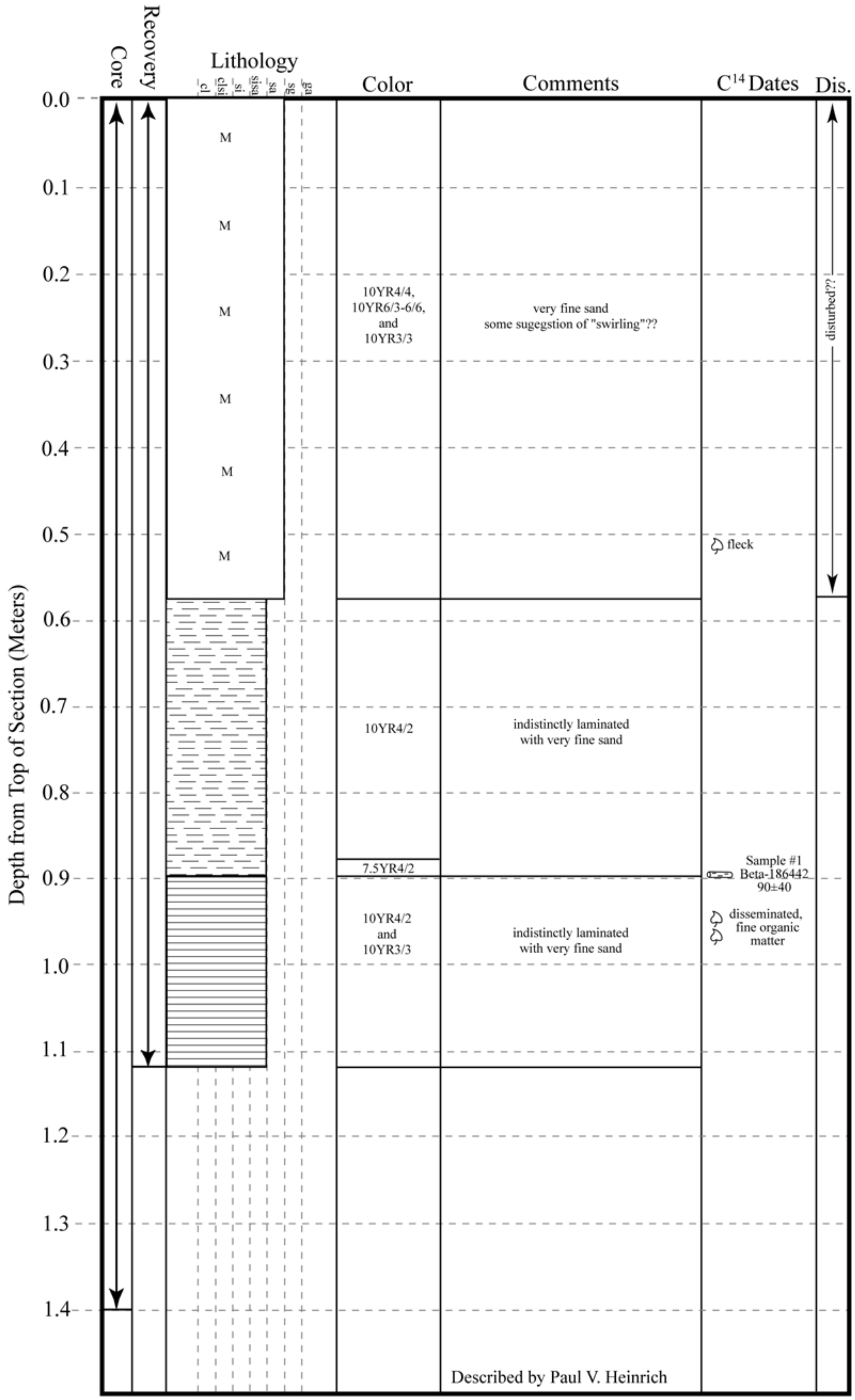
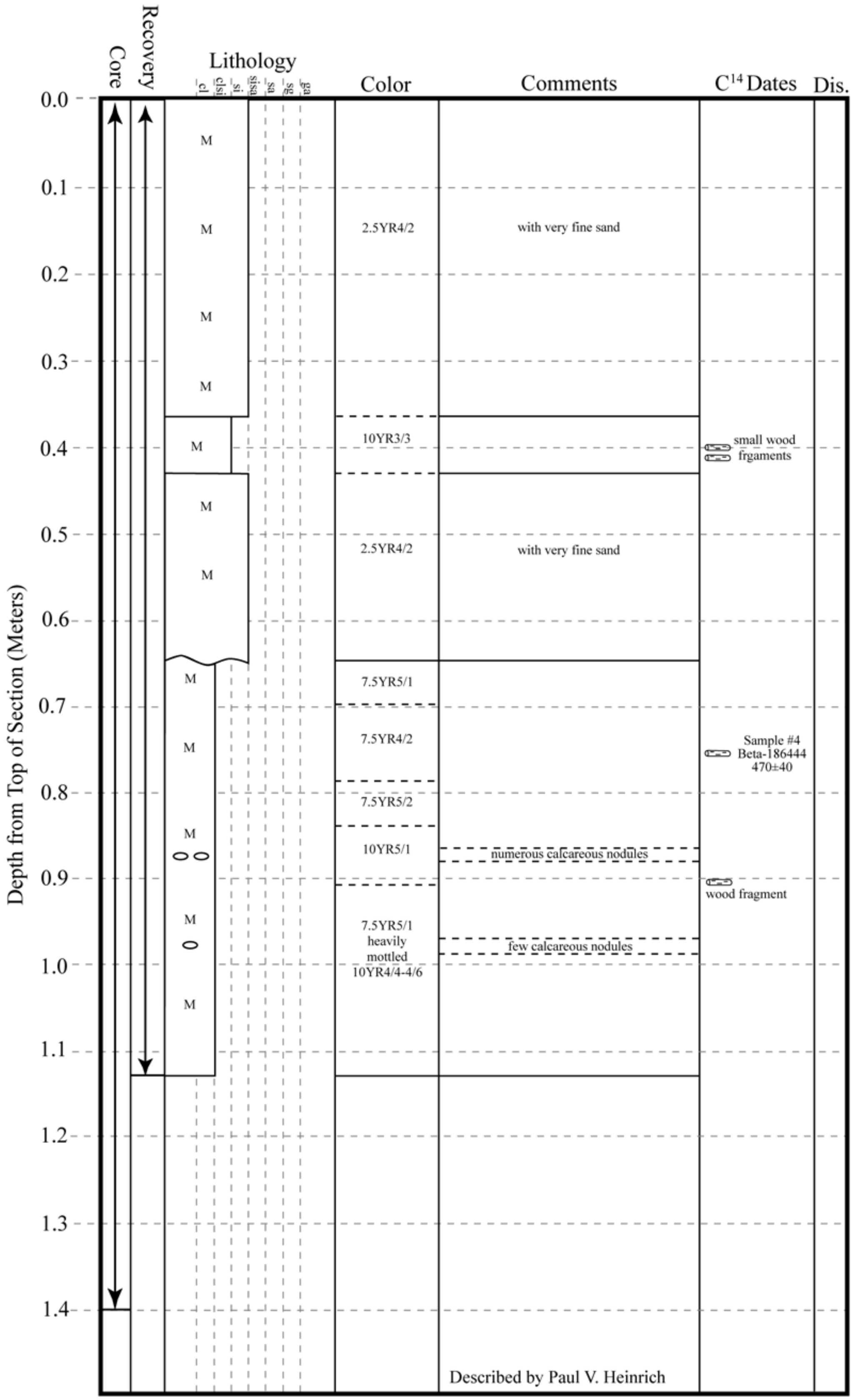


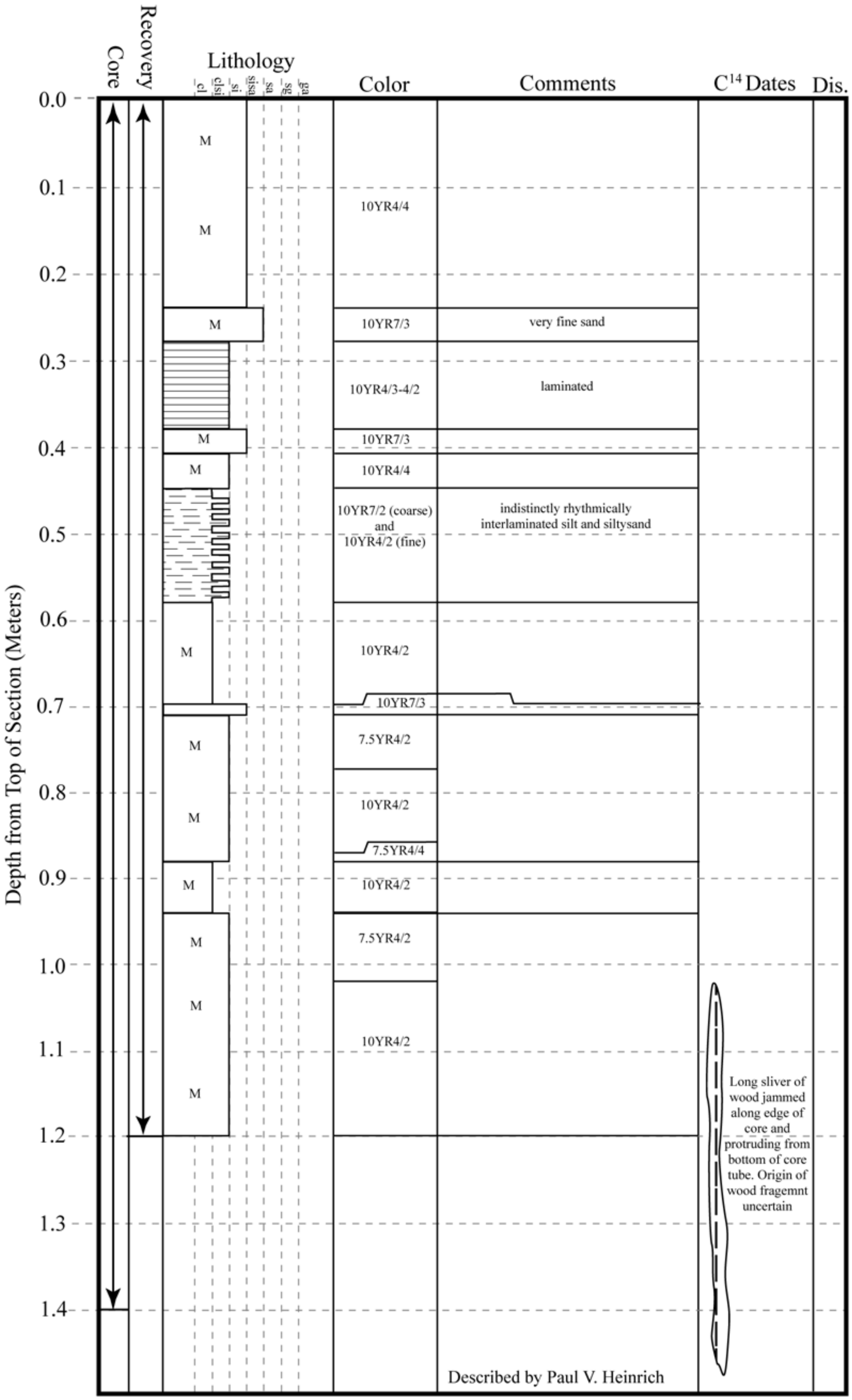
Boring 9-3, St. Landry Parish, Louisiana. Depth: 2.8-4.2 m, page 3 of 5.



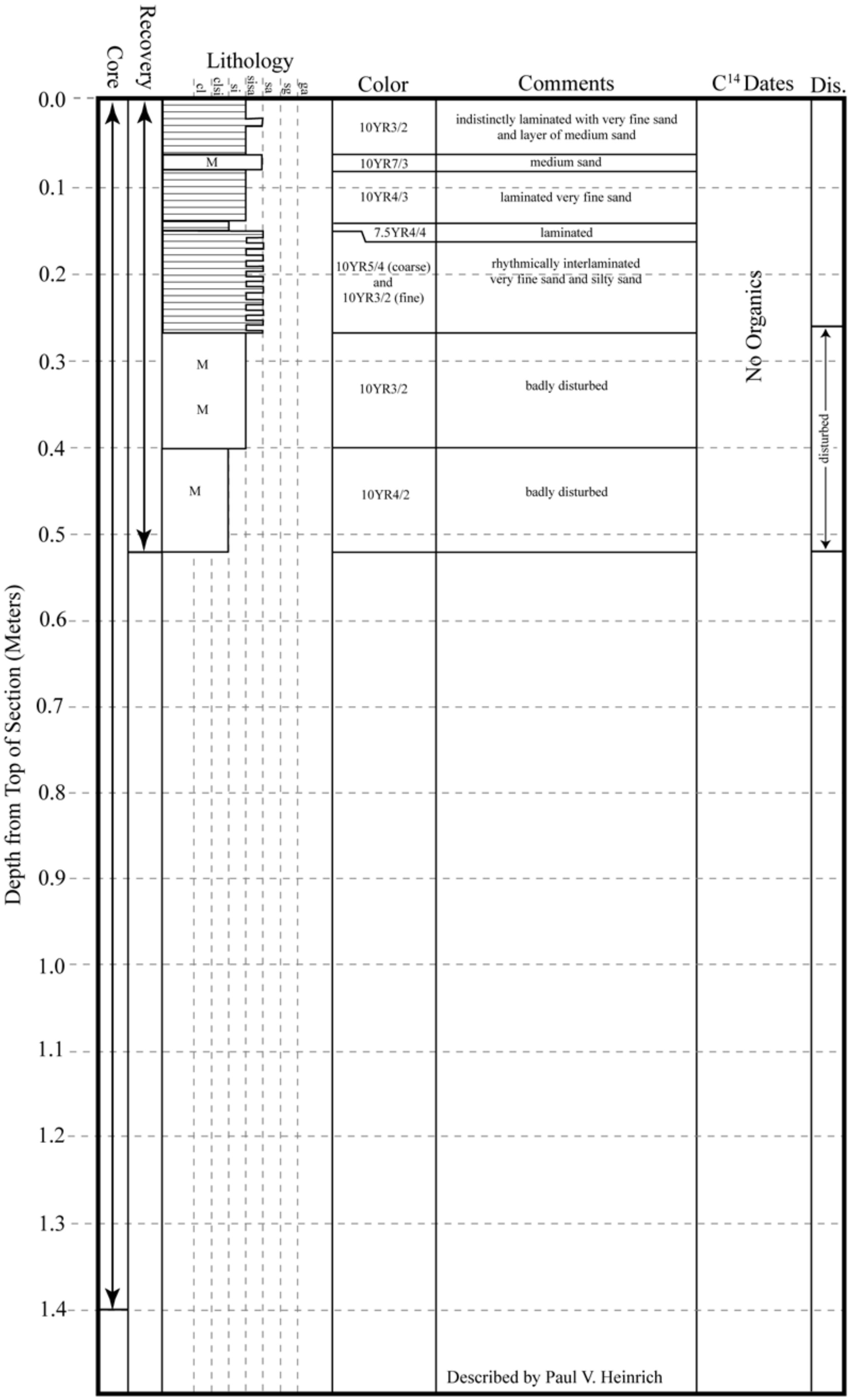
Boring 9-4, St. Landry Parish, Louisiana. Depth: 4.2-5.6 m, page 4 of 5.



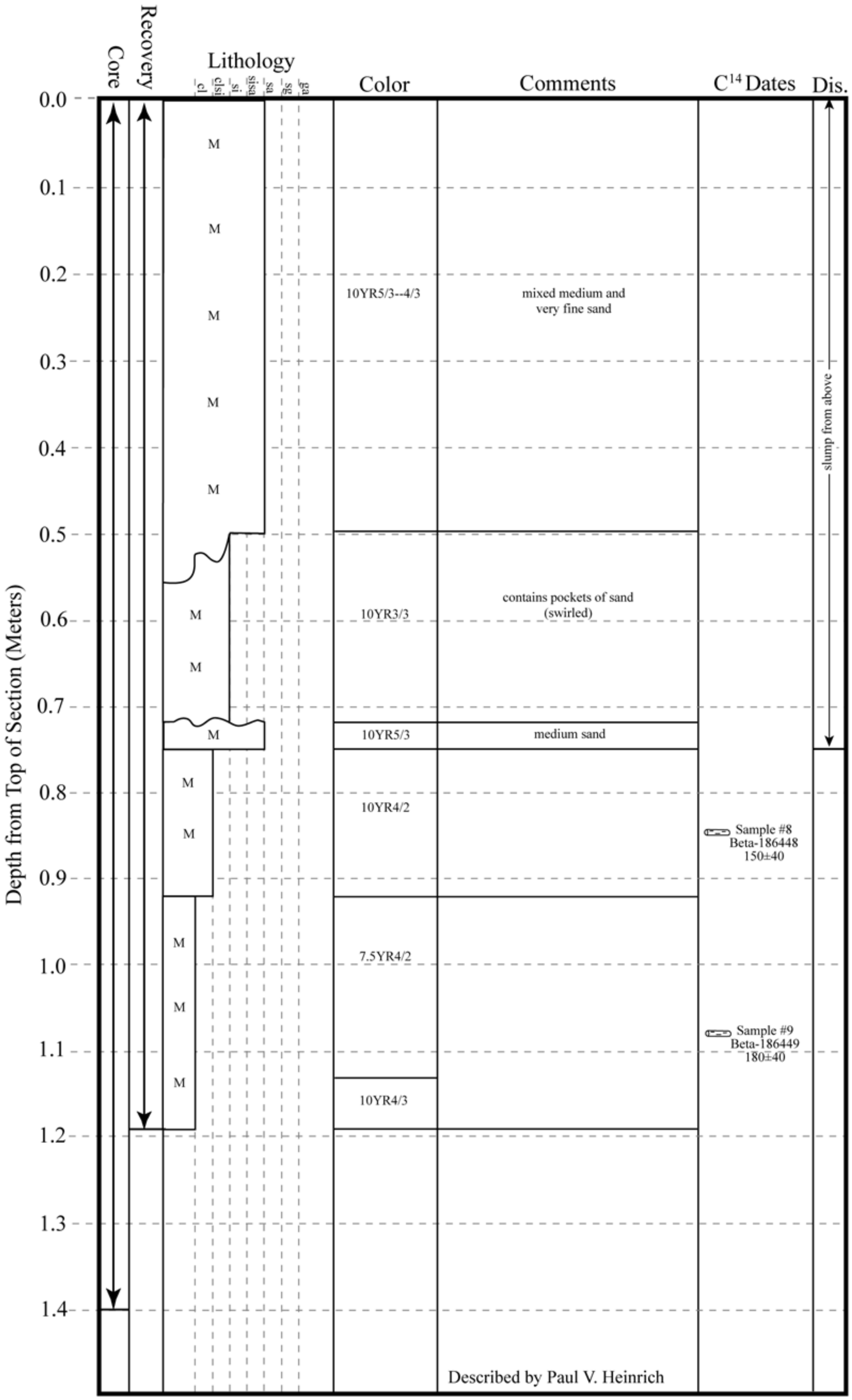
Boring 9-5, St. Landry Parish, Louisiana. Depth: 5.6-7.0 m, page 5 of 5.



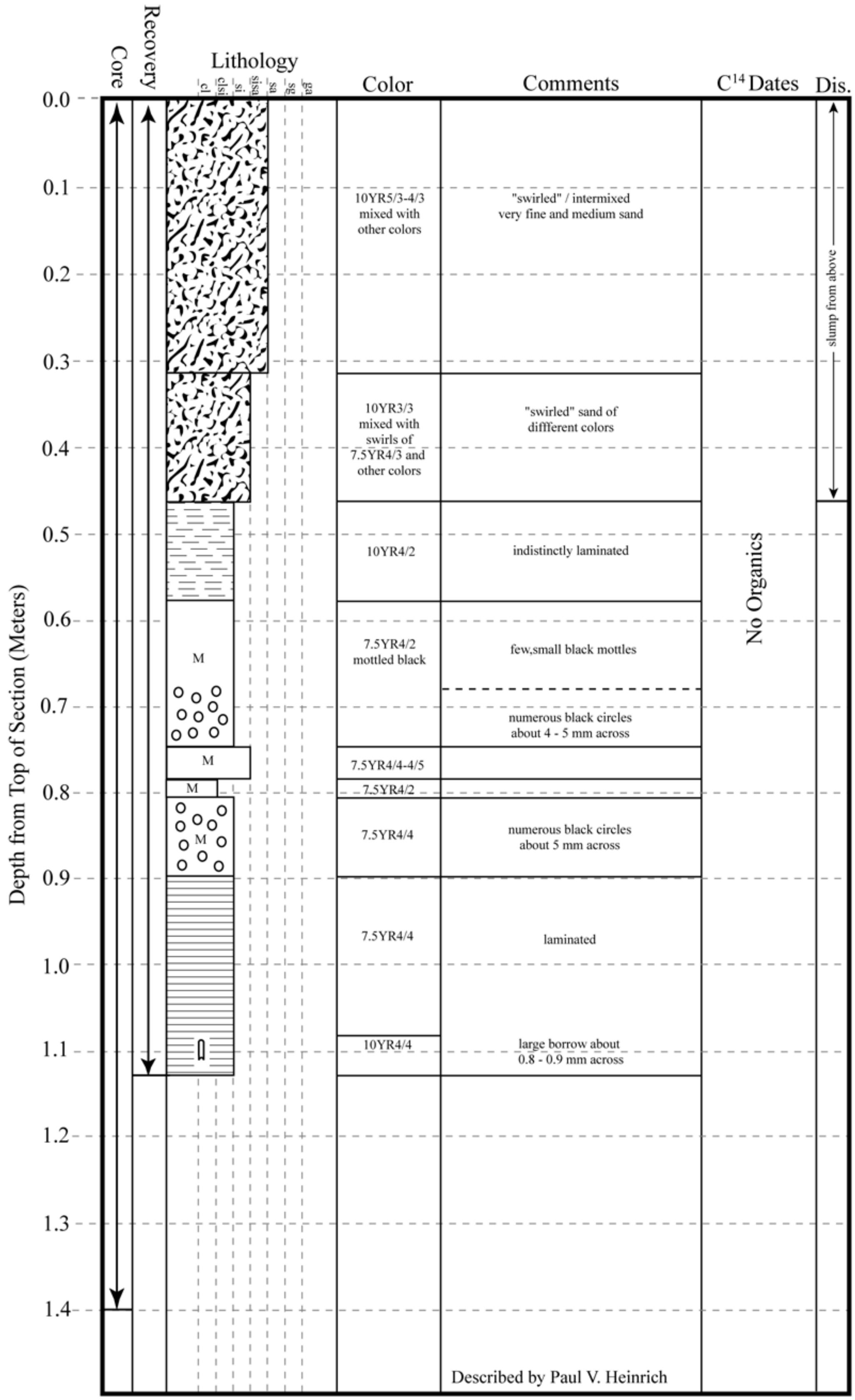
Boring 10-1, St. Landry Parish, Louisiana. Depth: 0.0-1.4 m, page 1 of 5.



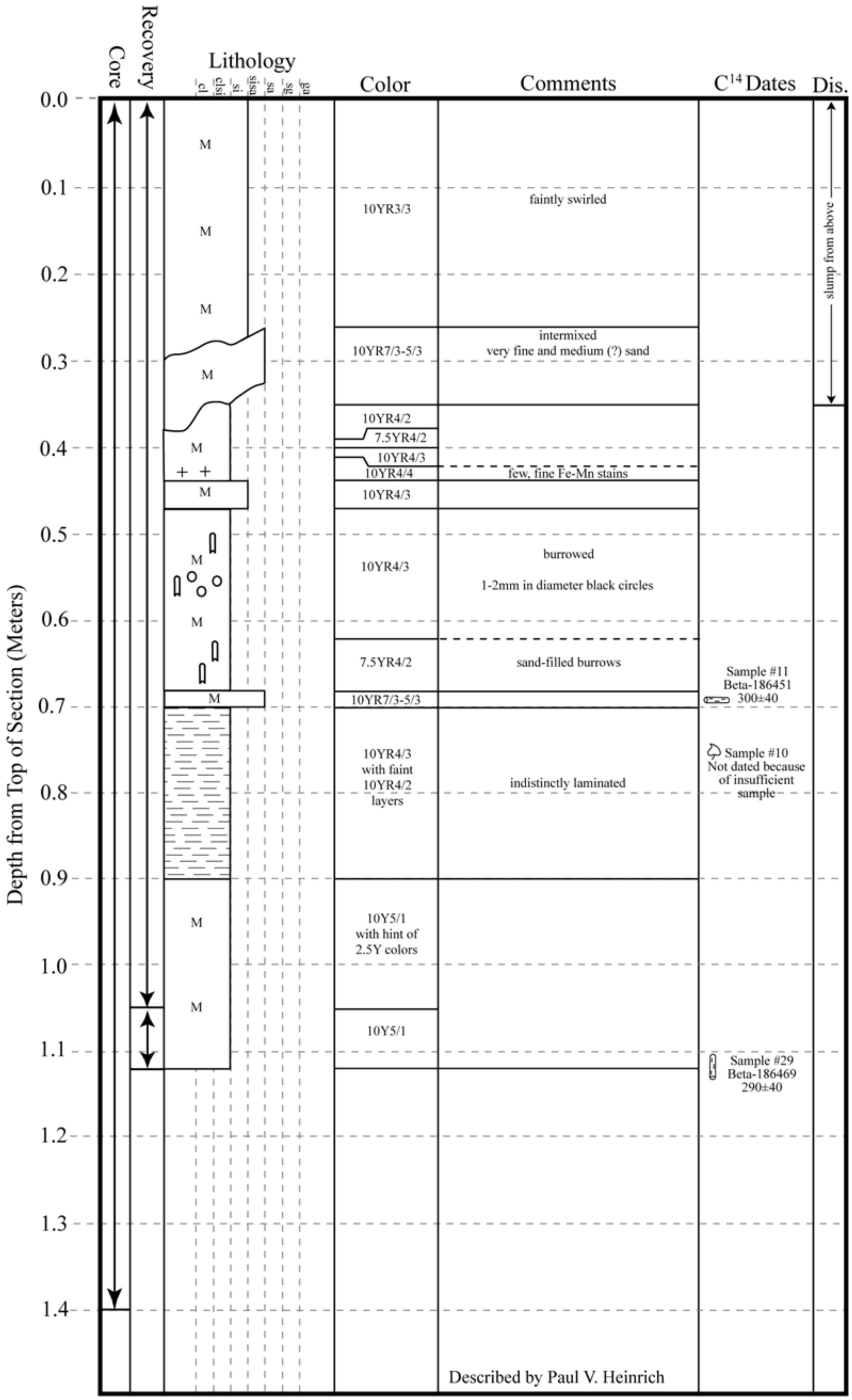
Boring 10-2, St. Landry Parish, Louisiana. Depth: 1.4-2.8 m, page 2 of 5.



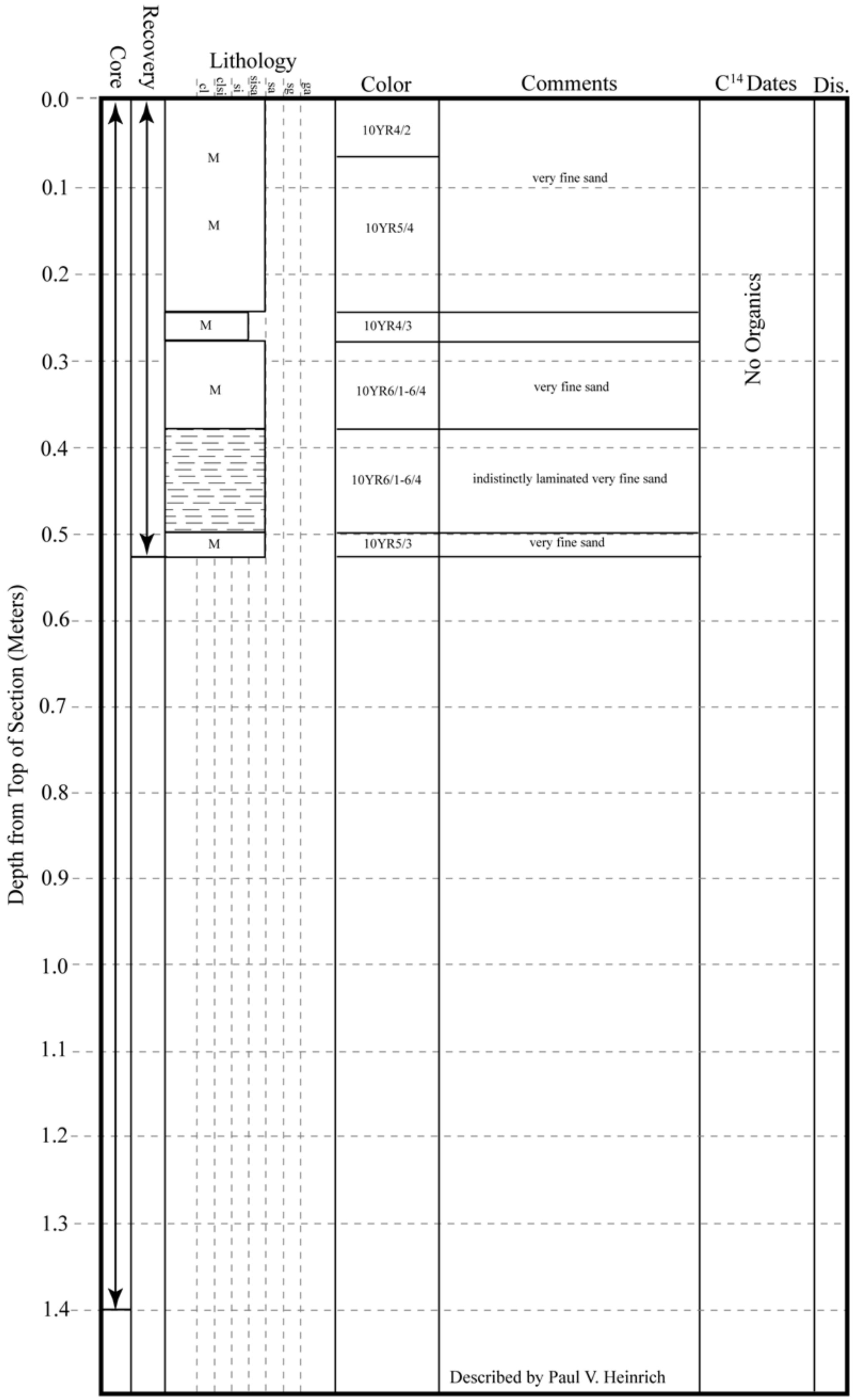
Boring 10-3, St. Landry Parish, Louisiana. Depth: 2.8-4.2 m, page 3 of 5.



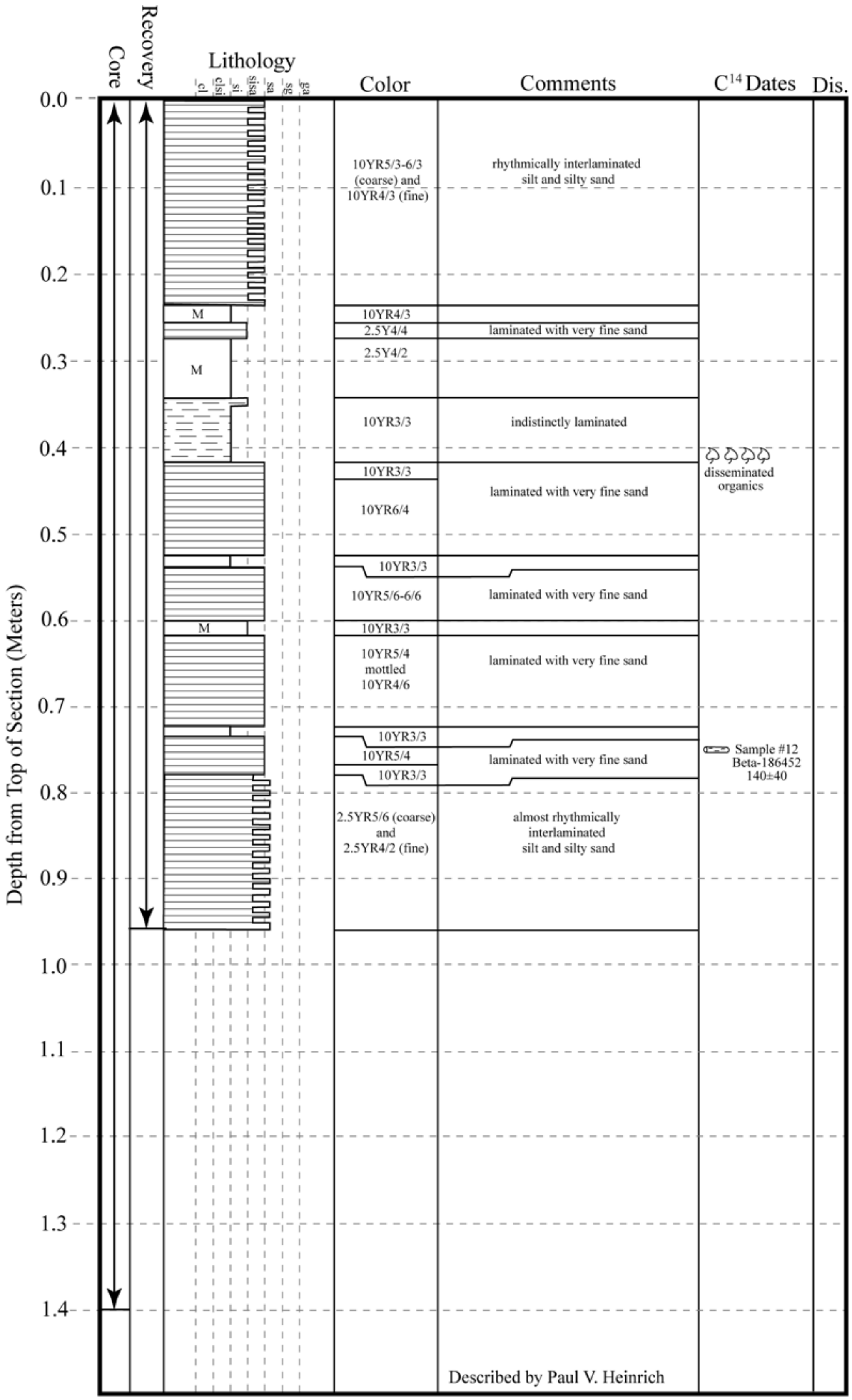
Boring 10-4, St. Landry Parish, Louisiana. Depth: 4.2-5.6 m, page 4 of 5.



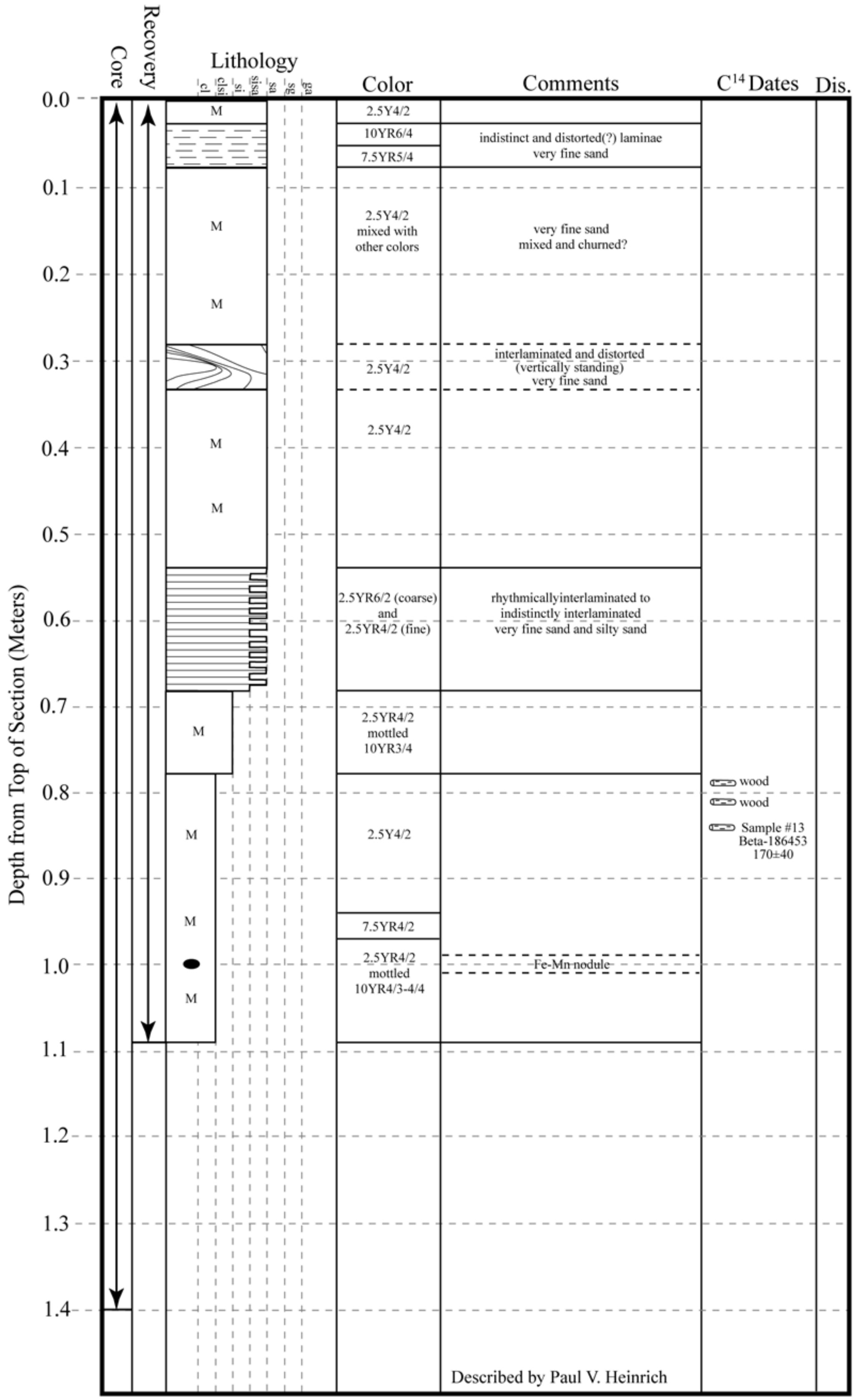
Boring 10-5, St. Landry Parish, Louisiana. Depth: 0.0-1.4 m, page 5 of 5.



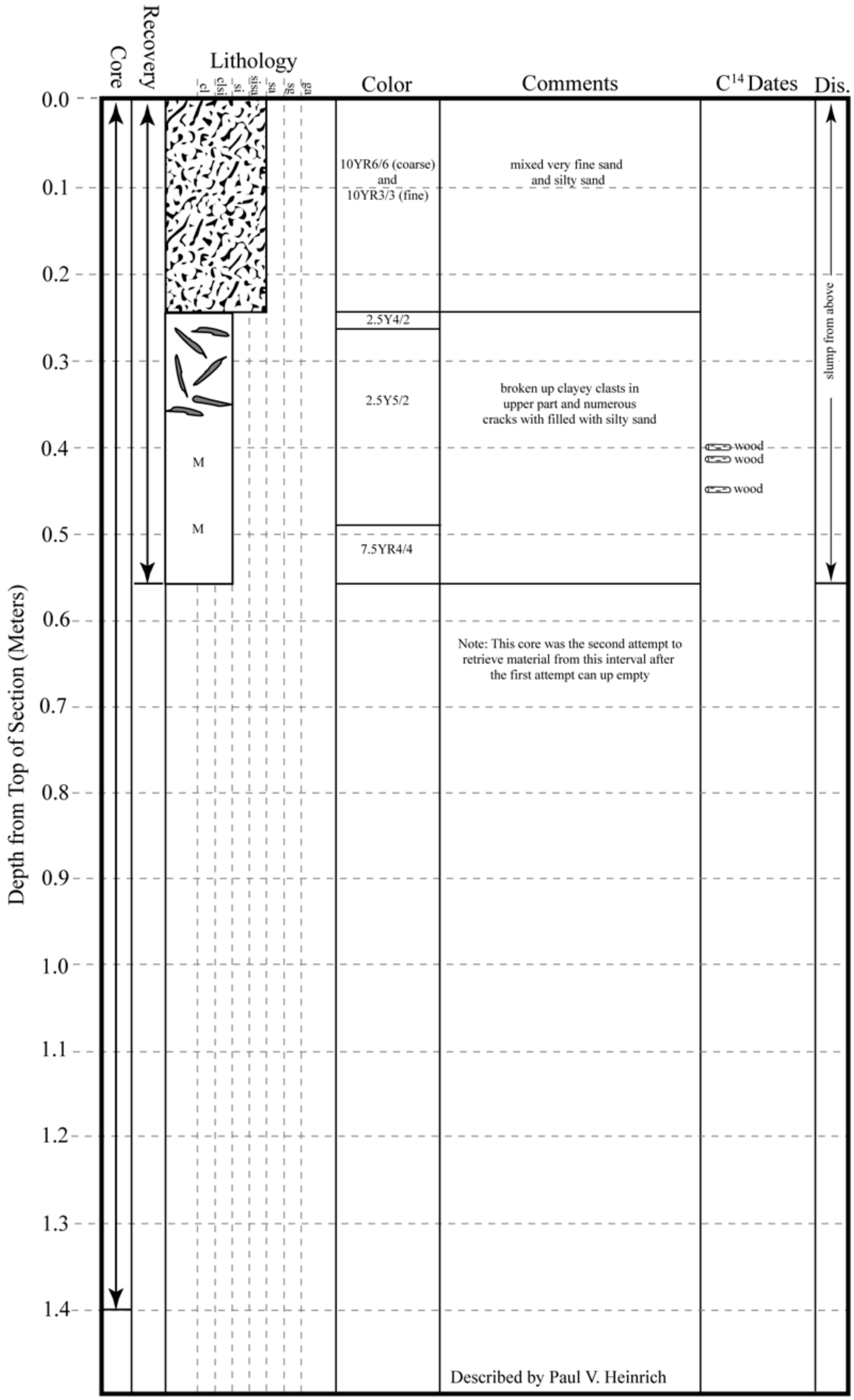
Boring 11-1, St. Landry Parish, Louisiana. Depth: 0.0-1.4 m, page 1 of 7.



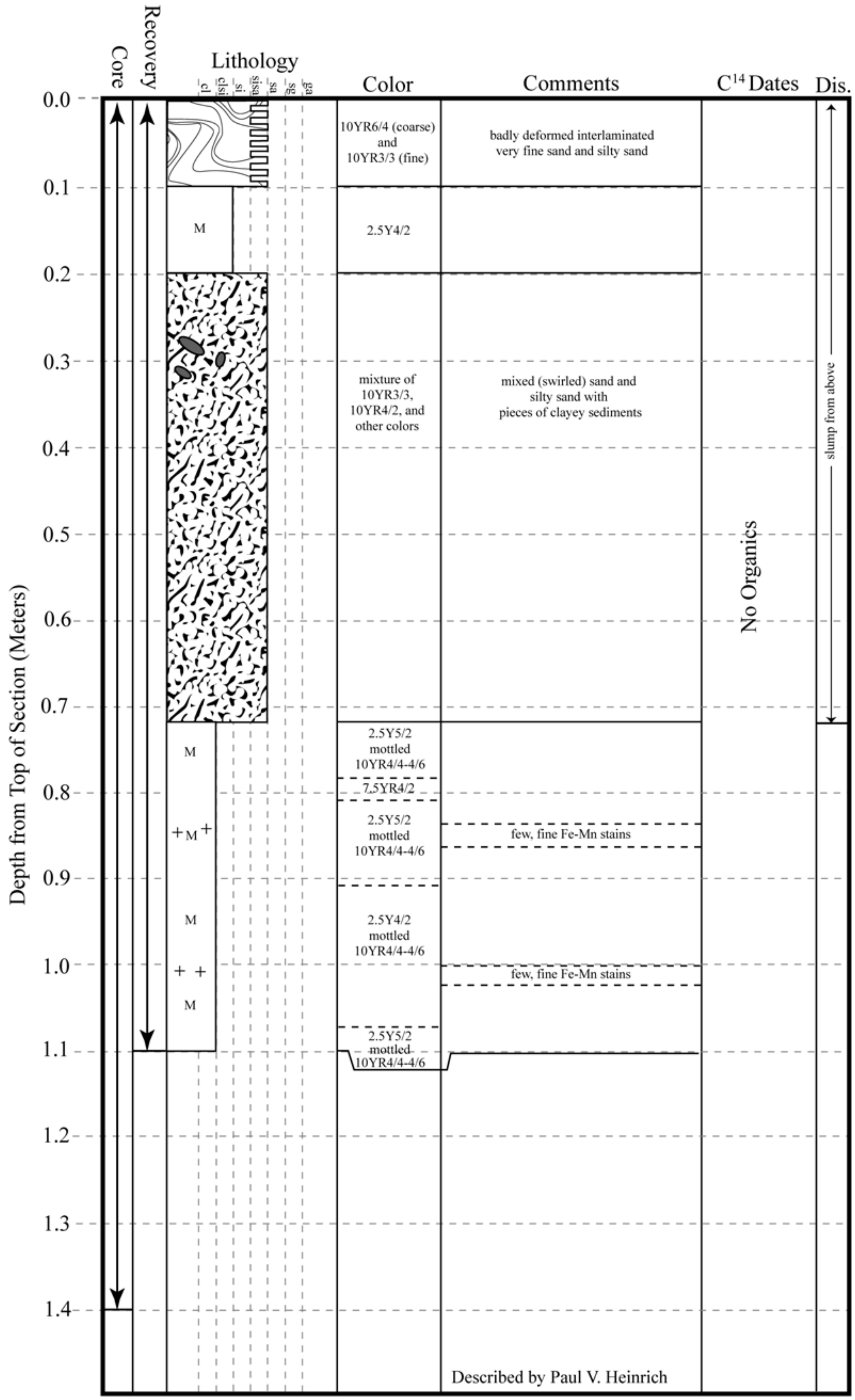
Boring 11-2, St. Landry Parish, Louisiana. Depth: 1.4-2.8 m, page 2 of 7.



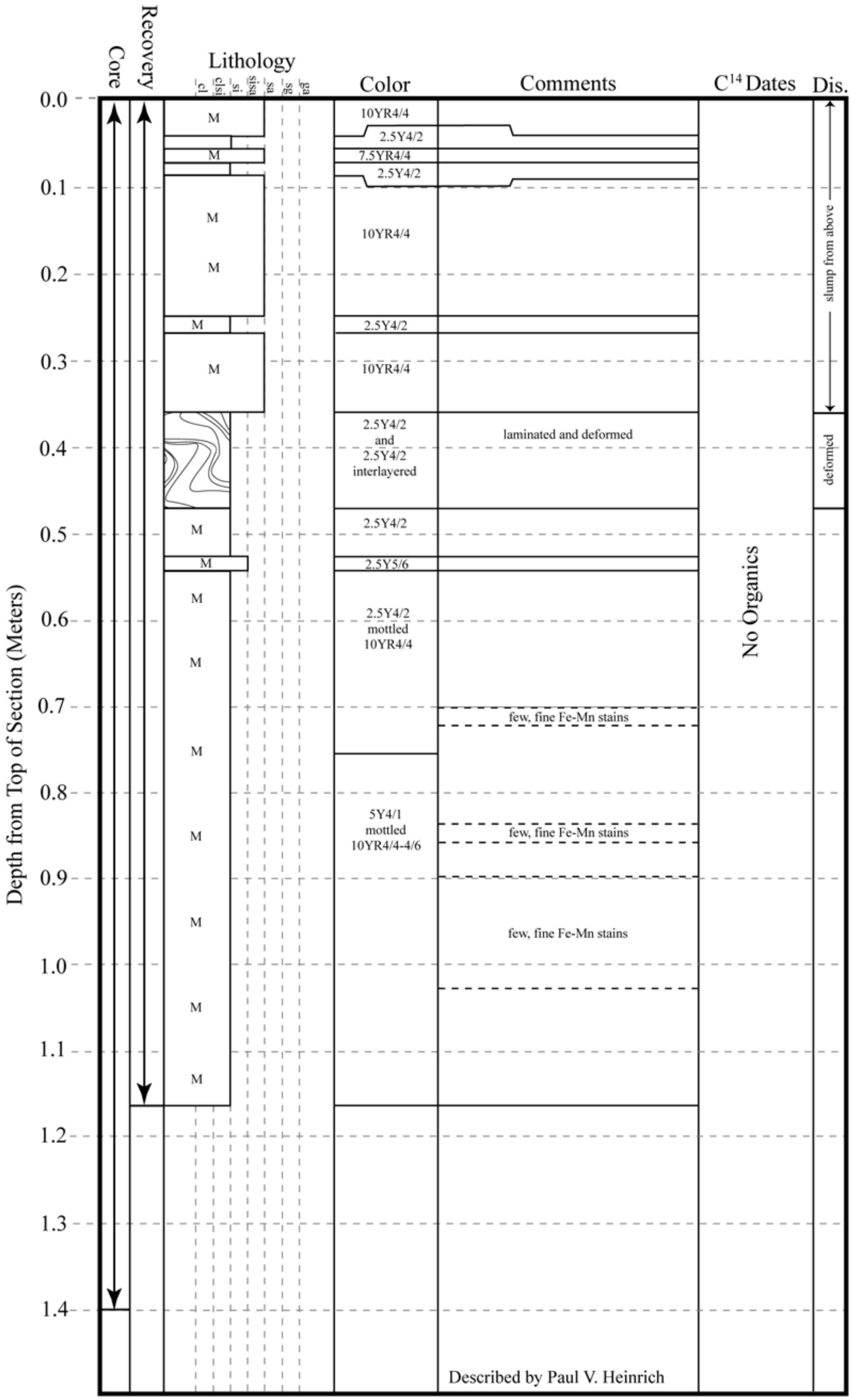
Boring 11-3, St. Landry Parish, Louisiana. Depth: 2.8-4.2 m, page 3 of 7.



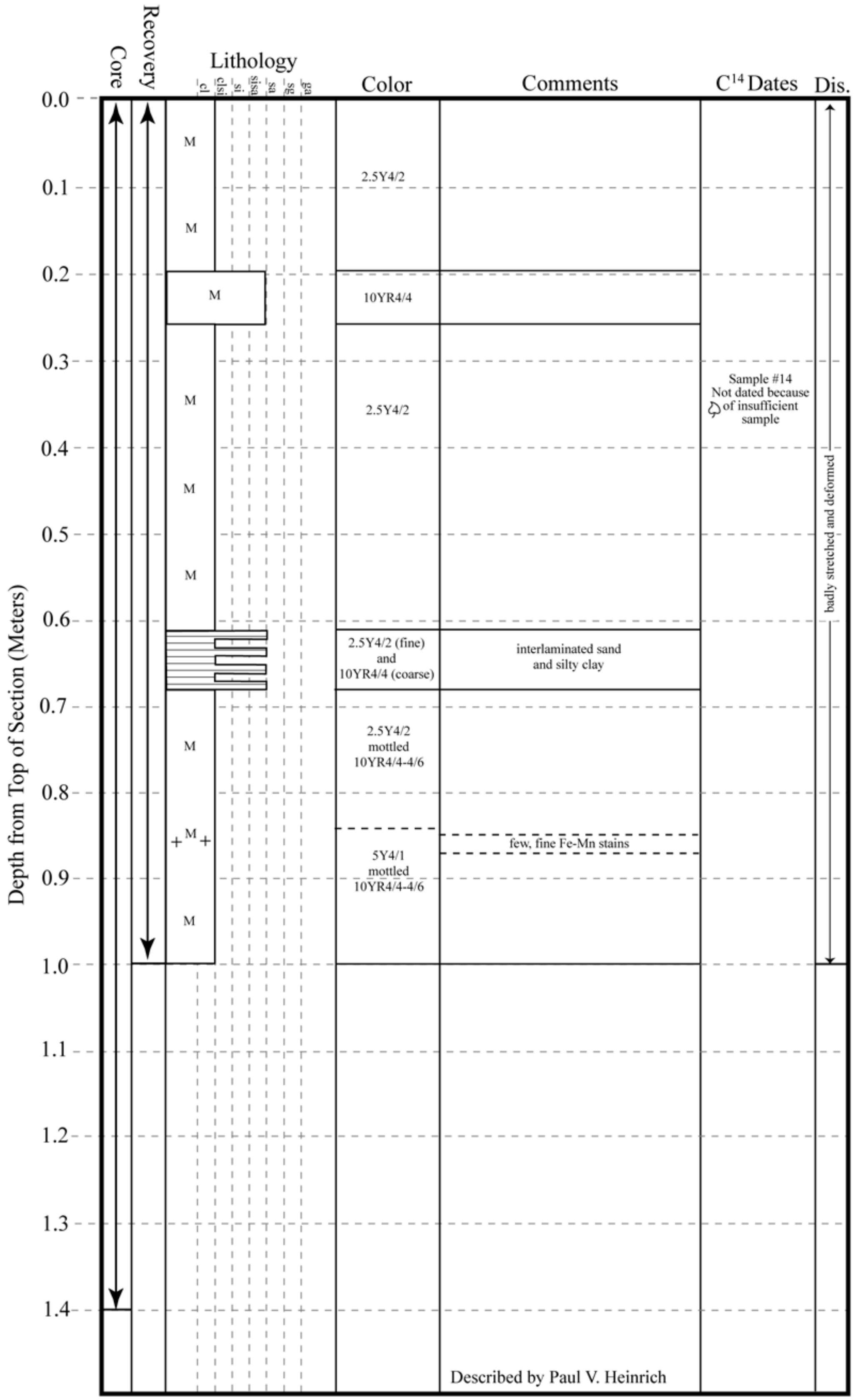
Boring 11-4, St. Landry Parish, Louisiana. Depth: 4.2-5.6 m, page 4 of 7.



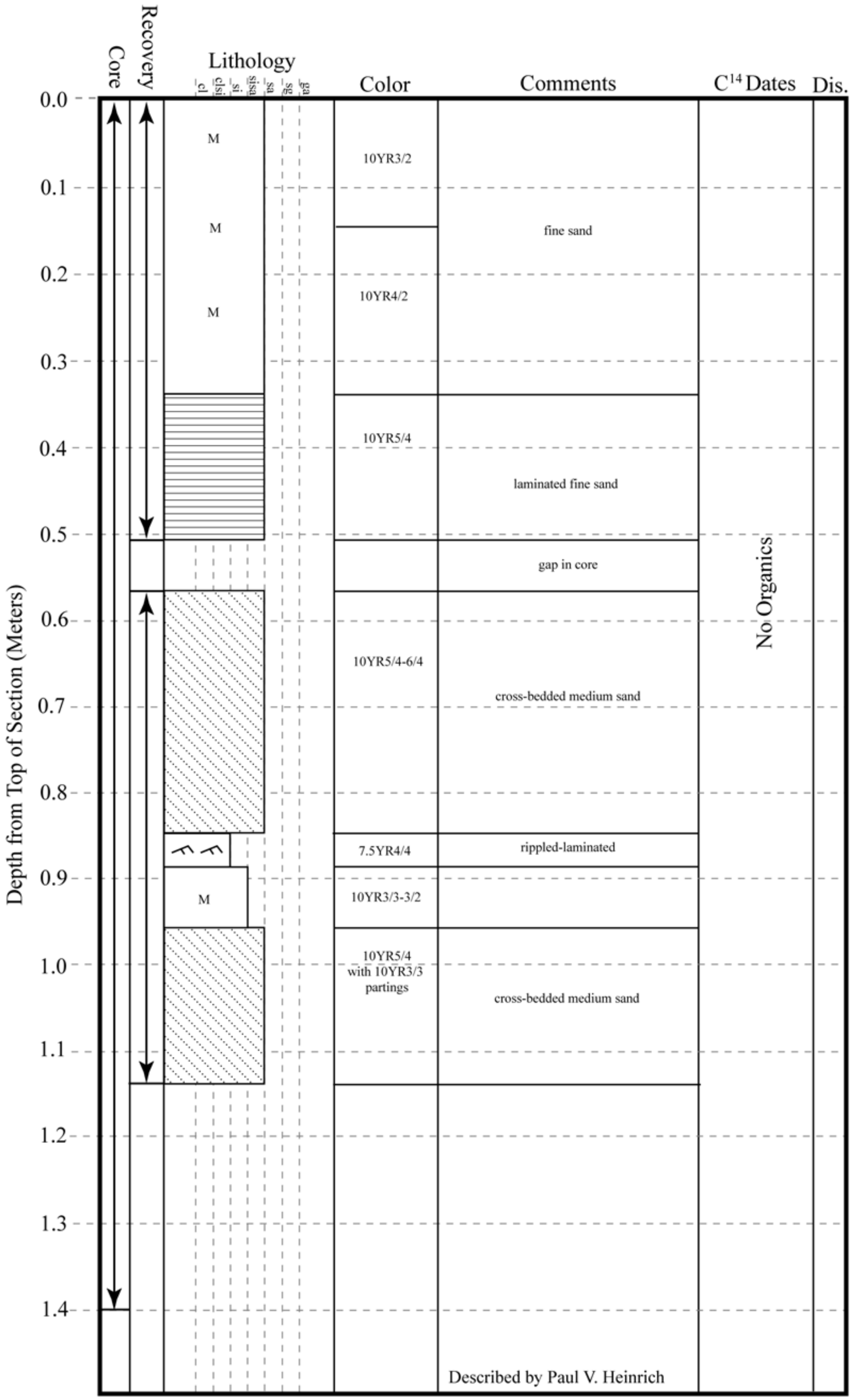
Boring 11-5, St. Landry Parish, Louisiana. Depth: 5.6-7.0 m, page 5 of 7.



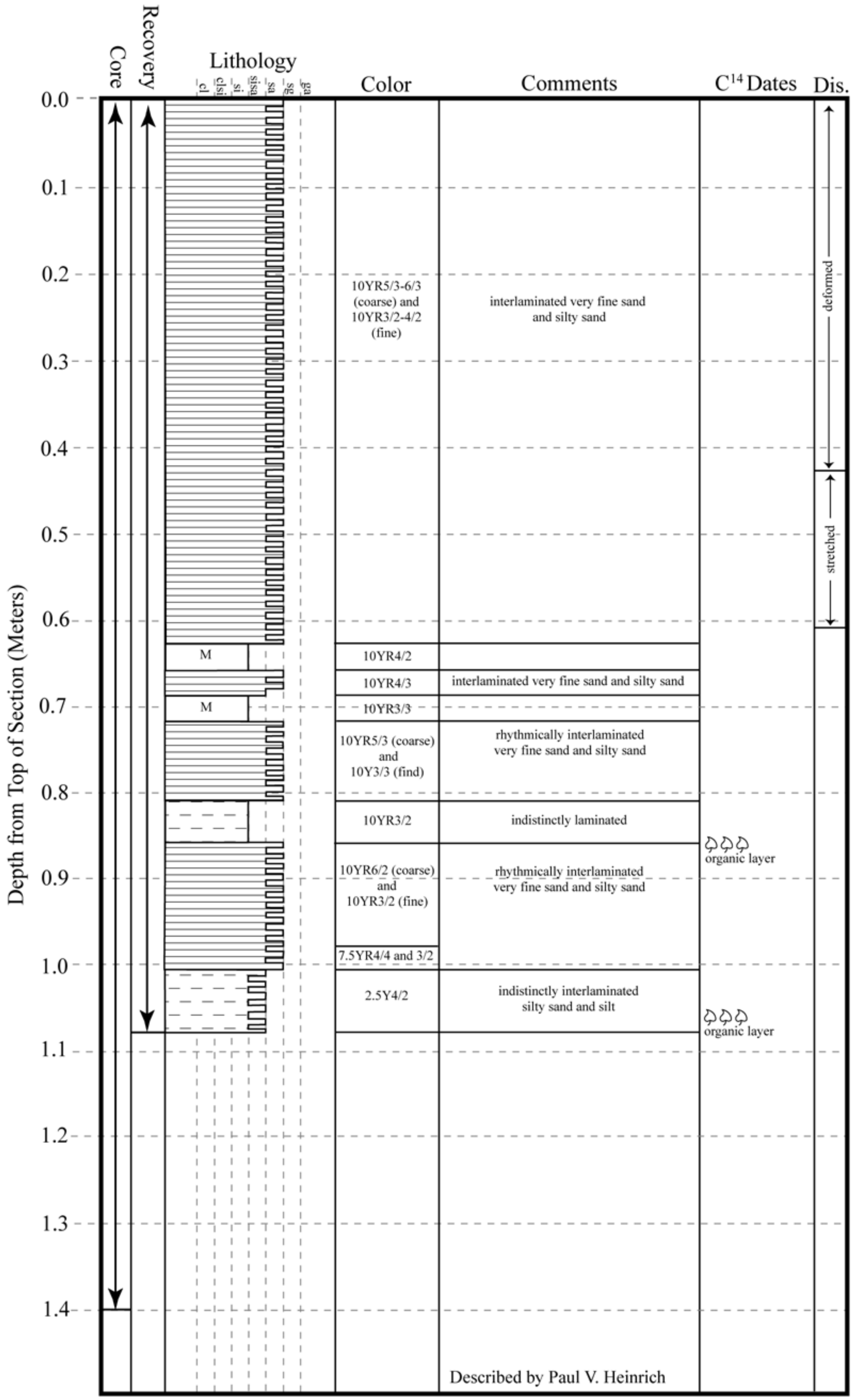
Boring 11-6, St. Landry Parish, Louisiana. Depth: 7.0-8.4 m, page 6 of 7.



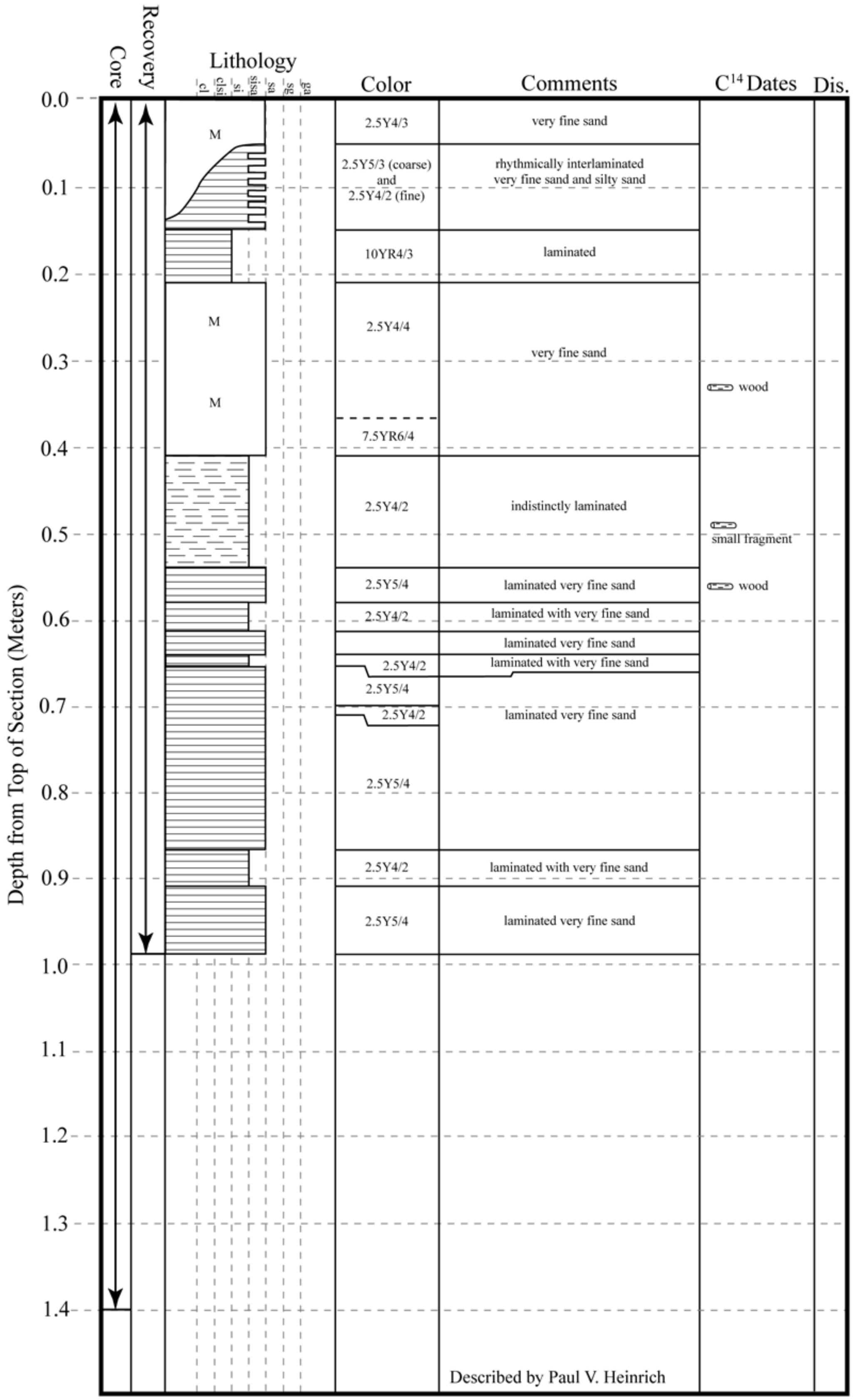
Boring 11-7, St. Landry Parish, Louisiana. Depth: 8.4-9.8 m, page 7 of 7.



Boring 12-1, St. Landry Parish, Louisiana. Depth: 0.0-1.4 m, page 1 of 3.



Boring 12-2, St. Landry Parish, Louisiana. Depth: 1.4-2.8 m, page 2 of 3.



Boring 12-3, St. Landry Parish, Louisiana. Depth: 2.8-4.2 m, page 3 of 3.

APPENDIX B

RADIOCARBON DATES FROM THE INDIAN BAYOU NORTH PROJECT AREA

Appendix B. Radiocarbon Dates from the Indian Bayou North Project Area, with $^{13}C/^{12}C$ Ratio Corrections and Resulting Calibrated Dates and Ages.

Laboratory Number	Provenience: Core and Section (Depth within Section)	Sample Material (Analysis Method)	Conventional Radiocarbon Age, with $^{13}C/^{12}C$ Ratio Correction*	$^{13}C/^{12}C$ Ratio Correction (in Years)	Intercept(s) of Radiocarbon Age with Calibration Curve	Conventional Radiocarbon Age Calibrated to Dendrochronological Scale (1 sigma calibration over 2 sigma calibration)**	Comments
Beta-186441	Core 9, Section 2 (45 cm)	Plant material (AMS)	240 ± 40 BP	-28.1 o/oo (-50)	Cal A.D. 1660 (Cal. BP 290)	Cal A.D. 1640 to 1670 (Cal BP 310 to 280) or Cal A.D. 1530 to 1560 (Cal BP 420 to 390), Cal A.D. 1630 to 1680 (Cal BP 320 to 270, Cal A.D. 1740 to 1800 (Cal BP 200 to 150, and Cal A.D. 1930 to 1950 (Cal BP 20 to 0)	Probably a reasonable date for the crevasse deposits that blanket the area.
Beta-186442	Core 9, Section 4 (90 cm)	Plant material (AMS)	90 ± 40 BP	-29.7 o/oo (-80)	Cal A.D. 1890 (Cal BP 60), Cal A.D. 1910 (Cal B.P. 40), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1690 to 1730 (Cal BP 260 to 220), Cal A.D. 1810 to 1920 (Cal BP 140 to 30), and Cal A.D.1950 to 19500 (Cal BP 0 to 0) or Cal A.D. 1680 to 1770 (Cal BP 270 to 180), Cal A.D. 1800 to 1940 (Cal BP 150 to 10), and Cal A.D. 1950 to 1960 (Cal BP 0 to 0)	

(continued)

Appendix B. Continued.

Laboratory Number	Provenience: Core and Section (Depth within Section)	Sample Material (Analysis Method)	Conventional Radiocarbon Age, with $^{13}C/^{12}C$ Ratio Correction*	$^{13}C/^{12}C$ Ratio Correction (in Years)	Intercept(s) of Radiocarbon Age with Calibration Curve	Conventional Radiocarbon Age Calibrated to Dendrochronological Scale (1 sigma calibration over 2 sigma calibration)**	Comments
Beta-186443	Core 9, Section 5 (91 cm)	Plant material (AMS)	460 ± 40 BP	-24.9 o/oo (0)	Cal A.D. 1440 (Cal BP 510)	Cal A.D. 1420 to 1450 (Cal BP 530 to 500) or Cal A.D. 1410 to 1480 (Cal BP 540 to 470)	Probably a reasonable date for the under-lying backswamp deposits in the area.
Beta-186444	Core 9, Section 5 (76 cm)	Plant material (AMS)	500 ± 50 BP	-23.0 o/oo (30)	Cal A.D. 1420 (Cal BP 530)	Cal A.D. 1410 to 1440 (Cal BP 540 to 510) or Cal A.D. 1320 to 1340 (Cal BP 630 to 600) and Cal A.D. 1390 to 1460 (Cal BP 560 to 490)	Although older than Beta-18644, this is probably a reasonable date for the underlying back-swamp deposits in the area.
Beta-186445	Core 3, Section 2B (9-12 cm)	Plant material (AMS)	110 ± 30 BP	-28.5 o/oo (-60)	Cal A.D. 1700 (Cal BP 250), Cal A.D. 1720 (Cal BP 230), Cal A.D. 1820 (Cal BP 130), Cal A.D. 1840 (Cal BP 110), Cal A.D. 1880 (Cal BP 70), Cal A.D. 1920 (Cal BP 30), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1680 to 1730 (Cal BP 260 to 220), Cal A.D. 1810 to 1930 (Cal BP 140 to 20), and Cal A.D. 1950 to 1950 (Cal BP 0 to 0) or Cal A.D. 1680 to 1770 (Cal BP 270 to 180), Cal A.D. 1800 to 1940 (Cal BP 150 to 10), and Cal A.D. 1950 to 1950 (Cal BP 0 to 0)	Probably a reasonable date for the crevasse deposits that blanket the area.

(continued)

Appendix B. Continued.

Laboratory Number	Provenience: Core and Section (Depth within Section)	Sample Material (Analysis Method)	Conventional Radiocarbon Age, with $^{13}C/^{12}C$ Ratio Correction*	$^{13}C/^{12}C$ Ratio Correction (in Years)	Intercept(s) of Radiocarbon Age with Calibration Curve	Conventional Radiocarbon Age Calibrated to Dendrochronological Scale (1 sigma calibration over 2 sigma calibration)**	Comments
Beta-186446	Core 3, Section 3 (88-91 cm)	Plant material (AMS)	190 ± 40 BP	-29.3 o/oo (-70)	Cal A.D. 1670 (Cal BP 280), Cal A.D. 1780 (Cal BP 170), and Cal A.D. 1800 (Cal BP 150)	Cal A.D. 1660 to 1680 (Cal BP 290 to 270), Cal A.D. 1740 to 1810 (Cal BP 210 to 140), and Cal A.D. 1930 to 1950 (Cal BP 20 to 0) or Cal A.D. 1650 to 1700 (Cal BP 300 to 250), Cal A.D. 1720 to 1820 (Cal BP 230 to 130), Cal A.D. 1840 to 1880 (Cal BP 110 to 70), and Cal A.D. 1920 to 1950 (Cal BP 30 to 0)	
Beta-186448	Core 10, Section 3 (85 cm)	Plant material (AMS)	150 ± 40 BP	-28.9 o/oo (-60)	Cal A.D. 1680 (Cal BP 270), Cal A.D. 1740 (Cal BP 210), Cal A.D. 1810 (Cal BP 140), Cal A.D. 1930 (Cal BP 20), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1670 to 1700 (Cal BP 280 to 250), Cal A.D. 1720 to 1780 (Cal BP 230 to 170), Cal A.D. 1800 to 1820 (Cal BP 150 to 130), Cal A.D. 1840 to 1880 (Cal BP 110 to 70), and Cal A.D. 1920 to 1950 (Cal BP 30 to 0) or Cal A.D. 1660 to 1950 (Cal BP 290 to 0)	

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Appendix B. Continued.

Laboratory Number	Provenience: Core and Section (Depth within Section)	Sample Material (Analysis Method)	Conventional Radiocarbon Age, with $^{13}C/^{12}C$ Ratio Correction*	$^{13}C/^{12}C$ Ratio Correction (in Years)	Intercept(s) of Radiocarbon Age with Calibration Curve	Conventional Radiocarbon Age Calibrated to Dendrochronological Scale (1 sigma calibration over 2 sigma calibration)**	Comments
Beta-186449	Core 10, Section 3 (109 cm)	Plant material (AMS)	180 ± 40 BP	-29.8 o/oo (-80)	Cal A.D. 1670 (Cal BP 280), Cal A.D. 1770 (Cal BP 180), Cal A.D. 1800 (Cal BP 150), Cal A.D. 1940 (Cal BP 10), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1660 to 1680 (Cal BP 290 to 270), Cal A.D. 1730 to 1810 (Cal BP 220 to 140), and Cal A.D. 1930 to 1950 (Cal BP 20 to 0) or Cal A.D. 1650 to 1710 (Cal BP 300 to 240), Cal A.D. 1720 to 1880 (Cal BP 230 to 70), and Cal A.D. 1910 to 1950 (Cal BP 40 to 0)	
Beta-186451	Core 10, Section 5 (69-70 cm)	Plant material (AMS)	300 ± 40 BP	-26.5 o/oo (-20)	Cal A.D. 1640 (Cal BP 310)	Cal A.D. 1520 to 1590 (Cal BP 430 to 360) and Cal A.D. 1620 to 1650 (Cal BP 330 to 300) or Cal A.D. 1480 to 1660 (Cal BP 470 to 290)	

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Appendix B. Continued.

Laboratory Number	Provenience: Core and Section (Depth within Section)	Sample Material (Analysis Method)	Conventional Radiocarbon Age, with $^{13}C/^{12}C$ Ratio Correction*	$^{13}C/^{12}C$ Ratio Correction (in Years)	Intercept(s) of Radiocarbon Age with Calibration Curve	Conventional Radiocarbon Age Calibrated to Dendrochronological Scale (1 sigma calibration over 2 sigma calibration)**	Comments
Beta-1686452	Core 11, Section 2 (74-75 cm)	Plant material (AMS)	140 ± 40 BP	-26.2 o/oo (-20)	Cal A.D. 1680 (Cal BP 270), Cal A.D. 1730 (Cal BP 220), Cal A.D. 1810 (Cal BP 140), Cal A.D. 1930 (Cal BP 20), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1670 to 1710 (Cal BP 280 to 240), Cal A.D. 1720 to 1770 (Cal BP 230 to 180), Cal A.D. 1800 to 1880 (Cal BP 150 to 70), Cal A.D. 1910 to 1940 (Cal BP 40 to 10), and Cal A.D. 1950 to 1950 (Cal BP 0 to 0) or Cal A.D. 1660 to 1950 (Cal BP 290 to 0)	
Beta-186453	Core 11, Section 3 (84 cm)	Plant material (AMS)	170 ± 40 BP	-31.3 (-100)	Cal A.D. 1680 (Cal BP 270), Cal A.D. 1770 (Cal BP 180), Cal A.D. 1800 (Cal BP 150), Cal A.D. 1940 (Cal BP 10), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1660 to 1690 (Cal BP 290 to 260), Cal A.D. 1730 to 1810 (Cal BP 220 to 140), and Cal A.D. 1920 to 1950 (Cal BP 30 to 0) or Cal A.D. 1650 to 1890 (Cal BP 300 to 60) and Cal A.D. 1910 to 1950 (Cal BP 40 to 0)	

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Appendix B. Continued.

Laboratory Number	Provenience: Core and Section (Depth within Section)	Sample Material (Analysis Method)	Conventional Radiocarbon Age, with $^{13}C/^{12}C$ Ratio Correction*	$^{13}C/^{12}C$ Ratio Correction (in Years)	Intercept(s) of Radiocarbon Age with Calibration Curve	Conventional Radiocarbon Age Calibrated to Dendrochronological Scale (1 sigma calibration over 2 sigma calibration)**	Comments
Beta-186455	Core 5, Section 3 (104 cm)	Plant material (AMS)	140 ± 40 BP	-29.4 (-70)	Cal A.D. 1680 (Cal BP 270), Cal A.D. 1730 (Cal BP 220), Cal A.D. 1810 (Cal BP 140), Cal A.D. 1930 (Cal BP 20), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1670 to 1710 (Cal BP 280 to 240), Cal A.D. 1720 to 1770 (Cal BP 230 to 180), Cal A.D. 1800 to 1880 (Cal BP 150 to 70), Cal A.D. 1910 to 1940 (Cal BP 40 to 10), and Cal A.D. 1950 to 1950 (Cal BP 0 to 0) or Cal A.D. 1660 to 1950 (Cal BP 290 to 0)	
Beta-186456	Core 5, Section 3 (83 cm)	Plant material (AMS)	130 ± 40 BP	-32.2 o/oo (-120)	Cal A.D. 1690 (Cal BP 260), Cal A.D. 1730 (Cal BP 220), Cal A.D. 1810 (Cal BP 140), Cal A.D. 1920 (Cal BP 30), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1680 to 1770 (Cal BP 270 to 180), Cal A.D. 1800 to 1890 (Cal BP 150 to 60), Cal A.D. 1910 to 1940 (Cal BP 40 to 10), and Cal A.D. 1950 to 1950 (Cal BP 0 to 0) or Cal A.D. 1660 to 1950 (Cal BP 290 to 0)	

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Appendix B. Continued.

Laboratory Number	Provenience: Core and Section (Depth within Section)	Sample Material (Analysis Method)	Conventional Radiocarbon Age, with $^{13}C/^{12}C$ Ratio Correction*	$^{13}C/^{12}C$ Ratio Correction (in Years)	Intercept(s) of Radiocarbon Age with Calibration Curve	Conventional Radiocarbon Age Calibrated to Dendrochronological Scale (1 sigma calibration over 2 sigma calibration)**	Comments
Beta-186457	Core 5, Section 4 (95-99 cm)	Plant material (AMS)	170 ± 40 BP	-26.7 o/oo (-30)	Cal A.D. 1680 (Cal BP 270), Cal A.D. 1770 (Cal BP 180), Cal A.D. 1800 (Cal BP 150), Cal A.D. 1940 (Cal BP 10), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1660 to 1690 (Cal BP 290 to 260), Cal A.D. 1730 to 1810 (Cal BP 220 to 140), and Cal A.D. 1920 to 1950 (Cal BP 30 to 0) or Cal A.D. 1650 to 1890 (Cal BP 300 to 60) and Cal A.D. 1910 to 1950 (Cal BP 40 to 0)	
Beta-186458	Core 12, Section 2 (68 cm)	Plant material (AMS)	150 ± 40 BP	-30.0 o/oo (-80)	Cal A.D. 1680 (Cal BP 270), Cal A.D. 1740 (Cal BP 210), Cal A.D. 1810 (Cal BP 140), Cal A.D. 1930 (Cal BP 20), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1670 to 1700 (Cal BP 280 to 250), Cal A.D. 1720 to 1780 (Cal BP 230 to 170), Cal A.D. 1800 to 1820 (Cal BP 150 to 130), Cal A.D. 1840 to 1880 (Cal BP 110 to 70), and Cal A.D. 1920 to 1950 (Cal BP 30 to 0) or Cal A.D. 1660 to 1950 (Cal BP 290 to 0)	Probably a reasonable date for the crevasse deposits that blanket the area.

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Appendix B. Continued.

Laboratory Number	Provenience: Core and Section (Depth within Section)	Sample Material (Analysis Method)	Conventional Radiocarbon Age, with $^{13}C/^{12}C$ Ratio Correction*	$^{13}C/^{12}C$ Ratio Correction (in Years)	Intercept(s) of Radiocarbon Age with Calibration Curve	Conventional Radiocarbon Age Calibrated to Dendrochronological Scale (1 sigma calibration over 2 sigma calibration)**	Comments
Beta-186459	Core 12, Section 3 (56 cm)	Plant material (AMS)	130 ± 40 BP	-25.3 o/oo (0)	Cal A.D. 1690 (Cal BP 260), Cal A.D. 1730 (Cal BP 220), Cal A.D. 1810 (Cal BP 140), Cal A.D. 1920 (Cal BP 30), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1680 to 1770 (Cal BP 270 to 180), Cal A.D. 1800 to 1890 (Cal BP 150 to 60), Cal A.D. 1910 to 1940 (Cal BP 40 to 10), and Cal A.D. 1950 to 1950 (Cal BP 0 to 0) or Cal A.D. 1660 to 1950 (Cal BP 290 to 0)	
Beta-186460	Core 12, Section 2 (33 cm)	Plant material (AMS)	120 ± 40 BP	-30.2 o/oo (-90)	Cal A.D. 1690 (Cal BP 260), Cal A.D. 1730 (Cal BP 220), Cal A.D. 1810 (Cal BP 140), Cal A.D. 1920 (Cal BP 30), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1680 to 1740 (Cal BP 270 to 200), Cal A.D. 1800 to 1930 (Cal BP 150 to 20), and Cal A.D. 1950 to 1950 (Cal BP 0 to 0) or Cal A.D. 1670 to 1950 (Cal BP 280 to 0)	Probably a reasonable date for the crevasse deposits that blanket the area.

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Appendix B. Continued.

Laboratory Number	Provenience: Core and Section (Depth within Section)	Sample Material (Analysis Method)	Conventional Radiocarbon Age, with $^{13}C/^{12}C$ Ratio Correction*	$^{13}C/^{12}C$ Ratio Correction (in Years)	Intercept(s) of Radiocarbon Age with Calibration Curve	Conventional Radiocarbon Age Calibrated to Dendrochronological Scale (1 sigma calibration over 2 sigma calibration)**	Comments
Beta-186461	Core 8, Section 2 (70-72 cm)	Plant material (AMS)	130 ± 40 BP	-26.5 o/oo (-20)	Cal A.D. 1690 (Cal BP 260), Cal A.D. 1730 (Cal BP 220), Cal A.D. 1810 (Cal BP 140), Cal A.D. 1920 (Cal BP 30), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1680 to 1770 (Cal BP 270 to 180), Cal A.D. 1800 to 1890 (Cal BP 150 to 60), Cal A.D. 1910 to 1940 (Cal BP 40 to 10), and Cal A.D. 1950 to 1950 (Cal BP 0 to 0) or Cal A.D. 1660 to 1950 (Cal BP 290 to 0)	Probably a reasonable date for the crevasse deposits that blanket the area.
Beta-186462	Core 8, Section 2 (11-13 cm)	Plant material (AMS)	106.3 ± 0.53 pMC	-25.4 o/oo (0)	N/A	N/A	Sample less than 50 years old. Upper crevasse deposits.
Beta-186463	Core 8, Section 3 (95 cm)	Plant material (AMS)	170 ± 40 BP	-27.5 o/oo (-40)	Cal A.D. 1680 (Cal BP 270), Cal A.D. 1770 (Cal BP 180), Cal A.D. 1800 (Cal BP 150), Cal A.D. 1940 (Cal BP 10), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1660 to 1690 (Cal BP 290 to 260), Cal A.D. 1730 to 1810 (Cal BP 220 to 140), and Cal A.D. 1920 to 1950 (Cal BP 30 to 0) or Cal A.D. 1650 to 1890 (Cal BP 300 to 60) and Cal A.D. 1910 to 1950 (Cal BP 40 to 0)	

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Appendix B. Concluded.

Laboratory Number	Provenience: Core and Section (Depth within Section)	Sample Material (Analysis Method)	Conventional Radiocarbon Age, with $^{13}C/^{12}C$ Ratio Correction*	$^{13}C/^{12}C$ Ratio Correction (in Years)	Intercept(s) of Radiocarbon Age with Calibration Curve	Conventional Radiocarbon Age Calibrated to Dendrochronological Scale (1 sigma calibration over 2 sigma calibration)**	Comments
Beta-186464	Core 8, Section 3 (14 cm)	Plant material (AMS)	160 ± 40 BP	-31.0 o/oo (-100)	Cal A.D. 1680 (Cal BP 270), Cal A.D. 1740 (Cal BP 200), Cal A.D. 1800 (Cal BP 150), Cal A.D. 1930 (Cal BP 20), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1670 to 1690 (Cal BP 280 to 260), Cal A.D. 1730 to 1810 (Cal BP 220 to 140), and Cal A.D. 1920 to 1950 (Cal BP 30 to 0) or Cal A.D. 1660 to 1950 (Cal BP 290 to 0)	
Beta-186465	Core 7, Section 2 (44-45 cm)	Plant material (AMS)	190 ± 40 BP	-28.8 o/oo (-60)	Cal A.D. 1670 (Cal BP 280), Cal A.D. 1780 (Cal BP 170), and Cal A.D. 1800 (Cal BP 150)	Cal A.D. 1660 to 1680 (Cal BP 290 to 270), Cal A.D. 1740 to 1810 (Cal BP 210 to 140), and Cal A.D. 1930 to 1950 (Cal BP 20 to 0) or Cal A.D. 1650 to 1700 (Cal BP 300 to 250), Cal A.D. 1720 to 1820 (Cal BP 230 to 130), Cal A.D. 1840 to 1880 (Cal BP 110 to 70), and Cal A.D. 1920 to 1950 (Cal BP 30 to 0)	

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Appendix B. Concluded.

Laboratory Number	Provenience: Core and Section (Depth within Section)	Sample Material (Analysis Method)	Conventional Radiocarbon Age, with $^{13}C/^{12}C$ Ratio Correction*	$^{13}C/^{12}C$ Ratio Correction (in Years)	Intercept(s) of Radiocarbon Age with Calibration Curve	Conventional Radiocarbon Age Calibrated to Dendrochronological Scale (1 sigma calibration over 2 sigma calibration)**	Comments
Beta-186466	Core 1, Section 2 (61 cm)	Plant material (AMS)	150 ± 40 BP	-28.9 o/oo (-60)	Cal A.D. 1680 (Cal BP 270), Cal A.D. 1740 (Cal BP 210), Cal A.D. 1810 (Cal BP 140), Cal A.D. 1930 (Cal BP 20), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1670 to 1700 (Cal BP 280 to 250), Cal A.D. 1720 to 1780 (Cal BP 230 to 170), Cal A.D. 1800 to 1820 (Cal BP 150 to 130), Cal A.D. 1840 to 1880 (Cal BP 110 to 70), and Cal A.D. 1920 to 1950 (Cal BP 30 to 0) or Cal A.D. 1660 to 1950 (Cal BP 290 to 0)	Probably a reasonable date for the crevasse deposits that blanket the area.
Beta-186467	Core 6, Section 1, end (115 cm)	Plant material (AMS)	150 ± 40 BP	-27.1 o/oo (-30)	Cal A.D. 1680 (Cal BP 270), Cal A.D. 1740 (Cal BP 210), Cal A.D. 1810 (Cal BP 140), Cal A.D. 1930 (Cal BP 20), and Cal A.D. 1950 (Cal BP 0)	Cal A.D. 1670 to 1700 (Cal BP 280 to 250), Cal A.D. 1720 to 1780 (Cal BP 230 to 170), Cal A.D. 1800 to 1820 (Cal BP 150 to 130), Cal A.D. 1840 to 1880 (Cal BP 110 to 70), and Cal A.D. 1920 to 1950 (Cal BP 30 to 0) or Cal A.D. 1660 to 1950 (Cal BP 290 to 0)	

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Appendix B. Concluded.

Laboratory Number	Provenience: Core and Section (Depth within Section)	Sample Material (Analysis Method)	Conventional Radiocarbon Age, with $^{13}C/^{12}C$ Ratio Correction*	$^{13}C/^{12}C$ Ratio Correction (in Years)	Intercept(s) of Radiocarbon Age with Calibration Curve	Conventional Radiocarbon Age Calibrated to Dendrochronological Scale (1 sigma calibration over 2 sigma calibration)**	Comments
Beta-186468	Core 6, Section 2 (71-76 cm)	Plant material (AMS)	340 ± 40 BP	-26.0 (-20)	Cal A.D. 1520 (Cal BP 430), Cal A.D. 1590 (Cal BP 360), and Cal A.D. 1620 (Cal BP 330)	Cal A.D. 1480 to 1640 (Cal BP 470 to 310) or Cal A.D. 1450 to 1650 (Cal BP 500 to 300)	
Beta-186469	Core 10, Section 5, bottom (112 cm)	Plant material (AMS)	290 ± 40 BP	-24.7 o/oo (0)	Cal A.D. 1640 (Cal BP 310)	Cal A.D. 1520 to 1580 (Cal BP 430 to 380) and Cal A.D. 1630 to 1650 (Cal BP 320 to 300) or Cal A.D. 1490 to 1660 (Cal BP 460 to 290)	
Beta-186470	Core 1, Section 1 (67 cm)	Plant material (AMS)	107.7 ± 0.54 pMC	-32.2 o/oo (0)	N/A	N/A	Sample less than 50 years old. Probably a reasonable date for the crevasse deposits that blanket the area.

• To obtain the measured radiocarbon age, simply subtract the year figure (listed in parenthese in the next column) from the conventional radiocarbon age.

** All samples calibrated by Beta Analytic, Inc., using the INTCAL98 Calibration Procedure (Stuiver and van der Plicht 1998; Stuiver et al. 1998; Talma and Vogel 1993).