Louisiana Geological Survey

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Tuscaloosa Marine Shale Research Cited in AAPG *Explorer*

An article in the October 2012 issue of the American Association of Petroleum Geologists (or AAPG) *Explorer* publication cites the Louisiana Geological Survey's 1997 study of the Tuscaloosa Marine Shale (or TMS) as having originated interest in the play. Describing the TMS play as a "long-tantalizing yet elusive" drilling zone for oil, the article describes how ongoing high oil prices make the TMS a "sleeping giant" in this era of horizontal drilling and multi-stage hydraulic fracturing. The article provides an update on production in the shale play: 13 completions reported, well costs in the range of $13 to $15 million, and average total vertical depth of about 12,500 feet. Successful development of the TMS play is expected to greatly increase revenues to the state and substantially increase the number of jobs in the area.

The LGS study, "An Unproven Unconventional Seven Billion Barrel Oil Resource - the Tuscaloosa Marine Shale," can be viewed online at http://www.lgs.lsu.edu/deploy/uploads/Tuscaloosa%20Marine%20Shale.pdf

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LGS Mission Statement

The goals of the Geological Survey are to perform geological investigations that benefit the state of Louisiana by:

(1) encouraging the economic development of the natural resources of the state (energy, mineral, water, and environmental);

(2) providing unbiased geologic information on natural and environmental hazards; and

(3) ensuring the effective transfer of geological information.

The Louisiana Geological Survey was created by Act 131 of the Louisiana Legislature in 1934 to investigate the geology and resources of the State. LGS is presently a research unit affiliated with the Louisiana State University and reports through the Executive Director of the Center for Energy Studies to the Vice Chancellor for Research and Graduate Studies.

The Louisiana Geological Survey is housed on the second and third floors of the Energy, Coast & Environement Building.

Waterfalls in the Sicily Island Hills Wildlife Management Area

Richard P. McCulloh

The area in northern Catahoula Parish encompassing Sicily Island and the Chalk Hills to its west is underlain by sediment comprising mudstone of the Oligocene Vicksburg Group and sandstone of the Catahoula Formation (Miocene–Oligocene), the latter of which is overlain by the Pleistocene graveliferous Bentley alloformation of the Upland allogroup (Figure 1), capped by two Pleistocene loess units (Miller et al., 1985, their figures 2 and 3). On Sicily Island, the Sicily Island Hills Wildlife Management Area (SIHWMA) owned and administered by the Louisiana Department of Wildlife and Fisheries (LDWF) contains mature forest communities with associated floral and faunal assemblages of unique ecologic significance, including some notably rare species (LDWF, 2012). According to the LDWF's Louisiana Natural Heritage Program (LNHP, 2000), these communities originally were noteworthy, but became rare through heavy logging and its initiation of successional changes. In addition to its ecological sensitivity, the SIHWMA area is highly susceptible to erosion following physical disturbance, because of its high relief and steep slopes maintained by the loess-capped Bentley sediments overlying Catahoula sandstone.

The SIHWMA area has considerable scenic value and appeal for tourism of the kind permitted within the framework of wildlife management areas. The forest itself is unlike any with which Louisianians are familiar elsewhere in the state, resembling more something perhaps characteristic of the Appalachians (LNHP, 2000); but the area contains as well a number of waterfalls, localized in places along the base of the Bentley at its contact with the Catahoula (Figures 2, 3). Both the Bentley and Catahoula are aquifers in this area (Van Biersel and Milner, 2010)—the Bentley corresponding to all or a substantial portion of the "Upland Terrace" aquifer—and the permeability contrast between unconsolidated Bentley sand and gravel and the underlying hard Catahoula sandstone creates preferential pathways for the flow of water to the surface. One of these waterfalls is the state's tallest (LNHP, 2000), and was written up in a popular guide to out-of-the-way places of interest to tourists in Louisiana (Odom, 1994). Many of the waterfalls may be visited via hiking trails, and it is reported that the unique character of the SIHWMA makes it a popular destination for hiking clubs from inside and outside the state.

The forest itself is unlike any with which Louisianians are familiar elsewhere in the state, resembling more something perhaps characteristic of the Appalachians

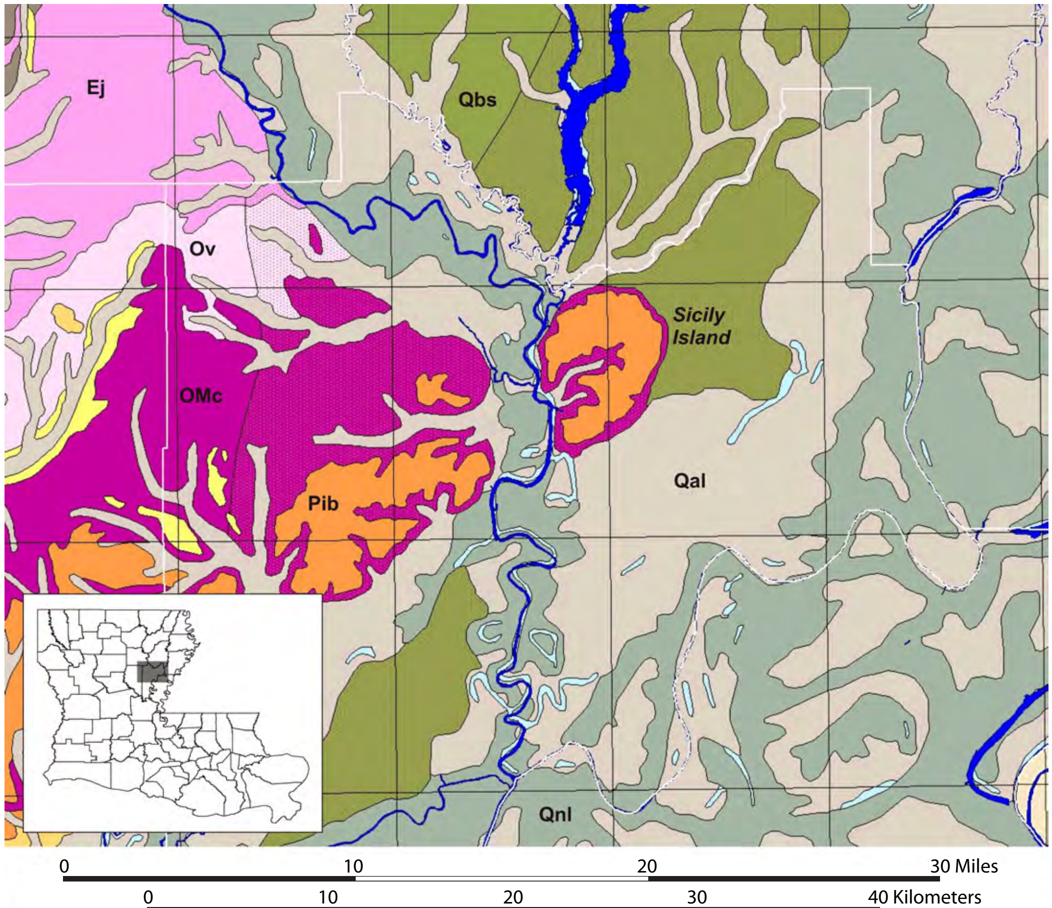

Figure 1. Geology of the area encompassing Sicily Island (adapted from the state geologic map). Stippling indicates areas covered by a total thickness of loess equal to or greater than 1 m (3.3 ft). [Ej, Eocene Jackson Group; Ov, Oligocene Vicksburg Group; OMc, Oligocene–Miocene Catahoula Formation; Pib, Pleistocene Bentley alloformation; Qbs, Pleistocene "braided stream terraces" (now Macon Ridge alloformation); Qnl, Holocene natural levee deposits of the Mississippi, Ouachita, and Arkansas rivers; Qal, Holocene undifferentiated allluvium]

Acknowledgments

I thank Riley Milner, Louisiana Geological Survey (LGS), and Thomas Van Biersel (Louisiana Department of Natural Resources, Office of Coastal Management) for helpful discussion; Milner, Chacko John, and Paul Heinrich (LGS) for reviews; and Reggie Wycoff and Clyde Thompson (LDWF) for facilitating the field work covering the area containing the waterfalls in 2001–2002.

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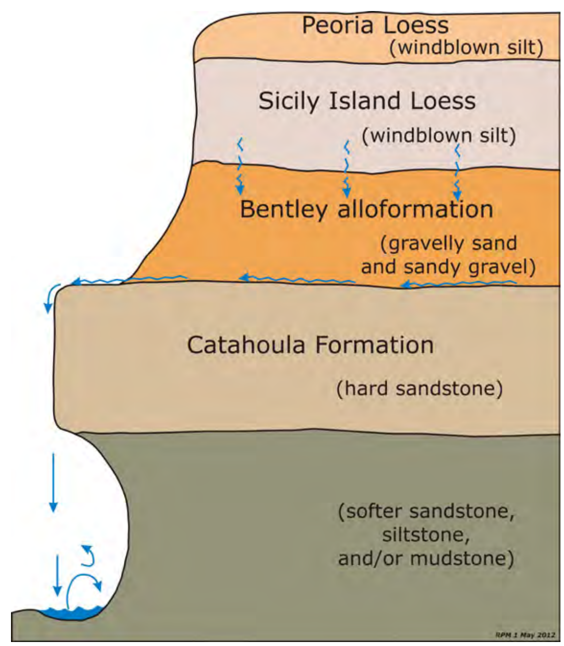
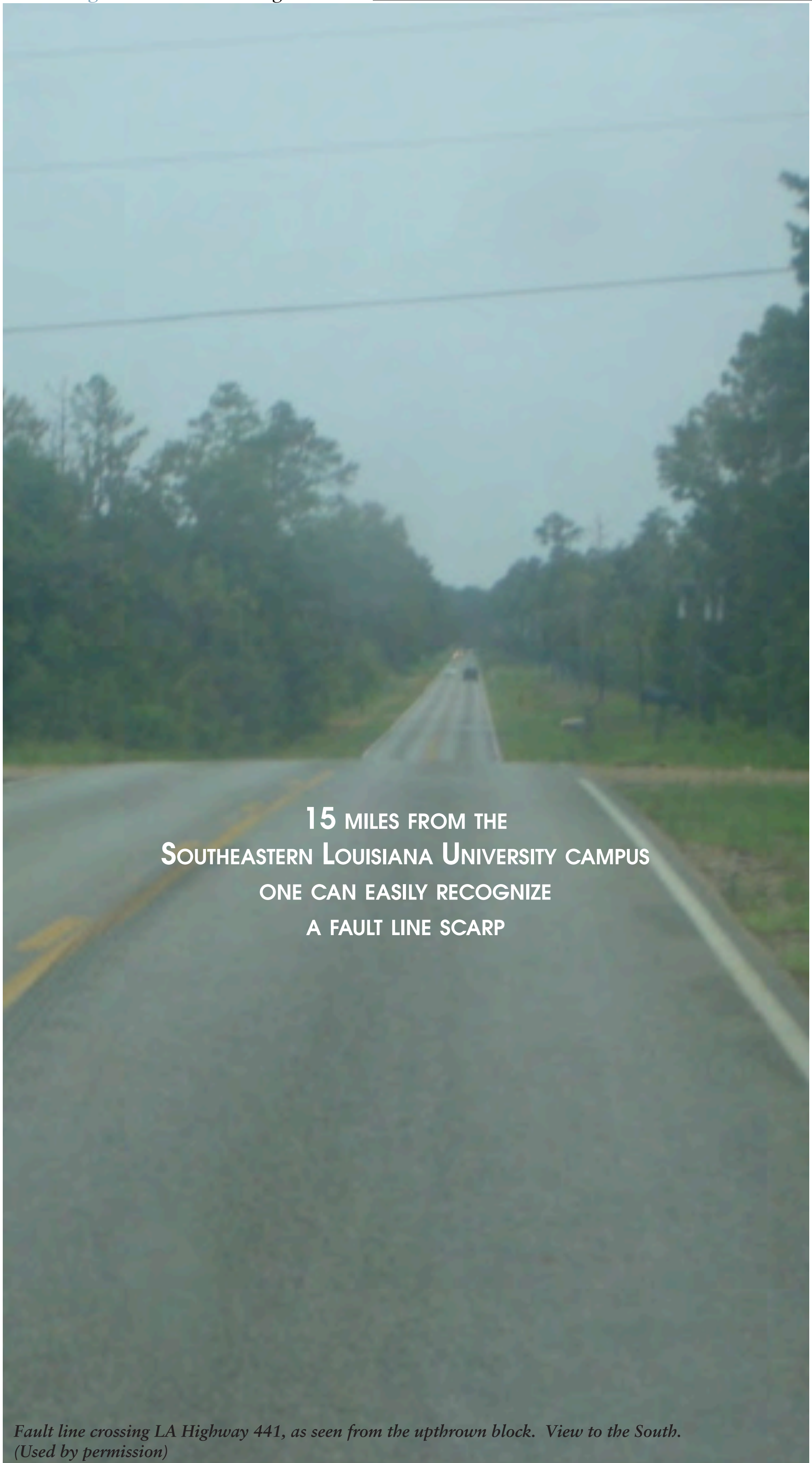


Figure 2. Schematic diagram (no scale) of a typical waterfall on Sicily Island.

Figure 3. *Photographs of waterfalls on Sicily Island (upper photograph shows Clyde Thompson, LDWF; lower photograph shows Thompson with Paul Heinrich, LGS).*

One of these waterfalls is the state's tallest (LNHP, 2000), and was written up in a popular guide to out-of-the-way places of interest to tourists in Louisiana

Dr. Wrenn, Department of Geology and Geophysics, LSU (left) and Rick McCulloh, LGS (right).



Fault line crossing LA Highway 441, as seen from the upthrown block. View to the South. (Used by permission)

Southeastern Louisiana University Students "Find the Fault"

Warren Schulingkamp

One of the challenges of teaching Earth Science at Southeastern Louisiana University in Hammond is getting students to actually go out into the field to see on the ground features which were described in the classroom. This is particularly the case in southeast Louisiana, where outcrops are few and far between and are not particularly impressive. Examples of other geologic features, such as a fault line scarp, are even fewer in number, and most of these are less than obvious to the casual observer. The challenge then becomes finding a place where students can easily see and recognize a geologic feature at a location convenient to campus. Fault line scarps in the Baton Rouge area are well known (McCulloh, 2001, 2008a, 2008b), but are not convenient to the Southeastern Louisiana University campus for most students.

There is a location only about 15 miles from the Southeastern campus where one can easily recognize a fault line scarp as a noticeable dip in the roadway and the surrounding countryside. The fault is a segment of the Baton Rouge - Tepetate Fault System and it crosses LA Highway 441 in Tangipahoa Parish, LA, only about one half mile south of Interstate 12. The fault can also be seen on the Ponchatoula 30 x 60 Minute Geologic Quadrangle map, published by the Louisiana Geological Survey (McCulloh et. al. 2003).

Students in Earth Science (EASC) 102 at Southeastern Louisiana University are encouraged, as an optional exercise, to go out and "Find the Fault." They are given instructions as to how to get to the location, and that they are to locate the fault line scarp. Students demonstrate that they have "Found the Fault" by having a partner take a recognizable photograph of themselves with the fault scarp in the background (Figure 4). Students who successfully find the fault, as all of those who attempt the exercise eventually do, are given a small extra credit towards their final grade. This exercise has proven to be popular among the students and has been adopted by other instructors of EASC 102 at Southeastern. The author thankfully acknowledges the permission given by those students who allowed their photographs to be used in this article.

Fault line scarp on LA Highway 441 approximately one half mile south of Interstate 12. View to the North. (Used by permission.)

A Southeastern Louisiana University student has "Found the Fault" on LA Highway 441 (Used by permission).

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Underfit Courses of the Central Red River Valley, Louisiana

Paul V. Heinrich

Abstract

Within the central Red River Valley, the courses of bayou and streams have long been presumed to be the partially filled, but original, relict courses of a prehistoric meandering Red River. Recent examination of LIDAR DEMs, high-resolution aerial imagery, available subsurface data, and soils mapping contradicts this interpretation of the origin of these fluvial courses. The review of the available data found that these bayous and streams occupy much younger fluvial courses that were likely created by extensive vertical aggradation of natural levee and overbank sediments and associated in-channel vertical accretion of sediments without significant lateral migration As a result of the vertical aggradation of sediments, these younger fluvial courses, which are called "stream-course palimpsests," directly overlie and mimic the paths of prehistoric Red River courses that now lie buried beneath them. The widespread accumulation of sediments, possibly associated with the Great Raft, within the central Red River Valley has buried and largely concealed the meander belts associated with these prehistoric Red River courses. In addition to stream-course palimpsests, the detectable remnants of these buried meander belts consist only of scattered palimpsests of ridge and swale topography and abandoned channel segments (ghost channels) that can be faintly discerned through an overlying blanket of natural levee sediments. The burial of prehistoric Red River meander belts and the accompanying formation of stream-course palimpsests and ghost channels has significant implications for both geoarchaeological and geological research within the central Red River Valley.

Introduction

Starting with Fisk (1938, 1940), the underfit nature of the meandering courses of the bayous and other drainages within the central Red River Valley has been recognized by a number of geologists, e.g. Murray (1948), Russ (1975), Smith and Russ (1974), Pearson (1986), and Abington (1973). They recognize these drainages as misfit fluvial landforms because the discharges associated with the wavelength and radii of meander loops exhibited by these courses differ considerably from the modern discharge of the streams and bayous that currently occupy them. These misfit fluvial courses are refer to as "underfit streams" because the discharges associated with the wavelength and radii of meander loops exhibited by these courses greatly exceed the current discharge of drainages occupying these meandering courses. The terminology used for these courses by Saucier (1994) is "underfit channel." However, the term "underfit stream" is used because it is the most widely used and accepted terminology for these fluvial landforms (Neuendorf et al., 2005).

Many researchers have assumed, without providing any detailed supporting evidence, that these underfit courses represent the primary, Late Holocene abandoned channel segments and courses of the Red River. They are regarded to be primary abandoned channel segments and courses in that they are presumed to represent the original courses or channels that have not been significantly modified since their abandonment, except for the infilling and narrowing of the original Red River channels. However, an reexamination of LIDAR DEMs, aerial imagery, and review of existing subsurface data during personal research into its geoarchaeology, geomorphology, and geology of the central Red River Valley and geological mapping for STATEMAP funded projects found relationships that contradict the presumed primary nature of these underfit courses. As a result, a detailed reexamination of the nature and origin of underfit courses within part of the central Red River Valley was undertaken.

Methods and Materials

For an examination of the origin of these underfit courses, the Red River Valley within the Winnfield 30 by 60 minute quadrangle was mapped in detail. The mapping was performed using georeferenced raster versions of 2006 and 2010 US Department of Agricultural NAIP aerial imagery; historical black and white USDA aerial photography; colored relief map created from 2004 LIDAR digital elevation models; a composite of LIDAR and USGS topographic mapping created by Richard P. McCulloh for STATEMAP sponsored geological mapping; georeferenced USGS 7.5-minute topographic maps; and soil mapping from the Soil Survey Geographic (SSURGO) Database (National Resource Conservation Service nd), as GIS layers in an ArcGIS 10.3 workspace. The color relief maps were created using Global Mapper 12.01 from LIDAR data from LSU CADGIS Research Laboratory (nd). The linework for the geological mapping of the geology of this part of the Red River Valley was composed and compiled as shapefiles in ArcgGIS 10.1. Also, using ArcgGIS 10.1, the upland geology using shapefiles from the mapping of STATEMAP 2011 Mapping Team (2012) was revised and incorporated into this data set. Profiles for mapping and figures were created using Global Mapper 12.01.

The surface geology was mapped on the basis of well-documented and distinctive morphology of different types of fluvial landforms, tonal variations as seen in aerial imagery, and associated soils, as discussed by Bridge (2003). Natural levees were recognized by their morphology, which consist of distinctly asymmetrical ridges flanking both sides of a channel. As seen in topographic maps and LIDAR, such ridges are highest immediately adjacent to the channel and drop gradually in elevation away from it. In addition, SSURGO soil mapping demonstrated that the surface sediments of these ridges exhibit the classic downslope gradation found in natural levees. In the modern natural levees of the Red River, surface sediments grade from very fine sandy loams on their crests to silt loams on their intermediate flanks, to clays on their distal edges for the modern Red River natural levees. As noted by Bordelon (2012), the catena of the inactive, pre-modern natural levees typically consist of Gallion and Caspiana silt loams on upper parts of natural levees, Armistead and Latanier clays on the intermediate parts of the natural levees and Buxin and Moreland clays on the lower parts of the natural levees or in the backswamps.

Point bar deposits and the meander belts that they comprise were recognized and mapped on the basis of their ridge and swale topography created by a migrating river course. As seen in the SSURGO soil mapping and summarized by Bordelon (2012), the modern meander belt of the Red River is associated with a catena of Roxana very fine sandy loam, Coushatta silt loam, Latanier clay and Moreland clay. This meander belt has a well-defined topographic expression that can seen in both 1:24,000 scale topographic mapping and LIDAR DEMs. Older ridge and swale topography could be mapped only on the surface as isolated meander belt fragments separated from the adjacent stream courses by their well-developed natural levees. In sharp contrast to the modern Red River meander belt, the ridge and swale topography of the older prehistoric meander belt fragments has a very subtle tonal expression on aerial imagery and a very subdued topographic expression. With very rare exceptions, this subdued topography is typically not seen in 1:24:000 scale topographic maps and often can only be clearly discerned using LIDAR DEMs. In addition, the SSURGO soil mapping shows the older prehistoric meander belt fragments as having clayey soils, which are identical to adjacent or enclosing natural levees.

Numerous crevasse splays were also recognized and mapped. These were recognized on the basis of their lobate surface morphology and association with a stream course or abandoned channel segment as seen best in LIDAR DEMS. In addition, in both LIDAR DEMs and aerial imagery, the radiating channel system of the crevasse could be typically identified.

In addition to the surface mapping, the available subsurface data, e.g. logs of water wells and engineering borings, were collected. Although scattered and highly variable in their quality, they provided critical data concerning the general thickness of overbank sediments beneath which point bar deposits and their associated meander belts have been buried within the study area. Attempts were made to find copies of U.S. Army Corps of Engineers geotechnical borings used by Smith and Russ (1974) in their mapping. Despite a detailed search of their files, staff at the Waterways Experimental Station, Vicksburg, Mississippi, could not locate copies of them (Dunbar 2012). Unfortunately, the cross-sections of Smith and Russ (1974) lack the resolution needed for measuring the thickness of overbank and other units with the precision needed for the present study. As a result, these data could not be incorporated into the study in any meaningful manner.

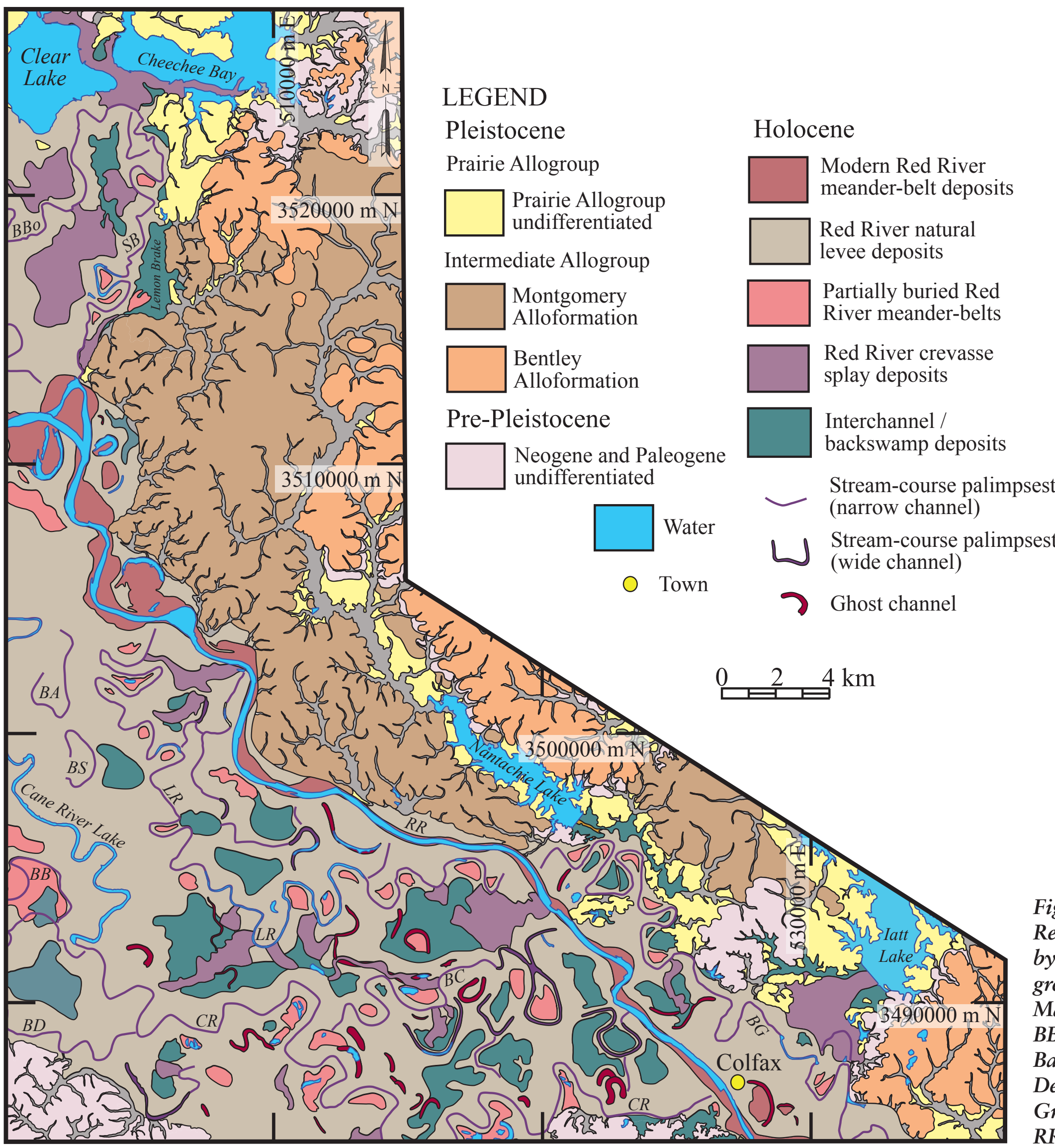


Figure 1. Preliminary geological map of the Red River Valley within the Winnfield 30 by 60 minute quadrangle. Generalized and greatly revised from STATEMAP 2011 Mapping Team (2012). BA = Bayou Athao, BB = Bayou Brevelle, BBo = Bourbeaux Bayou, BC = Bayou Cocodrie, BD = Bayou Derbonne, BS = Bayou Seep, BG = Bayou Grappe, CR = Cane River, LR = Little River, RR = Red River, and SB = Saline Bayou.

Results

Mapping reveals that this section of the Red River Valley is largely blanketed by the coalesced natural levees of the Red River and its distributaries (Figure 1). Along the modern course of the Red River, these deposits consist of its modern natural levees. Away from the modern course, the surface of the Red River Valley is covered largely by the natural levees largely associated with the courses of underfit streams. Enclosed within these natural levees are isolated fragments of the natural levees, channel segments, and ridge and swale topography of older, partially buried meander belts. In some areas, these natural levees have either coalesced to form a continuous blanket of natural levee deposits or are separated by disconnected interchannel depressions (Figure 1).

Within the central Red River Valley, three general types of underfit streams were discerned. As illustrated by Cane River Lake-Cane River, Bayou Grappe, Little River, and Bourbeaux-Saline Bayou courses, there are underfit streams that are characterized by the longest and most continuous courses. For example at Cane River Lake, these underfit streams are associated with the most pristine natural levees that form fluvial ridges with the highest elevation and relief (Figure 2). These courses typically begin and end at the edge of the modern Red River meander belt. As illustrated by Bayou Cocodrie and Bayou Derbonne, there are a few underfit streams that consist of shorter, more isolated courses (Figure 1). These underfit streams have natural levees that are less well preserved and form ridges that are significantly shorter and lower in elevation and relief than those found along the more continuous courses. Finally, within the interchannel areas, there are discontinuous underfit streams, e.g. Bayou Athao, Bayou Seep, and Bayou Brevelle, which lack well-developed natural levees (Figures 1 and 2). Some of these underfit streams, e.g. Bayou Brevelle, are associated with barely discernible ridge and swale topography. As noted earlier, all of these underfit streams have wavelengths and radii that previous researchers have interpreted to be characteristic of a large meandering river course.

Only scattered and isolated fragments of prehistoric Red River meander belts could be recognized and mapped on the basis of observable ridge and swale topography and abandoned channel segments (Figures 1 and 2). Judging from the pronounced muting of the topographic and tonal expression of their ridge and swale topography and the lack of any significant differences from the soil associated with adjacent natural levees, these meander belt fragments are all partially buried by a blanket of natural levee and other overbank sediments. The typically clayey character of the soil series, e.g. Amstead, Latanier, and Moreland clay, associated with these meander belt fragments supports this inference and indicates strongly that a blanket of overbank sediments at least 1.5 m (5 ft.) thick covers their original surface. In addition, the natural levees, abandoned channels, and ridge and swale topography of these meander belt fragments typically lies significantly below the level of the natural levees associated with the most continuous underfit streams. This relationship and available subsurface data indicate that these meander belt fragments are parts of meander belts that now lie almost entirely buried beneath fluvial ridges formed by the natural levees of the underfit streams.

Narrow, low benches are associated with the convex banks of Cane River Lake, the underfit stream with the highest and most well defined natural levees (Figure 2). These benches are about 35 to 140 m (115 to 460 ft.) in width and exhibit a ridge or ridges less than a meter (3.3 ft.) high. Although it proved impractical to examine these benches in the field and impossible to find any subsurface data for them, their surface morphology suggests that they are incipient point bars that are directly associated with this underfit stream. Similar, but smaller, less distinct and less defined benches are associated with the underfit stream of Bayou Grappe. However, the nature, even existence, of these benches is problematic.

Within this segment of the Red River Valley, backswamps either exist or once existed in a number of locations. As noted by Murray (1948), the surviving patches of backswamp now occur primarily as rim swamps that lie between the valley walls of the alluvial plain. The majority of these rim swamps occupy the valleys of drainages where they join the Red River Valley. LIDAR DEMs show that discontinuous depressions occur between the natural levees associated with underfit streams (Figure 1). In the past, backswamps likely occupied these interchannel depressions between the natural levees of the modern Red River and underfit streams. During the time of the Great Raft, a series of massive logjams that blocked over 300 km (190 mi) of the main channel of the Red River, semipermanent lakes also occupied some of these interchannel depressions. Because these areas have been drained and extensively modified for agricultural use, the precise boundaries and extent of backswamps within these interchannel areas could not be established. The precise delineation of the backswamps within these areas will require a detailed analysis of historical records and maps. Finally, within with some segments of underfit streams, e.g. Bayou Grappe, their natural levees have coalesced at meander necks to form enclosed basins. Judging from their location and shape, the patches of backswamp that occupy some of these basins likely overlie buried Red River meander belt fragments (Figure 1).

Fluvial Palimpsests: Judging from the geomorphic mapping, LIDAR DEM interpretation, and limited subsurface data, the underfit streams within this part of the Red River Valley are not the original, partially-filled, abandoned channels of prehistoric Late Holocene Red River courses as have been previously presumed. Instead, they are secondary, younger stream courses. The original, prehistoric Red River courses now lie buried along with their contemporary meander belts and natural levees beneath younger natural levee deposits associated with the younger underfit streams (Figure 3).

Historians first used the term "palimpsest" to refer to manuscript pages, typically parchment, from which writing has been scraped off and reused for writing again. Often, the early writing was only partially erased by scraping (Crang 1998). As a result, as the later writing faded, a complex assemblage of older text overprinted by the later text appeared. Geologists and geomorphologists, e.g. Bloom (1991) and Jackson (1997), use the term "palimpsest" to describe landforms in which previous processes and stages of development can be recognized. In case of the central Red River Valley, the underfit streams are fluvial palimpsests whose present courses directly mimic and are inherited from older Red River meandering courses. Within the younger underfit streams, previous Late Holocene stages in the development of the Red River can be recognized. Within this part of the Red River Valley, two main types of fluvial palimpsest features recognized are stream-course palimpsests and ghost channels. In addition, being buried by younger overbank sediments, the mapped fragments of prehistoric Red River meander belts are also regarded as palimpsest landforms.

Stream-Course Palimpsests: The underfit streams of the Red River Valley found within the Winnfield 30 by 60 minute quadrangle are interpreted to be stream-course palimpsests. A stream-course palimpsest consists of the sinuous course of either stream or bayou that mimics the large-scale meandering course of a prehistoric meandering river that underlies and is buried by the deposits of the existing channel. The natural levees and sediments within which the stream-course

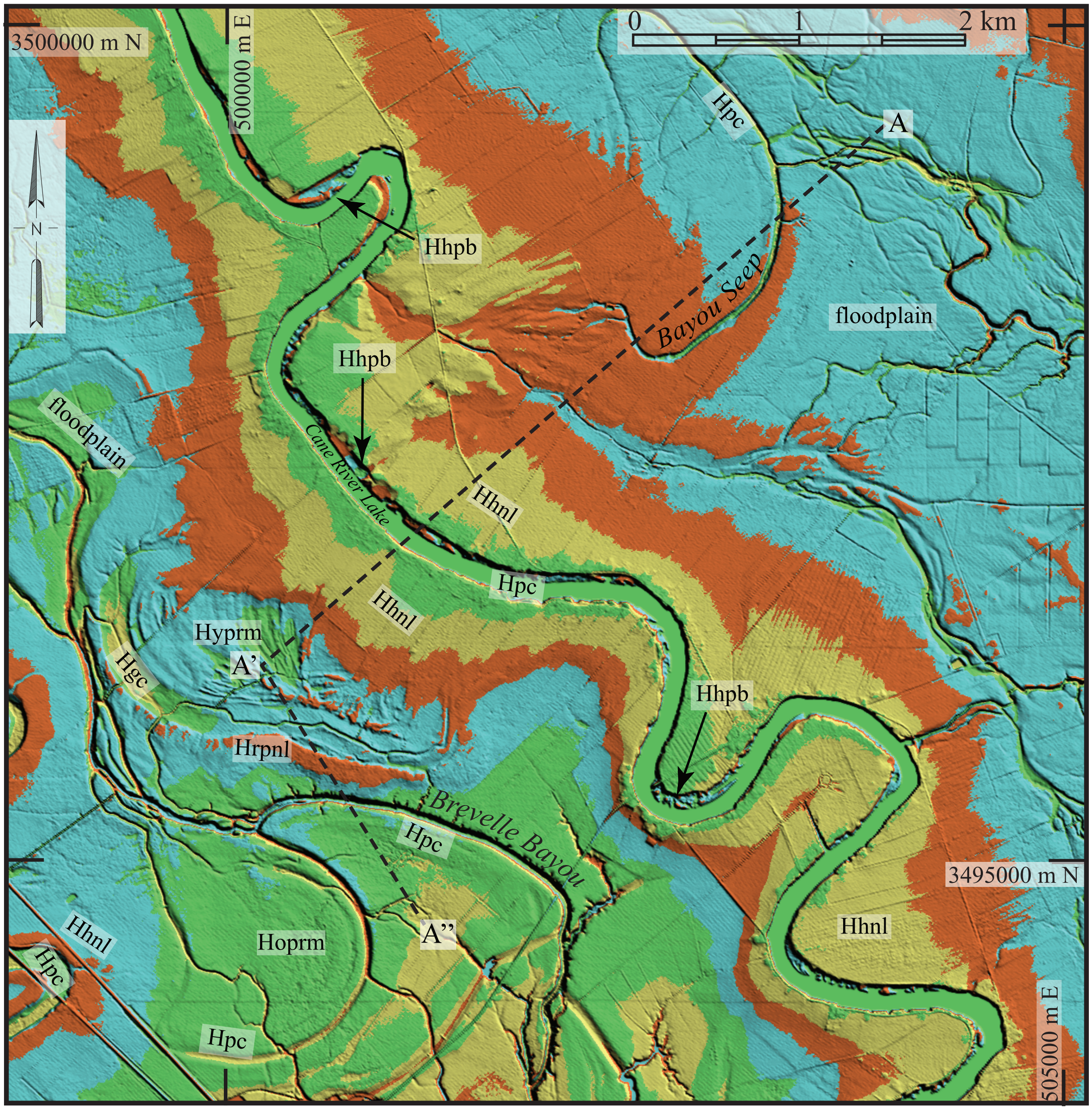


Figure 2. Colored relief map of a segment of Cane River Lake, Natchitoches Parish, Louisiana, which illustrates different types palimpsest channels and associated landforms. Colors represent 1 m (3.3 ft.) elevation intervals. Palimpsest channels types are stream-course palimpsest channels (Hpc) and ghost channels (Hgc). Associated landforms are historic natural levees (Hhnl), historic point bars (Hhpb), younger prehistoric Red River meander belts (Hyprm), older prehistoric Red River meander belts (Hoprm), and prehistoric Red River natural levees (Hrpnl). Map produced Global Mapper 12.0 from LIDAR DEMs available from Atlas: The Louisiana Statewise GIS at http://atlas.lsu.edu/.

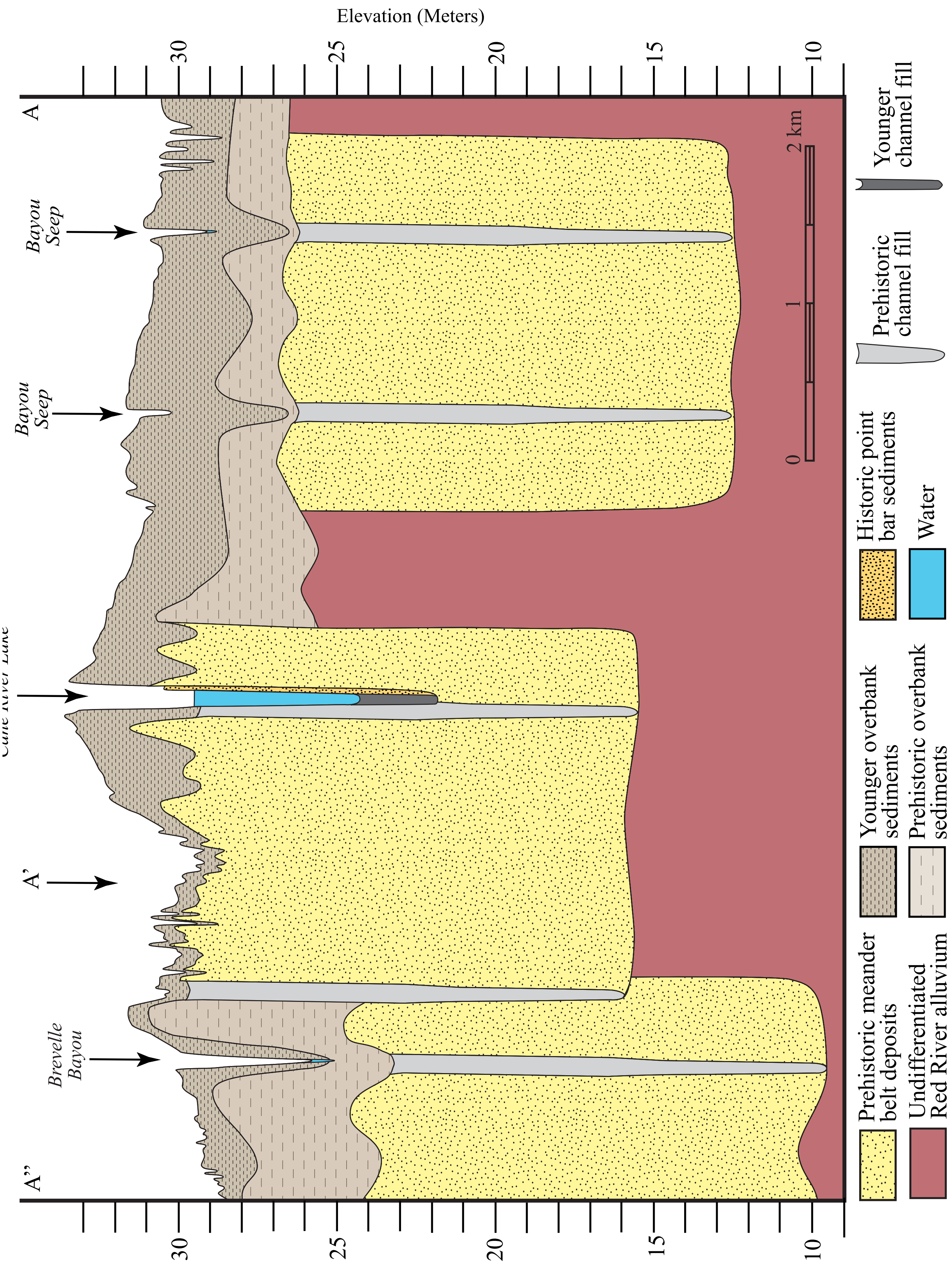
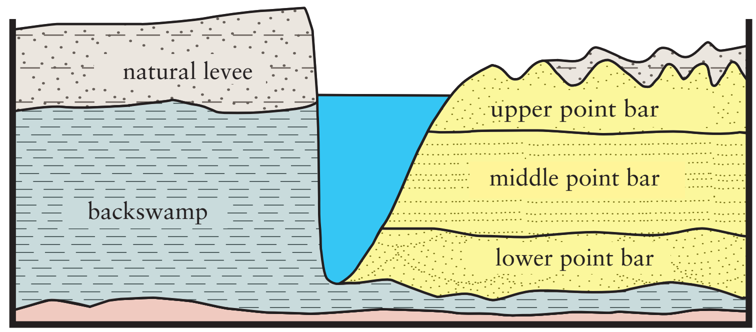


Figure 3. Conceptional cross-section based upon limited subsurface data showing relationship between late prehistoric - historic (“younger”) ?? stream channels and underlying prehistoric Red River courses and their associated point bar deposits. Location of cross-section indicated in Figure 2.

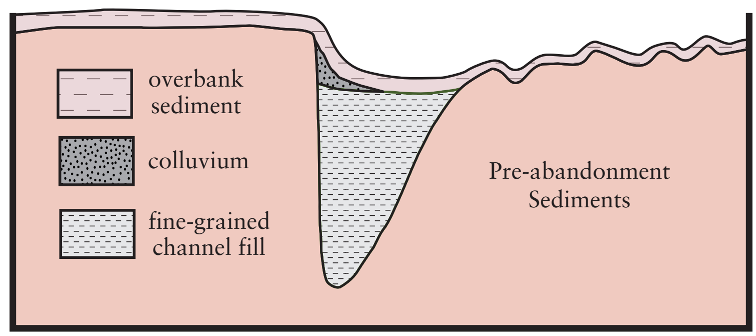
palimpsests lie are interpreted to be the result of the in-place vertical accretion of sediment within the channel of an Red River course and vertical aggradation of its associated natural levee and floodplain. As shown in Figure 3, the in-channel vertical accumulation of sediment has resulted in the upward displacement of the entire channel with time. As a result, although from a plan view, the original prehistoric meandering Red River course has been retained, it and its associated meander belt have been buried beneath younger deposits and the course of the younger stream-course palimpsest has been superimposed directly on top of it. Except for the stream-course palimpsest of Cane River Lake, the lack of recognizable point bars indicates that the course of the stream-course palimpsest is directly superimposed on top of the prehistoric Red River course without any modification by later meandering. In case of the Cane River Lake stream-course palimpsest, benches associated with convex banks of bends suggestive of incipient point bars indicate that limited migration of the channel occurred during the upward displacement of its channel (Figure 2).

In the Shreveport North 30 by 60 minute quadrangle, the courses, e.g. Cottonwood Bayou, Scotts Slough, Red Bayou, and Black Bayou, of specific Red River crevasse distributaries are underfit streams with distinct meandering patterns (McCulloh and Heinrich 2006). Although the wavelength, radii, and meandering of these stream courses are indicative of a Red River course, they are the main channels of crevasse distributaries that lack any associated meander belt deposits. Again, the misfit between channel morphology and associated landforms suggests that these streams are also stream-course palimpsests in which younger distributary channels directly reflect buried courses of the Red River. Initially, a younger distributary channel occupied an abandoned course of the Red River. Over time, accretion of sediment within the distributary channel and associated overbank sedimentation built up the crevasse distributary, locally buried a preexisting Red River meander belt, and lifted the distributary channel upward above the level of the original Red River channel.

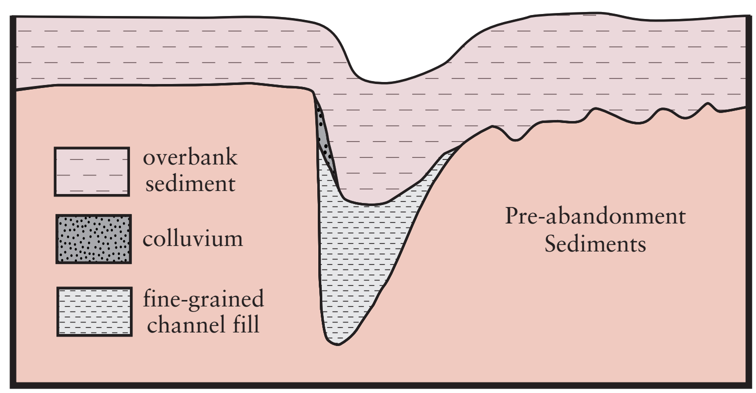
Ghost Channels: Often, but not always associated with the stream-course palimpsests is another fluvial palimpsest informally referred to as a "ghost channels" by Heinrich (2009). They consist of either a narrow, sinuous depression, a dark tonal pattern, or a combination of both that has the form of a meandering river course lying within backswamps. Within the study area, these dark channel-like tonals lie between approximately 0.3 to 1.5 m (1 to 5 feet) below the level of either the enclosing backswamp or distal natural levee and range from 45 to 190 m (148 to 623 feet) in width as measured from LIDAR DEMs. They exhibit wavelength and meander radii, which are very similar in size to the course of the nearby stream-course palimpsest. In most cases, the ghost channel is concave relative to the course of the nearest stream-course palimpsest (Figure 1). This suggests, but does not prove, that such ghost channels are buried segments of the Red River courses associated with adjacent stream-course palimpsests. In other cases, the ghost channels occur as isolated segments that lack any obvious relationship to a specific stream-course palimpsest within the interchannel areas (Figure 1). These ghost channels indicate that Red River meander belts exist within the Winnfield 30 by 60 quadrangle that have been buried by natural levees and other overbank sedimentation to the extent that they are undetectable to surface mapping techniques.



Stage 1. Active migration of Red River channel creates typical floodplain with levees and ridge and swale topography.



Stage 2. Upon abandonment, overbank sedimentation from Red River blankets surface with thin layer that mimics original surface topography of abandoned floodplain.



Stage 3. Contining overbank sedimentation from Red River completely buries surface of abandoned floodplain. Compaction of fine-grained channel fill causes subsidence of current floodplain that creates sinuous depression and dark tonal feature.

Figure 4. Diagram Showing Stages in tthe Development of ghost channel palimpsests. modified from Heinrich (2009).

Based upon their morphology, tonal pattern, and associated depressions, Heinrich (2009) hypothesized that ghost channels are deeply buried abandoned prehistoric river channel segments. He proposed that these depressions within the surface of the floodplain were created by the compaction of fine-grained sediments filling the channel of a buried course or segment of a long abandoned prehistoric river (Figure 4). As such, they are an indication of a rapid aggradation within a floodplain. Ghost channels have been found elsewhere within the Red, Ouachita, and Mississippi river valleys. For example, Heinrich and Autin (2000) mapped as "river channel remnants" a ghost channel representing the buried course of a major tributary (Yazoo) river within the backswamp, Bluff Swamp, of the Mississippi River just south of Baton Rouge, Louisiana (Heinrich 2009). Snead et al. (2002) also mapped a number of ghost channels as "Red River channel remnants" within the backswamps and distal natural levees of the Red River within Avoyelles and St. Landry parishes. The continuous nature of these ghost channels indicates that they are the surface expression of buried river courses associated with completely buried Red River meander belts. About 15 to 19 km (9 to 12 miles) southeast and east of Monroe, Louisiana, McCulloh and Heinrich (2010) mapped ghost channels of the Arkansas River as "river channel remnants." Finally, Heinrich (2008) recognized isolated ghost channels of the Mississippi River within the backswamp of Concordia Parish about 36 km (22 miles) northeast of Marksville, Louisiana. These "river channel remnants" are sinuous tonal patterns that are interpreted to be abandoned river channels and courses that are buried beneath backswamp and natural levee deposits. Because of the lack of identifiable meander belt landforms and their palimpsest nature, they should not be, and were not mapped, as meander belts for these geological maps.

Great Raft: Possibly starting either around 1,100 to 1,200 years BP or earlier, a series of gigantic log jams, known as the "Great Raft" blocked the main course of the Red River. When first observed by European explorers, it stretched for over 300 km (190 mi) along the Red River. It likely first formed further downstream and over time has migrated upstream to where it was first observed. Between 1833 and 1878, the Great Raft was removed to open the Red River to river commerce (Albertson and Patrick, 1996; Guardia, 1933; Murray, 1948).

The Great Raft provides a plausible explanation for the reoccupation of abandoned Red River courses and formation of stream-course palimpsests and ghost channels. When Captain Henry Shreve navigated the Red River in 1833, he discovered that it was an anastomosing, not a meandering, river system. Thus, the Red River was not characterized by a single river course. Instead, it consisted of multiple anabranches that included former abandoned river courses and formed an anastomosing river system (Albertson et al., 1988; Albertson and Patrick, 1996; Abington, 1973, Murray, 1948). For example, at this time, Cane River, including the part now occupied by Cane River Lake, was a significant course of the Red River for a period of more than 125 years and provided river access to towns such as Cloutierville and Chopin, Louisiana. The massive logjams created local base levels, which locally accelerated the aggradation of natural levees and adjacent floodplain relative to other portions along the main channel (Guardia, 1933). These local base levels were propagated down whatever courses of the anastomosing river system were active and accelerated not only the aggradation of their natural levees but their associated courses. Given that different courses randomly became active and inactive as the raft disintegrated, reformed, and shifted, vertical accretion of sediments within their channels and on their natural levees would have varied with time. The overall effect would have been the formation of low energy cohesive floodplain and associated anastomosing river system in which the vertical in-channel accretion of sediments within channels and natural levee and floodplain aggradation occurred without significant lateral channel migration (Makaske, 2001; Nanson and Croke, 1991). The burial of prehistoric Red River courses and meander belts by the vertical aggradation of sediments in such a floodplain would explain the formation of stream-course palimpsests and ghost channels within this part of the Red River Valley.

Significance

Within the Winnfield 30 by 60 minute quadrangle, both the stream-course palimpsests and ghost channels provide significant evidence of rapid aggradation of this part of the Red River Valley during the Late Holocene. Judging from the geomorphology of the underfit courses within this part of the Red River Valley, these courses were active at sometime after their associated meander belts were abandoned. During this period of post-meandering activity, significant vertical aggradation of the natural levees, channel, and adjacent floodplain of these courses occurred without any significant meandering of the channel. In addition to the creation of stream-course palimpsests and ghost channels, this has significant implications with respect to the geoarchaeology of and geological mapping within the Red River Valley.

Geoarchaeology: The interpretation of underfit streams within the Red River Valley as stream-course palimpsests has great significance for the preservation and identification buried archaeological deposits. The preservation of the original meandering course of a Late Holocene Red River course means that a stream-course palimpsest is the result of vertical accretion of sediments within the channel and upon the associated natural levees and adjacent floodplain without lateral migration. This indicates that the extensive lateral migration normally associated with a meandering channel has not occurred since the abandonment of the buried meander belt. As a result, the natural levee deposits and associated cultural deposits that may have accumulated during their occupation were not destroyed by the lateral migration of the channel of the stream-course palimpsest. This should have allowed the vertical accretion of thick natural levee deposits that have the possibility to contain well preserved, stratified archaeological deposits representing a significant period of time. In addition, any archaeological deposits lying on the surface of the buried meander belt at the time of its abandonment will also be preserved. Thus, there should be significant buried archaeological deposits associated with stream-course palimpsests and to a more limited extent with ghost channels. Unfortunately, locating these archaeological resources will be a daunting task and their study financially and technically challenging because of depths to which they might be buried.

Geological Mapping: Because of the palimpsest nature of the underfit streams within this part of Red River Valley, they cannot be used as the primary basis for mapping meander belts within this region. Although stream-course palimpsest and ghost channels presumably reflect prehistoric abandoned courses and channels segments of the Red River, they are much younger fluvial landforms that have been detached from and rose above the original Red River courses by later aggradation of the channel's natural levee and floodplain. The original abandoned prehistoric Red River courses and channel segments associated with these stream-course palimpsests now lie buried beneath a significant thickness of younger natural levee deposits. In addition, a significant part of their associated meander belts lies buried deeply enough beneath younger natural levee and interchannel deposits so as to be completely masked and impossible to map directly using LIDAR DEMs, soils, or other surficial data. In such cases, the buried meander belts are too deep to be mapped as part of the surface geology and the underfit channels would be problematic and unreliable criteria for the mapping of the extent of meander belts in the absence of other features and data.

Even where ridge and swale topography of prehistoric Red River meander belts can be discerned within the Winnfield 30 by 60 minute quadrangle using either LIDAR DEMs, aerial imagery, other data, or combination of these, the observable ridges and swales are not the actual surface of a prehistoric Red River meander belt. Instead, they are also palimpsest landforms reflecting the buried surface of an older meander belt as shown in Figure 3.

In case of the geologic mapping of Smith and Russ (1974), the extent of buried Red River meander belts was inferred from a combination of underfit streams, associated ghost channels, and very sparse subsurface data. Although underfit streams and ghost channels, as used by Smith and Russ (1974), can be used to infer the minimum extent of buried meander belts, they do not provide a reliable guide to the exact location of outer edges of the meander belt. This is because the outer edge of a meander belt typically lies outside of the area enclosed by the abandoned course of a meandering river at any one time (Bridges, 2003). Also, given the uncertain association of specific ghost channels with a specific stream-course palimpsest, their usefulness in determining the boundaries of a buried meander belt are also problematic and of questionable reliability. Furthermore, as indicated by stippling on their mapping that shows the presence of natural levee sediments overlying them, the older, prehistoric Red River meander belts that Smith and Russ (1974) mapped are primarily subsurface units. Thus, their meander belt units represent a type of stack-unit geological mapping instead of a geological map of surface geology.

Similarly, the validity of the Red River meander belts mapped within the Ville Platte 30 by 60 geologic quadrangle by Snead *et al.* (2002) is questionable and needs to be reexamined in detail. The examination of LIDAR DEMs, which were not available when this mapping was conducted, and aerial imagery revealed an almost complete absence of observable ridge and swale topography and identifiable abandoned channel segments associated with the mapped meander belts. In addition, the topography and soils within the areas, which are mapped as meander belts, are characteristic of Red River natural levees and backswamps (National Resource Conservation Service). As a result, the identification of these meander belts are based solely on the morphology of the underfit streams. Therefore, the boundaries of these hypothetical meander belts are largely a matter of speculation judging from the overall lack of recognizable surface morphology and extremely limited amount of available subsurface data.

The virtual lack of any observable meander belt morphology indicates that the underfit streams within the Ville Platte 30 by 60 geologic quadrangle are also likely stream-course palimpsests that postdate the meandering of these Red River courses. Their formation has likely buried any hypothetical meander belts that might be associated with these courses. For example, subsurface data from the St. Landry Parish Solid Waste facility on Bayou Boeuf near Beggs, Louisiana, in Ardaman & Associates, Inc. (2007) indicate that the surface of a possible prehistoric meander belt associated with this underfit stream lies buried beneath at least 6 to 7 m (20 to 23 ft.) of younger natural levee and other overbank sediments. At such depths, a meander belt lies buried too deep, greater than 1.5 to 2 m (5 to 6.6 ft.) to be mapped either as a surface geological unit or shown on a geologic map.

Summary

The reexamination of underfit streams historically regarded as the primary abandoned channels of Late Holocene Red River courses, found older interpretations contradicted by surface geomorphology and available subsurface data. An examination of LIDAR DEMs, high-resolution aerial imagery, and limited subsurface data indicate that these underfit streams are stream-course palimpsests and not primary abandoned courses of the Red River. These stream-course palimpsests and the ridges created by their associated natural levees are interpreted to be much younger landforms created by the in-channel vertical accretion of sediments and aggradation of associated natural levees an floodplains in the absence of lateral channel migration. Similar palimpsest landforms, which are known as "ghost channels," are interpreted to be the surface expression of deeply buried abandoned channel segments of the Red River. The proposed origin of the underfit streams and associated "ghost channels" within the Red River Valley imply that significant cultural resources lie deeply buried beneath large parts of the central Red River Valley. The nature of the underfit streams in this part of the Red River Valley make them problematical and unreliable as the primary criteria for the mapping of meander belts in the absence of ridge and swale topography, detailed subsurface data, and other observations.

Acknowledgments

I thank John Anderson of the Cartographic Information Center for enabling me to examine historic aerial photography for Natchitoches and adjacent parishes essential to conducting this research. The Interlibrary Loan Department at the Louisiana State University Middleton Library helped in obtaining publications for this research. Teri Tharp of the Environmental Division of the Louisiana Department of Natural Resources, Office of Conservation helped me find logs of water wells within the study areas. I also greatly appreciated the efforts of Dr. Joseph B. Dunbar of the Geotechnical and Structures Lab, U.S. Army Corps of Engineers in Vicksburg, Mississippi, to search for the Red River borings of Smith and Russ (1974). The Louisiana State University CADGIS Laboratory's "Atlas: The Louisiana Statewide GIS" and National Resource Conservation Service's Geospatial Data Gateway archives were essential sources of GIS data. In addition, this research used GIS and other base data collected and compiled in an ArcGIS workspace for geological mapping funded by U.S. Geological Survey STATEMAP Assistant Award No. G11AC20242. Finally, I thank Dr. Charles "Chip" McGimsey, Louisiana State Archaeologist; Dr. Jeff Girard, Northwest Louisiana Regional Archaeology Program, Northwestern State University; Marc J. Bordelon, MLRA SSO Leader Ruston Soil Survey, Natural Resource Conservation Service; Dr. Daniel R. Muhs U.S. Geological Survey, Denver, Colorado; and Warren Schulingkamp, Louisiana Geological Survey for reviewing the manuscript of this paper and providing me with either their evaluation, comments, or combination of both. What was done with their reviews and comments remains the responsibility of the author.

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STATEMAP 2011 Mapping Team, 2012, Winnfield 30 x 60 LA 30 X 60 minute geologic quadrangle (1:100,000): Louisiana Geological Survey Open-File Map 2011-03, 1 sheet.

LSU Petroleum Engineering Geothermal Project

LGS researchers are partnering with facultyfrom LSU Petroleum Engineering and other LSU departments on a three year Petroleum Engineering Department project funded by the U.S. Department of Energy for $997,000 titled "Zero Mass Withdrawal, Engineered Convection, and Wellbore Energy Conversion." The project will evaluate the technological and economic feasibility of technologies that circulate reservoir fluids to increase heat extraction. The project focuses on geopressured geothermal brines which are a huge potential energy resource in the U.S., especially in the Gulf of Mexico region. The project work is split up in different tasks to be performed by the investigators located in the various LSU departments. The LGS task is to determine the resource scope and characterization and involves collecting requisite data on brine composition, reservoir geometry and rock properties for input into the modeling applications.

Louisiana Geological Survey Contributes to the National Geothermal Data System

The focus of this three-year project is to identify, catalog, and create geothermal databases and maps for inclusion in the National Geothermal System which will facilitate the potential development of geothermal (geopressured-geothermal) resources in the United States. All the 50 state Surveys in the country are participants in this $21 million project represented by the Association of American State Geologists, funded by the U.S. Department of Energy and managed by the Arizona Geological Survey. All required project deliverables to date have been completed and submitted to AZGS. This includes over 6,000 well temperature profiles and a georeferenced map showing the depths to the South Louisiana Geopressured Tertiary Sandstone. When completed in 2013, the U.S. Department of Energy Geothermal Data System (NGDS) will have geothermal data from all states. It will help mitigate much of the upfront risks associated with exploring for, confirming and characterizing the potential of available geothermal resources in the country.

Geologic Data Creation for Three Louisiana Parishes (Iberville, Pointe Coupee, and West Baton Rouge) for Use in the USGS National Geologic Carbon Dioxide Sequestration Assessment

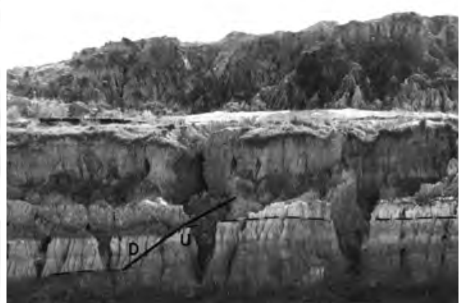
The main objective of this one-year project funded by the USGS was to identify and describe suitable sites for carbon dioxide (CO_2) sequestration in a three parish area and to present relevant information on these sites in the format desired by the USGS. Because of time and funding limitations, the LGS focused attention on a three-parish area in southeastern Louisiana consisting of Iberville, Pointe Coupee and West Baton Rouge Parishes and covering the Bayou Bleu, Bayou Choctaw, Bayou Sorrel, Fordoche, and Livonia fields. These fields are typical of the geologic settings of oil and gas accumulation in Louisiana and are representative of settings where CO_2 sequestration might be accomplished in Louisiana. The fields selected for study were active and depleted oil and gas fields and saline aquifers which met the USGS assessment criteria (depth 3,000ft – 13,000ft; 500,000 BOE) to determine their suitability as CO_2 sinks. LGS compiled a database of relevant information for those fields which included publically available cross sections, maps, formation tops, lithographic data, permeability, porosity and calculated appropriate estimates of potential CO_2 storage volume in the reservoirs. All information generated was provided to the USGS in the final project report.

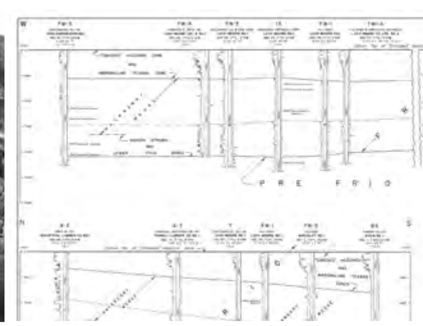
Inventory and Digital Infrastructure of Historic Louisiana Geologic Map Data

LGS was a participant in this USGS funded project under the National Geological and Geophysical Data Preservation Program (NGGDPP) passed by the U.S. Congress. LGS addressed two of the program priorities: creating an inventory of the LGS historic geologic map collection and improving upon the state and national digital map infrastructure. Thousands of published and unpublished geologic maps, cross-sections, sample site maps, and other geo-data dating back over a century exist in LGS cartographic storage rooms. This un-indexed material consists of lithographic prints, working drafts, historic reference maps, and many original manuscripts on linen, vellum, positive and negative film, contact prints, and even some metal plates.

The LGS inventory team continues an effort to systematically conduct a proper inventory, assess the quantity, condition, and importance of the material, and catalog retained items into a relational database. A catalog record for each document was prepared and the on-line inventory completed on the Data Preservation website. The LGS digital infrastructure team selected documents for digitization. Items were scanned at high resolution, post-processed in Photoshop, and metadata records were prepared and uploaded to the National Digital Catalog portal.

Thousands of published and unpublished geologic maps, cross-sections, sample site maps, and other geo-data dating back over a century exist in LGS cartographic storage



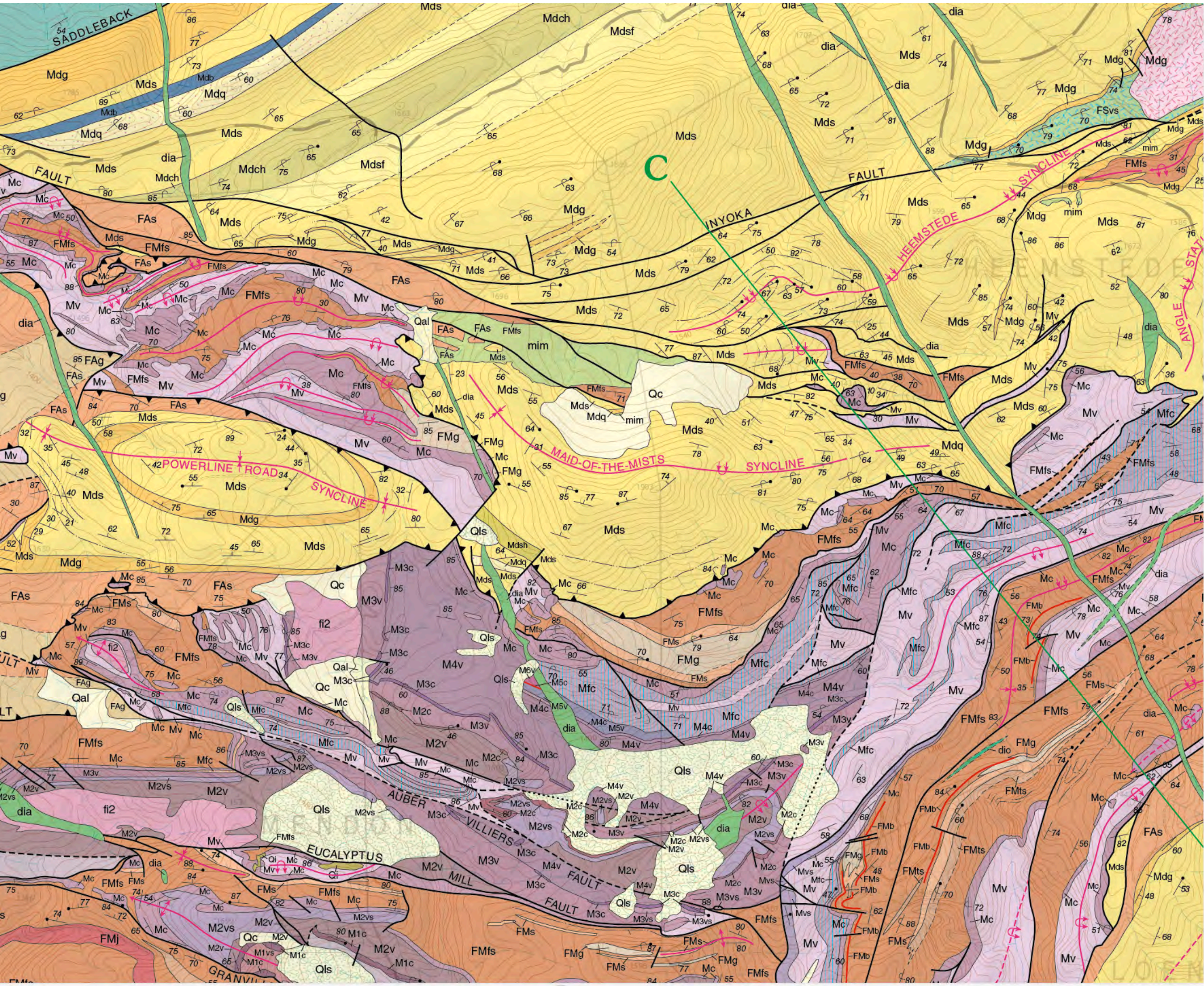


"Blowout of Louisiana Oil & Refining Co. Gleason No.1 well in Webster Parish" from Geological Bulletin No. 29 Figure 7

Some Major Features of Basin Configuration Related to Cycles of Deposition (Figure 2) from Geological Bulletin No. 42: Cenozoic Cyclic Deposition in the Subsurface of Central Louisiana

"Fault in South Wall of Abandoned Wolfe Gravel Pit (Indian Village) Showing Apparent Dip and Throw" from Geological Bulletin No. 36 Figure 6

Cross-Sections of Lower-Middle Frio in Bayou Serpent Area (Plate 5) from Geological Bulletin No. 36: Geology of Acadia and Jefferson Davis Parishes



Geologic Map of the Barberton Greenstone Belt, South Africa

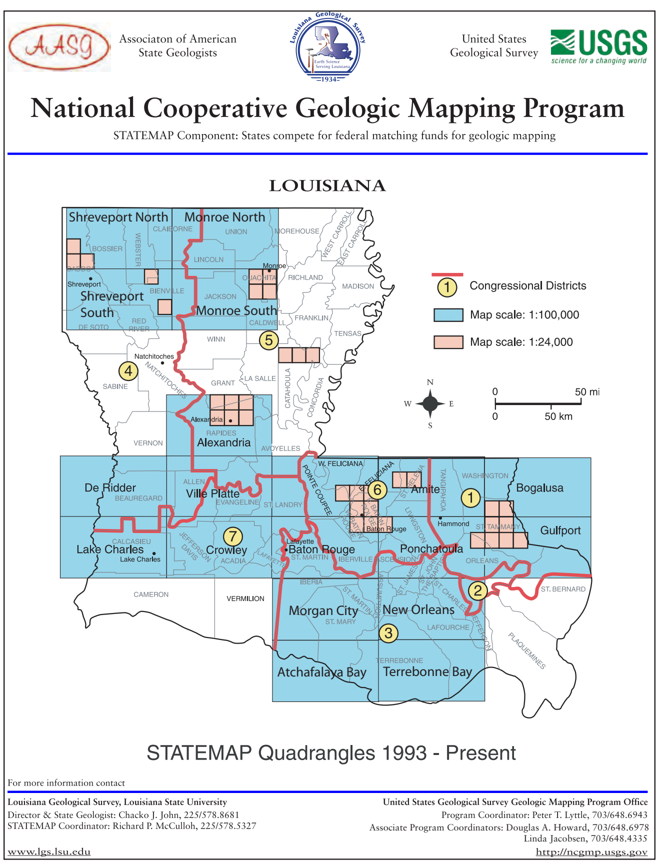
The LGS Cartographic Section is providing technical and cartographic assistance in support of producing oversized (55x70 in) lithographic wall map of some of the oldest sedimentary maps in the world (the Barberton Greenstone Belt, South Africa). This project is sponsored by the Stanford University Department of Geological and Environmental Sciences and the LSU Department of Geology and Geophysics. The map was published by the Geological Society of America in November and is available from GSA as map MCH-103 on their website www.geosociety.org/bookstore/i/catalog.pdf

Status of Geologic Mapping In Louisiana

LGS is the only research organization doing geologic mapping in the state of Louisiana. LGS surface geologic mapping activity, supported by cooperative agreements with the U.S. Geological Survey under the National Cooperative Geologic Mapping Program, STATEMAP component, continued in fiscal year 2011 with three 30 × 60 minute quadrangles covering a substantial portion of north Louisiana: Leesville (west-central Louisiana), Winnfield (south-central north Louisiana), and Natchez (southeastern north Louisiana). A highlight of the field excursions in the Winnfield quadrangle was a tour guided by local hunting club and timber company representatives of the Zenoria–Little Creek structure in northwestern La Salle Parish, which is arguably the most enigmatic geologic structure in the state.

Cartographic preparation of lithographs of 30 × 60 minute quadrangles previously compiled with STATEMAP support for public release continued with two quadrangles in the western delta plain (Morgan City and Atchafalaya Bay) and one in north-central Louisiana (Monroe North). The Morgan City quadrangle is noteworthy for containing all five salt domes of the Five Islands trend (Jefferson, Avery, Weeks, Cote Blanche, and Belle Isle) within its extent.

Other activities included finalization of a paper entitled, "Surface Faults of the South Louisiana Growth-Fault Province" by R. P. McCulloh and P. V. Heinrich, submitted to a Geological Society of America special volume developed as an outgrowth of a 2010 annual convention conference session. This paper chronicles the notable increase in the number of surface faults interpreted in south Louisiana over the past 20 years, which primarily reflects the results of STATEMAP-supported LGS surface geologic mapping projects since 1993 and the availability of LIDAR imagery that began ca. 2000.



Surface Faults Paper for a GSA Special Volume Publiction

Rick McCulloh and Paul Heinrich finalized and submitted page-proof corrections of a paper entitled, "Surface Faults of the South Louisiana Growth-Fault Province" included in a Geological Society of America (GSA) special volume edited by R. T. Cox and others, which is being developed as an outgrowth of a 2010 Denver GSA conference session. The paper chronicles the dramatic increase in the number of interpreted surface faults in south Louisiana during the past 20 years, attributable to: (1) application of traditional analysis of topographic maps and aerial-photographic imagery over increasingly large areas, particularly in southwest Louisiana, (2) the employment of geophysical surveying techniques in the Holocene delta plain where surface scarp relief is negligible, and (3) the advent of LiDAR digital elevation models (DEMs).

The first of these developments was stimulated primarily by the advent in 1993 of cooperative agreements with the U.S. Geological Survey under the National Cooperative Geologic Mapping Program, STATEMAP component. This began an ongoing program of systematic preparation by the Louisiana Geological Survey of compilations of surface geology of 30 × 60 minute quadrangles at 1:100,000 scale recompiled in part from new source mapping at 1:24,000 scale. Although these one-year-duration projects did not permit detailed investigation of the faults interpreted in these areas, they led to the number and distribution of plausible surface fault candidates becoming better known.

Among the paper's conclusions is the observation that surface fault traces interpreted in south Louisiana since the early 1990s, when compiled together with those previously interpreted, reveal that many of the subsurface growth-fault systems in south Louisiana have surface expression, whereas prior to the early 1990s only the Baton Rouge–Tepetate fault systems were known to have produced surface faults.

View to southwest of fracture with strike-slip displacement.

A Fracture with Strike-Slip Displacement Near the Baton Rouge Fault in Southern East Baton Rouge Parish: Preliminary Observations

Richard P. McCulloh

A sidewalk fracture in a residential neighborhood not far north of the Baton Rouge fault in southern East Baton Rouge Parish exhibits transcurrent or strike-slip displacement of approximately 10 cm (3.9 in), with a left-lateral sense of separation. The fracture, which strikes approximately N 72° E, is subparallel to the sidewalk and transects portions of 6 sidewalk panels. The average strike of the Baton Rouge fault in the area to the south is approximately N 79° W, making the angle between the fracture and the fault approximately 29°.

The magnitude of displacement of the fracture is not large, but is yet significant. Although the fault plane of the Baton Rouge fault is understood as grossly shovel-shaped and flattening out increasingly with depth, it is characterized primarily by dip-slip movement at the surface and in the shallow subsurface. Thus, considering the proximity of this fracture to the Baton Rouge fault, its strike-slip character is perhaps unexpected. Its presence could suggest that though the onshore U.S. Gulf Coast is understood as a dominantly extensional province, within it there may be potential for at least brief and/or localized compression. Alternatively, a minor reconfiguration of the northeastern extent of one of the regional-scale sediment-and-salt masses hypothesized by Peel and others (1995) to have been mobilized Gulfward could bring its boundary through the observed location in a manner that would account for left-lateral strike-slip displacement along a fracture striking N 72° E.

Acknowledgments

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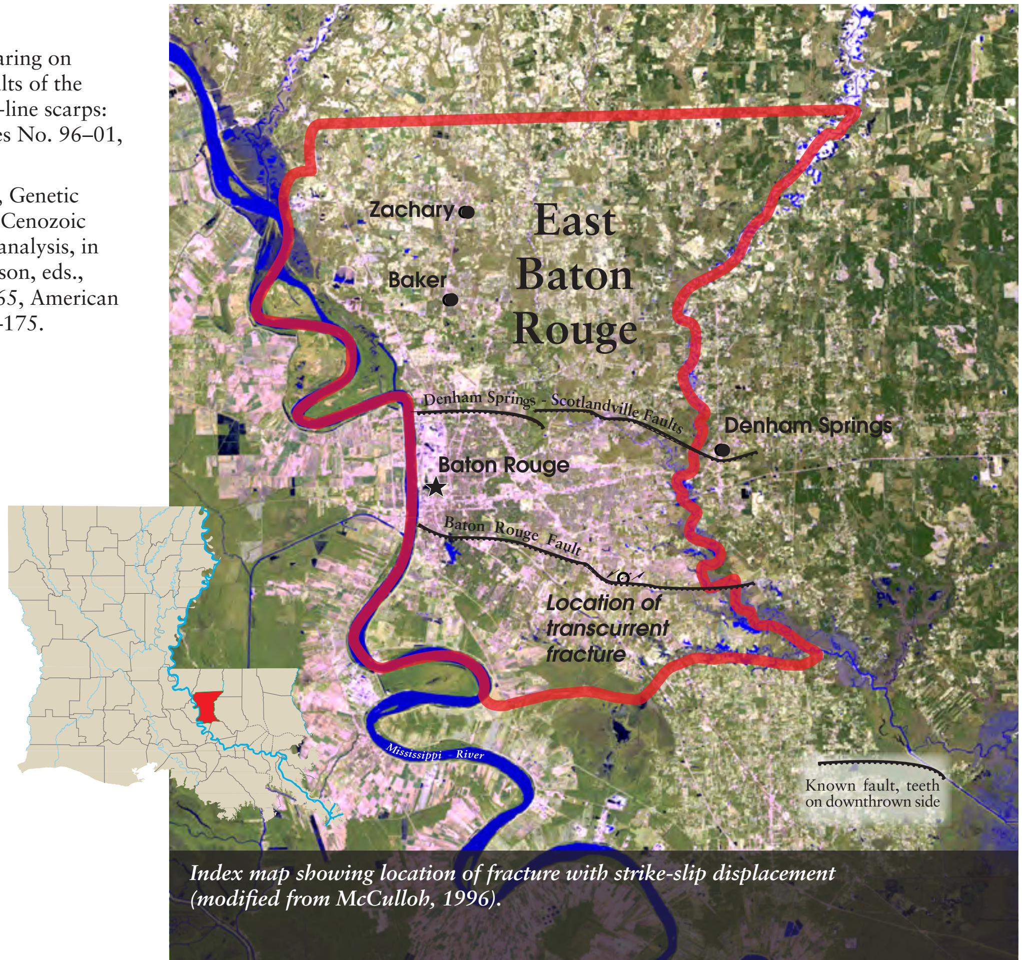
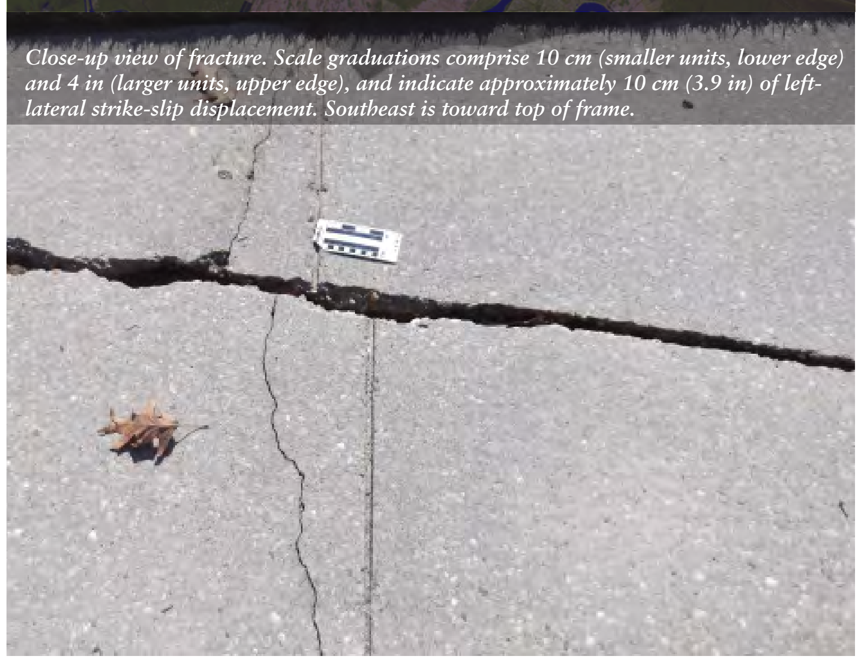


Index map showing location of fracture with strike-slip displacement (modified from McCulloh, 1996).



Close-up view of fracture. Scale graduations comprise 10 cm (smaller units, lower edge) and 4 in (larger units, upper edge), and indicate approximately 10 cm (3.9 in) of left-lateral strike-slip displacement. Southeast is toward top of frame.

Brushy Creek Impact Crater

The Brushy Creek Impact Crater identified in 1996 by LGS field mappers generates local and national interest. The Tourism Commission of St. Helena Parish is working on obtaining money to purchase the land containing the crater. They are looking into making it into a park. It also has inspired Marsha Allen Needham, a local artist, to paint a set of pictures, which she has exhibited locally. Also, T-shirts, which feature the crater, are on sale at Fred's Pharmacy, previously Curry Pharmacy, in Greensburg, Louisiana.

The Brushy Creek Crater was first observed in 1996 during the compilation of McCulloh et al (1997), which was funded by the US Geological Survey, STATEMAP program, under cooperative agreement 1434-HQ-96-AG-01490. During that research, Paul Heinrich, Richard McCulloh, and John Snead recognized it as anomalous circular depression, which can be seen in 7.5-minute USGS topographic mapping. It was not until early 2001, when new owners purchased the land containing the Brushy Creek crater, that permission was obtained to visit and conduct research on it. During 2002, petrographic analysis of samples from the crater identified intensively fractured quartz sand; quartz sand with rectilinear fracture systems; and shocked quartz.

Brushy Creek crater is a 1.2 mi (1.9 km) diameter circular impact crater located within St. Helena Parish about 9.3 kilometers southwest of Greensburg, LA. It has a relief of about 49 ft (15 m) as the result of erosion since its formation and post-impact slumping of its sides. It was mapped in the field and using a digital elevation model constructed from LIDAR elevation data. This crater is a depression formed in Pliocene fluvial sands and gravels of the Citronelle Formation. The impact origin of this feature is based upon intensively fractured quartz sand; quartz sand with rectilinear fracture systems; shocked quartz with well-developed planar deformation features (PDFs) that have shock-characteristic planar orientations; and deformation observed in an exposure of its rim (Heinrich 2003a, 2003b; King and Pertuny 2008).

The LGS is still involved in studying the Brushy Creek crater. This research includes conducting a magnetic survey of its area, further searches for meteorite fragments within the area adjacent to it, investigation of a possible secondary crater, and dating it by Optically Stimulated Luminescence techniques.

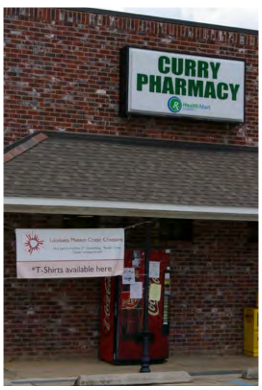
References

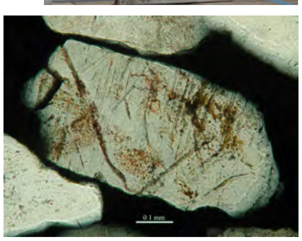
Heinrich, P. V., 2003a, Origin of a circular depression and associated fractured and shocked quartz, St. Helena parish, Louisiana. Gulf Coast Association of Geological Societies Transactions. vol. 53, pp. 313-322.

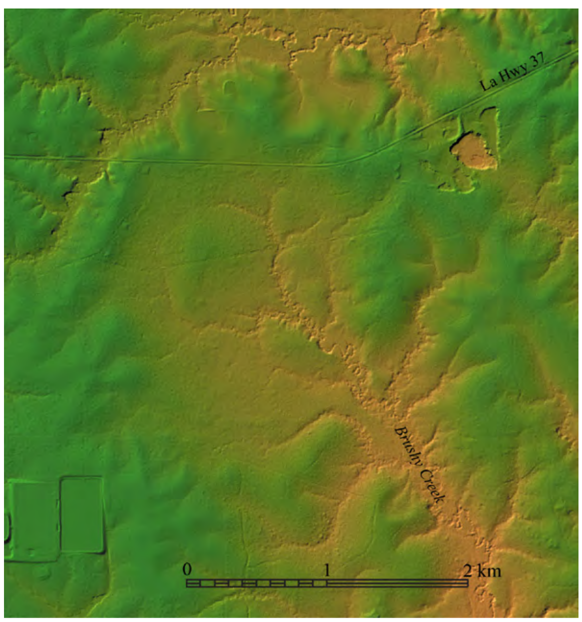
Heinrich, P. V., 2003b, Possible meteorite crater in St. Helena Parish, Louisiana. Louisiana Geological Survey News, Insights vol. 13, no. 1, pp. 3-5.

King, D. T., Jr. and L. W. Petruny, 2008, Impact stratigraphy of the US Gulf Coastal states. Gulf Coast Association of Geological Societies Transactions. vol. 58, pp. 503-516.

McCulloh, R. P., P. V. Heinrich, and J. Snead, compilers, 1997, Amite, Louisiana 30 x 60 minute geologic quadrangle (preliminary). Prepared in cooperation with US Geological Survey, STATEMAP program, under cooperative agreement no. 1434-HQ-96-AG-01490, 1:100,000-scale map plus explanation and notes.







Brushy Creek LIDAR – Colored relief map of Brushy Creek crater. Created with Global Mapper 10.3 using LIDAR (LIght Detection and Ranging) digital elevation model (DEM) of the southwest quarter of the Greensburg 7.5-minute quadrangle. LIDAR data downloaded from the Atlas: The Louisiana Statewide GIS website at http://atlas.lsu.edu .

Shocked Quartz Brushy Creek – Grain of shocked quartz in petrographic thin section of sample from alluvium of Brushy Creek (location 16SAPA). It exhibits two sets of planar deformation features (PDFs) at orientations of 1012 and 1013. Note dissolution of quartz grain and accumulation of iron oxides along PDFs. Viewed in polarized light.

Contracts/Grants

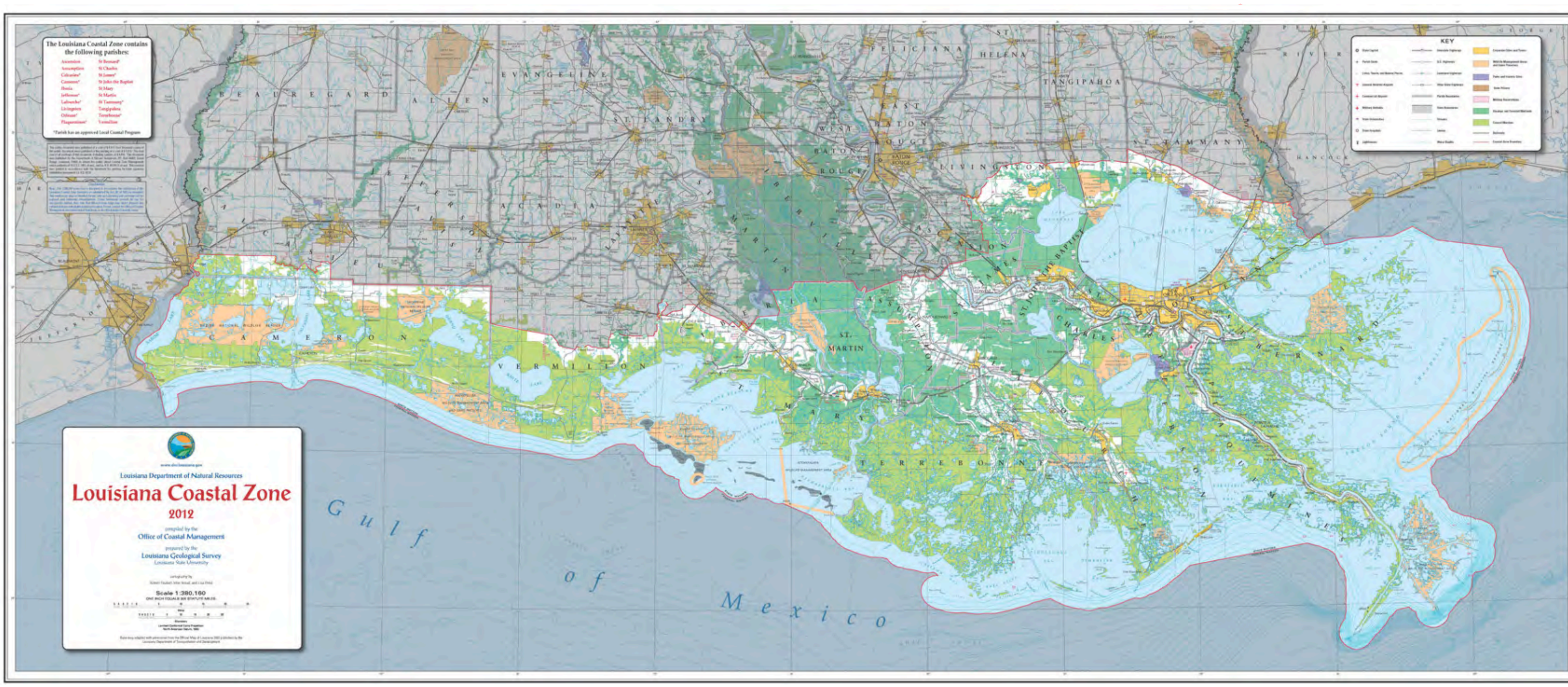
Late Quaternary Stream and Estuarine Systems to Holocene Sea Level Rise on the OCS Louisiana and Mississippi: Preservation Potential of Prehistoric Cultural Resources and Sand Resources

The Louisiana Geological Survey has entered a cooperative agreement from the Bureau of Ocean Energy Management (BOEM), Bureau of Safety and Environmental Enforcement (BSEE) to investigate possible sand resources and possible archeological sites in the Louisiana state waters in the Outer Continental Shelf. "Late Quaternary Stream and Estuarine Systems to Holocene Sea Level Rise on the OCS Louisiana and Mississippi: Preservation Potential of Prehistoric Cultural Resources and Sand Resources" is a two year $450,669.00 (obligated amount $225,000.00 for year 1) project with Paul Heinrich as Principal Investigator. The project will examine responses of late quaternary stream and estuarine systems to Holocene sea level rise. The objectives of the study are to develop a geophysical and geologic database for the study area, to develop geologic/stratigraphic models, develop a predictive model for paleo-landscape preservation potential, and to evaluate sand resources of paleo-fluvial channel fills within the study area. An understanding of these processes can result in the evaluation and refinement of models used to predict cultural and non fuel mineral resources within deltaic environments. A fully functional Geographic Information System (GIS) will be developed from all collected geospatial data. These data will be archived with the National Oceanographic Data Center (NODC) and the National Environmental Satellite, Data, and Information Service (NESDIS). The project is expected to be complete by September 30, 2014.

Map of Southwest Louisiana study area, indicated by purple line. Excerpt from Official Map of Louisiana, Louisiana Department of Transportation and Development.

Louisiana Coastal Zone Map

The Louisiana Geological Survey Cartographic Section, was awarded a contract with the Louisiana Department of Natural Resources, Office of Coastal Management, to update the Louisiana Coastal Zone Map. Act No. 588 of House Bill No. 656 Regular Session 2012, enacts R.S. 49:214.34(C). "... to redraw the coastal zone boundary; to provide relative to determination of fastlands within the coastal zone; to provide relative to required coastal use permits within the coastal zone; and to provide for related matters." The map was carefully prepared by LGS cartographers. 4,000 copies have been produced. Maps can be ordered through the LaDNR, Office of Coastal Management http://dnr.louisiana.gov.



LGS Publications

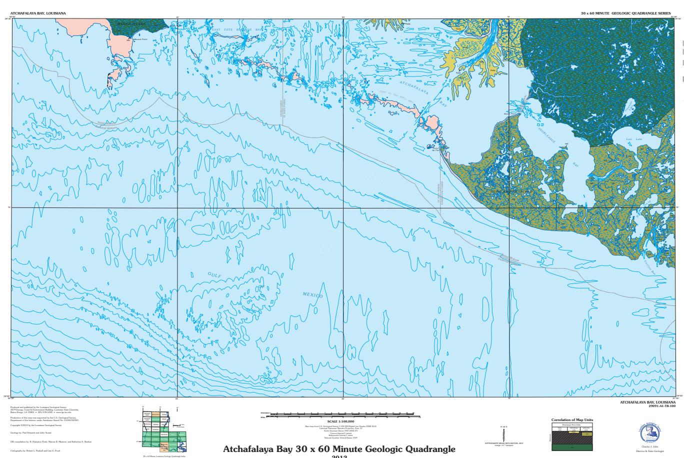
Geologic Quadrangle Maps (1:100,000)

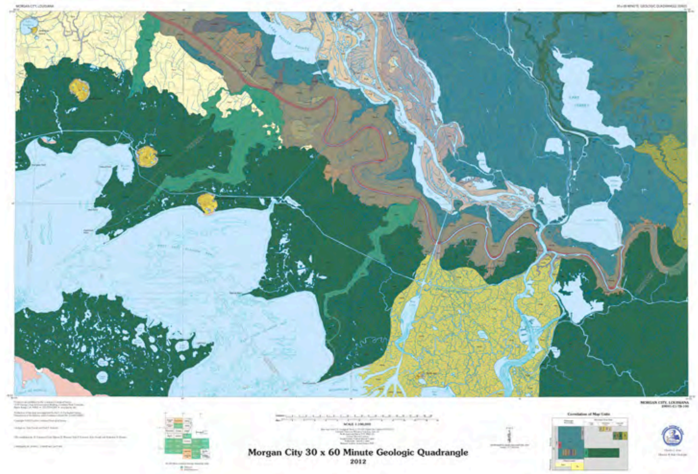
The LGS geologic quadrangle maps describe and illustrate the surface geology of the Atchafalaya Bay, Morgan City and Monroe North quadrangles. The colorful 28”x 46” maps, identify the various surface geologic formations and their composition, and the locations of fault lines and waterways. In addition to rendering the geologic framework of the surface of these areas, the maps can serve as a potential guide to derivative engineering properties of surface materials, such as in connection with the design and construction of flood-protection structures. The 30 x 60 minute geologic quadrangle maps are at 1:100,000 scale.

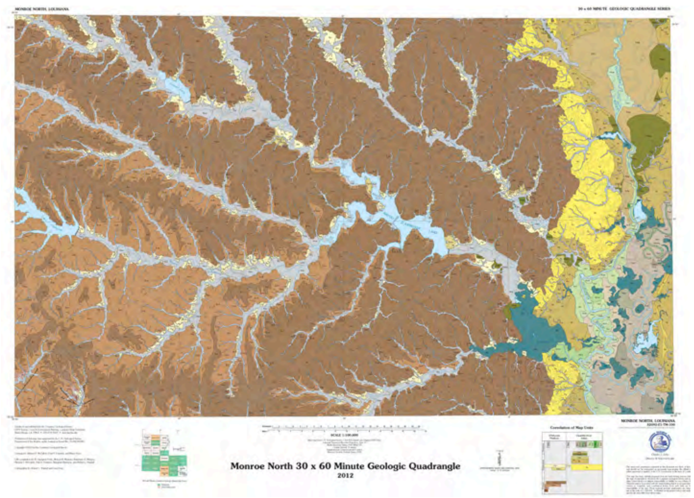
The Atchafalaya Bay Geologic Quadrangle, by Heinrich, P. V. and John Snead, 2012, 28 X 48 in. Scale = 1:100,000. Multicolored. Describes and illustrates the surficial geology of the Atchafalaya Bay quadrangle.

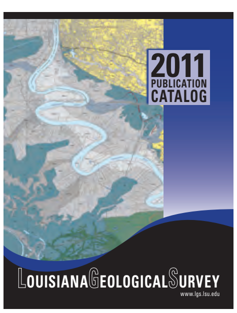
The Morgan City Geologic Quadrangle, by Snead, John and P. V. Heinrich, 2012, 28 X 48 in. Scale = 1:100,000. Multicolored. Describes and illustrates the surficial geology of the Morgan City quadrangle.

The Monroe North Geologic Quadrangle, by McCulloh, R. P., P. V. Heinrich and Marty Horn, 2012, 28 X 48 in. Scale = 1:100,000. Multicolored. Describes and illustrates the surficial geology of the Monroe North quadrangle.









La. Geological Survey’s Publication Catalog Available Online

The collection features some of the Survey’s earliest geological reports, including an overview of mineral resources and topography dating back to 1869, available for viewing only at the LSU Hill Memorial Library. Copies of “newer” reports, such as 1931’s “Geology of Iberia Parish", are available for order. An index provides a list of geological, mineral, and water reports and pamphlets available for Louisiana parishes. Most maps, atlases, and geological reports are available for order.

Conferences

GCAGS Convention

The 62nd Annual Gulf Coast Association of Geological Societies (GCAGS) conference was held at Austin, Texas and was hosted by the Austin Geological Society. LGS faculty and staff attended and participated in the meeting and abstracts of papers detailed below were printed in the GCAGS Transactions. LGS also had an exhibit booth displaying LGS publications which was staffed by Research Associate Riley Milner assisted by other LGS staff attending the conference.

Extended Abstracts

John, C. J., B. J. Harder, B. L. Jones, R. J. Bourgeois, and W. Schulingkamp, 2012, Potential for carbon dioxide sequestration in five fields along the Mississippi River industrial corridor in Louisiana: Gulf Coast Association of Geological Societies Transactions, v. 62, p.563-571.

Schulingkamp, W., C. J. John, B. J. Harder, and R. J. Bourgeois, 2012, A potential geopressured, geothermal area in Southwest Louisiana: Gulf Coast Association of Geological Societies Transactions, v. 62, p.609-614.

Abstracts

Carlson, D., and M. Horn, 2012, Evidence that old oil and gas fields influence chemistry of the overlying Wilcox Aquifer: Gulf Coast Association of Geological Societies Transactions, v. 62, p.675.

Carlson, D., and M. Horn, 2012, Impact of seasons, nutrient pulse, and Mississippi River flood of the spring-summer of 2011 on water quality in the Atchafalaya Basin, Louisiana: Gulf Coast Associates of Geological Societies Transactions, v. 62, p.677.

Carlson, D., M. Horn, G. Hanson, A. Lewis, and D. Soderstrom, 2012, Impact of the 2010-2011 drought on Wilcox Aquifer groundwater supply levels and water quality: Gulf Coast Association of Geological Societies Transactions, v. 62, p.679.

Hanson, G., D. Carlson, and A. Lewis, 2012, Drought of 2010-2011 causes water supply crises throughout northeastern Texas and northwestern Louisiana: Gulf Coast Association of Geological Societies Transactions, v. 62, p.723.

Johnston, J., 2012, The geologic review procedures: A regulatory intersection of energy, economics, and the environment: Gulf Coast Association of Geological Societies Transactions, v. 62, p.737.

Earth Science Week

Earth Science Week 2012 was celebrated from October 14-20, 2012. This years the focus was "Discovering Careers in the Earth Sciences". At the request of the Louisiana Geological Survey, Governor of Louisiana Bobby Jindal issued a proclamation declaring October 14-20, 2012 as Earth Science week in the State of Louisiana. Earth Science week is sponsored annually by the American Geosciences Institute (AGI) and all its member societies on behalf of the geoscience community. More information about AGI and Earth Science week can be found on their websites (www.agiweb.org and www.earthscienceweek.org).

United States of America
State of Louisiana
Governor
Bobby Jindal

Proclamation

WHEREAS, the earth sciences are integral to the discovery development, and conserving of mineral, energy, and water resources needed for Louisiana's continuing prosperity; and

WHEREAS, the earth sciences provide the basis for and mitigating wetland loss and natural hazards such as earthquakes, floods, coastal erosion, hurricanes, landslides, droughts, and subsidence experienced from time to time in Louisiana; and

WHEREAS, the earth sciences are critical to environmental and ecological issues ranging from surface water, ground water, oil spills and air quality to waste disposal; and

WHEREAS, geological factors of resources, hazards, and environmental are vital to land management and land use decisions made in Louisiana; and

WHEREAS, the Louisiana Geological Survey, since its establishment in 1934 has served the state and its citizens with valuable and relevant earth science investigations and information.

NOW, THEREFORE, I, Bobby Jindal, Governor of the State of Louisiana, do hereby proclaim October 9 – 15, 2011, as

EARTH SCIENCE WEEK
in the State of Louisiana.

In Witness Whereof, I have hereunto set my hand officially and caused to be affixed the Great Seal of the State of Louisiana, at the Capitol, in the City of Baton Rouge, on this the 9th day of October A.D., 2011

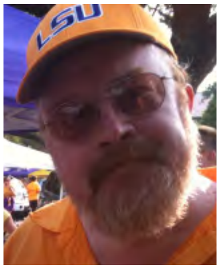
Attest By The Governor
Secretary of State

Governor of Louisiana

LGS Resource Center

The LGS Resource Center consists of a core repository and log library. It is located behind the old Graphic Services building on River Road and houses over 300 well cores from Louisiana, Mississippi, Texas, Arkansas, Alabama and Florida. Most of our cores are from the Smackover and Wilcox Formations. The core facility has more than 30,000 feet of core from wells mostly in Louisiana. The well log library contains over 50,000 well logs from various parishes in the state. The Core Lab is equipped with climate controlled layout area, microscopes, and a small trim saw. The core and log collections are included as part of the LSU Museum of Natural History as defined by the Louisiana Legislature and is the only one of its kind in Louisiana.The LGS Resource Center is available for use by industry, academia and government agencies, and others who may be interested. Viewing and sampling of cores can be arranged by calling Patrick O'Neill at 225-578-8590 or by email at poneil2@lsu.edu. Please arrange visits two weeks in advance. Daily usage fee is $300, Visa and MasterCard accepted. A list of available cores can be found at the LGS web site (www.lgs.lsu.edu).

Staff Recognition



John Snead, LGS Cartographic Manager, retired September 28 after 33 years of service. He returned to work in a part-time capacity for the Survey.

LSU Service awards for dedicated service to LGS/LSU were presented to the following staff members during the course of the year (2011).

Dr. Douglas Carlson – 10 years
Richard McCulloh – 15 years
Paul Heinrich – 15 years
Hampton Peele – 20 years
Reed Bourgeois – 20 years
John Johnston – 25 years
Dr. Chacko John – 25 years

Louisiana Geological Survey Personnel

Administrative Personnel

Chacko J. John, Ph.D., director and state geologist, professor-research
John Johnston, assistant director
Patrick O'Neill, research associate, LGS Publications Sales and Resource Center

Basin Research Energy Section

Marty Horn, assistant professor-research
Brian Harder, research associate
Warren Schulingkamp, research associate
Reed Bourgeois, computer analyst

Geological Mapping & Minerals Mapping Section

Richard McCulloh, research associate
Paul Heinrich, research associate

Water & Environmental Section

Douglas Carlson, assistant professor-research
Riley Milner, research associate

Cartographic Section

John Snead, cartographic manager
Lisa Pond, research associate
Robert Paulsell, research associate
R. Hampton Peele, research associate

Staff

Melissa Esnault, administrative coordinator
Jeanne Johnson, accounting technician

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