Louisiana Geological Survey
NewsInsights
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(Note: A color version of this issue can be viewed on the LGS website at www.lgs.lsu.edu).

LGS Celebrates 75th Anniversary

Historical Sequence of Organizational Names

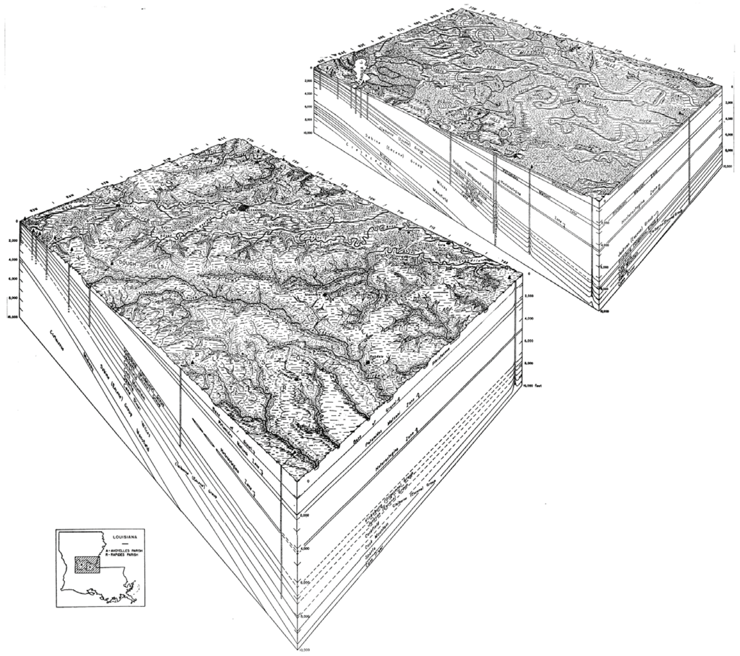
Topographical and Geological Survey of Louisiana, 1869-1872

Geological and Agricultural Survey of Louisiana, 1892-1902
Geological Survey of Louisiana, 1903-1909

Louisiana Soil and Geological Survey, 1914-1919

Bureau of Scientific Research,
Department of Conservation, 1931-1934

Louisiana Geological Survey, 1934-present
(LGS legislatively established in 1934)



TOPOGRAPHIC AND SUBSURFACE DIAGRAM OF CENTRAL LOUISIANA

Historical Sequence of Organizational Directors

Peter V. Hopkins, 1869-1872
Otto Lerch, 1892-1893
William W. Clendenin, 1894-1897
Gilbert D. Harris, 1899-1909
Frederick E. Emerson, 1914-1919
Cyril K. Moresi, 1931-1940
John Huner, Jr., 1940-1946
Paul Montgomery, 1946*
James M. Cunningham, 1946-1947*
Gerard O. Coignet, 1947*
Leo G. Hough, 1947-1977
Harry L. Roland, Jr., 1977-1978*
Charles G. Groat, 1978-1990
John E. Johnston III, 1990-1992*
William E. Marsalis, 1992-1997
Chacko J. John, 1997-present

* Acting Director and State Geologist

Organizational History

The Louisiana Geological Survey (LGS) had its beginnings in 1869, four years after the Civil War ended, when the Louisiana Legislature named Francis V. Hopkins, a Louisiana State University (LSU) professor, to be the first State Geologist. His primary assistant was Colonel Charles H. Lockett, head of LSU's Corps of Cadets. They published some of Louisiana's first geologic reports as well as the first topographical and geological maps of the state. In 1873, LSU being without funds, their pioneering work came to an end.

In 1894, LSU Professor William Clendenin was hired to continue Lerch's work. He did so for three years, publishing a number of geological, botanical and agricultural works.

In 1899, LSU hired Gilbert D. Harris of Cornell University to study the geology of the state. Until 1909 he and his assistants published numerous maps and reports. He initiated a tradition of cooperative work with the U.S. Geologic Survey that continues to the present day. Once again, a lack of funds caused the work of Harris and his staff to be discontinued.

The Louisiana Geological Survey

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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.

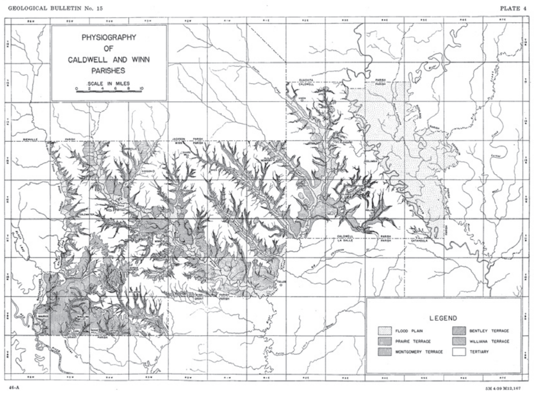
In 1913, Frederick E. Emerson came to LSU as a Professor of Geology and head of the new Louisiana Soil and Geological Survey, serving in this capacity from 1913 to 1919. Upon his death in 1919, which left LSU without a single geologist, the Survey was abolished.

In 1931 the Louisiana Legislature created the Bureau of Scientific Research of the Louisiana Department of Conservation. This unit, the immediate precursor of the modern LGS, was charged with the scientific study of the natural resources of the state and with the compilation of the resulting data. Cyril Moresi was named as head of this research unit, and he was assisted in his tasks by H.V. Howe, head of the LSU School of Geology.

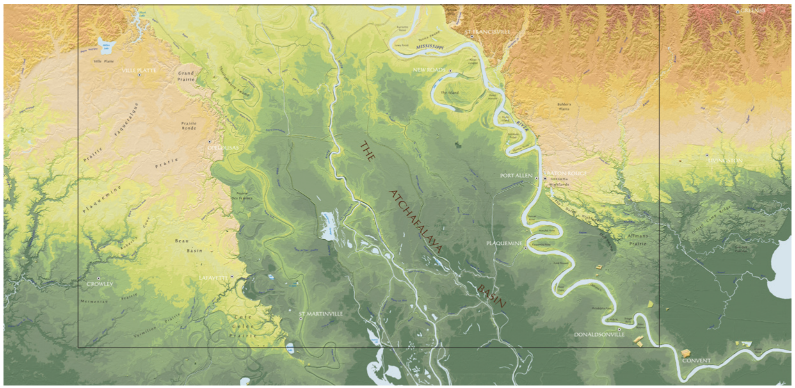
In 1934, the Louisiana Legislature created the Louisiana Geological Survey, naming Moresi as its first head. Over the next several years, the LGS, headquartered in the Geology Building at LSU, began extensive mapping and research work in Louisiana. The LGS staff included such well-known researchers as Dana Russell, Fred Kniffen, Benjamin Craft, Richard Russell, Harold Fisk, and H.V. Howe.

In 1940 Moresi was removed from office when LSU was reorganized. He was replaced by John Huner, Jr., who instituted a new system of state districts, each with its own district geologist. Huner left the LGS in 1946; after his departure there was a brief period of administrative turmoil. His successor, Paul Montgomery, left the LGS eight months later to join the oil industry, and Montgomery's successor, James M. Cunningham, left the LGS to do the same thing seven months after that. Following Cunningham's departure, an LGS cartographer, Gerald Coignet, served as head for three months until some stability could be established.

The turmoil led to the appointment in 1947 of the longest-serving head of the LGS, Leo W. Hough, who had been a geologist with the Louisiana Highway Department. From 1947 to 1973, under Hough's leadership, the LGS compiled a great many



Louisiana Shoreline Change 1937-2000



geologic maps and reports while serving as both the geological research arm of the state and as its geologic oil and gas regulatory arm. In 1973, the oil and gas component of the LGS, complete with its staff, became the Geologic Division of the Louisiana Department of Conservation. In 1977, Hough retired after thirty years of service as the head of the LGS.

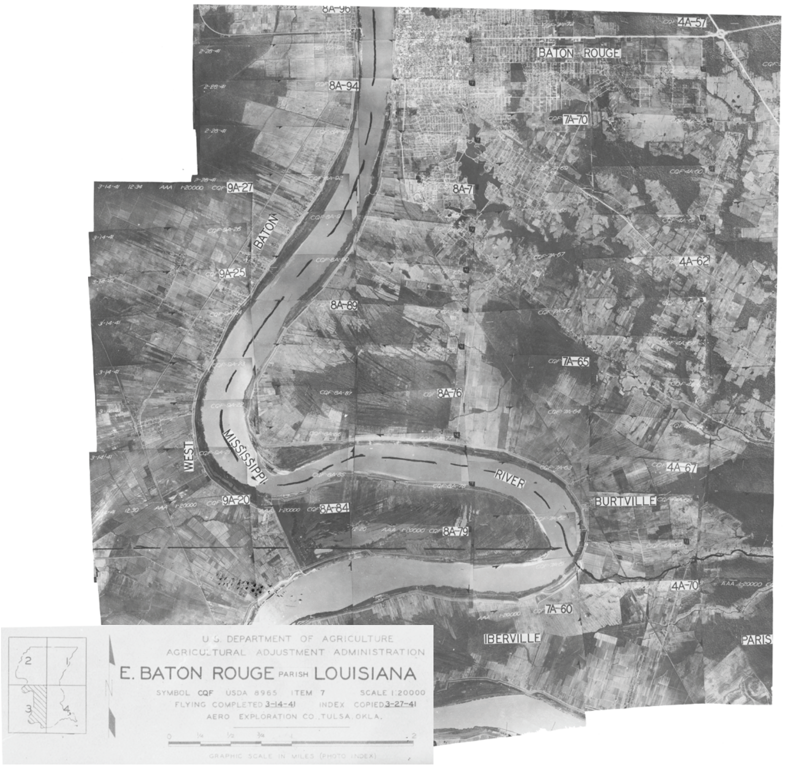
Upon Hough's retirement, his assistant Harry L. Roland Jr., served as the temporary organizational head for a year while the LGS searched for a new permanent head. During this time the parent organization of the LGS changed from the Louisiana Department of Conservation to the newly created Louisiana Department of Natural Resources.

In 1979, Charles G. Groat, who was at that time the Chairman of the Geology Department of the University of Texas at El Paso and who had served as the head of the Texas Bureau of Economic Geology, was hired to lead the LGS. Groat then proceeded to hire a number of geologists from the Bureau and the University of Texas – something that gave the LGS a very distinct Texas flavor throughout the 1980's – as part of his plan to modernize the LGS. Under his leadership the LGS expanded dramatically, acquiring new staff as well as modern equipment and technology, and receiving millions of dollars in federal, state, and private grants and contracts. Groat expanded on his role as head of the LGS, serving simultaneously at various times as a junior state cabinet officer and as the head of Louisiana's Coastal Zone Management Division. Many new research and regulatory assistance programs were begun; one of these programs, the Coastal Restoration Section of the LGS, has since grown to be a major unit of state government as the Louisiana Coastal Restoration Division.

In 1990, Groat took a leave of absence from the LGS to serve as director of the American Geological Institute. Groat's assistant (and current LGS Assistant Director) John E. Johnston III served as the acting head of the LGS during the years of his absence. In 1992 Groat formally resigned from the LGS, and William E. Marsalis, the Chief Geologist of the Louisiana Office of Mineral Resources, was named to head the LGS.

In 1997, the LGS was administratively transferred by the Louisiana Legislature from the Louisiana Department of Natural Resources to Louisiana State University, where it had always been housed, and it became a unit of LSU's Office of Research and Economic Development. As Marsalis chose to remain with DNR, Chacko J. John, who had previously served as Director of Research for the LGS and was serving as head of LSU's Basin Research Institute (BRI) and LSU Research Professor, was named to head the LGS. In 2000, the BRI merged with the LGS, and became the Basin Research Energy Section of the LGS. The LGS is now housed in the Energy, Coast and Environmental Building at LSU, just south of Tiger Stadium, the home of LSU's Fighting Tigers.

(Modified from : D.E. Pope, 1988, Louisiana, p. 177-198 in A.A. Socolew, Editor, The State Geological Surveys - A History: Association of American State Geologists, 499 p. and the LGS website www.lgs.lsu.edu).



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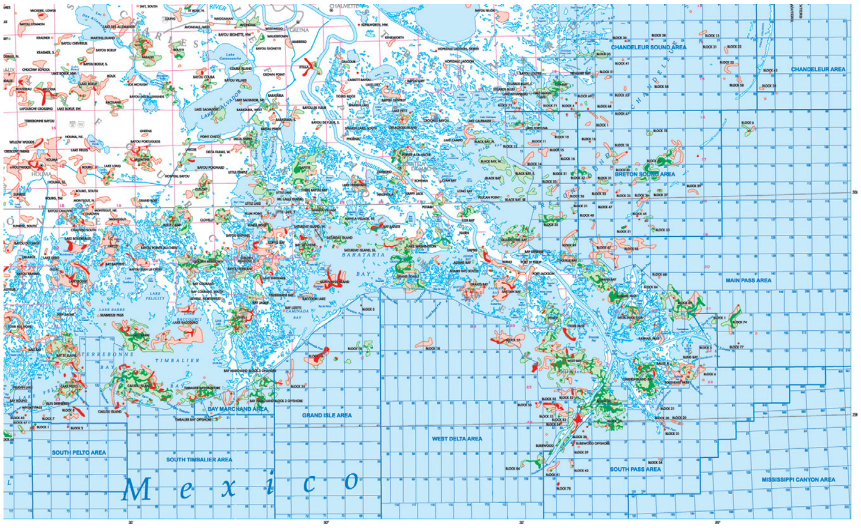

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Energy, Coast and Environmental Building at LSU.

LIDAR Imagery and Geologic Mapping in Louisiana and Similar Humid-Subtropical and Coastal-Plain Regions

Richard P. McCulloh and Paul V. Heinrich

INTRODUCTION

The landscape of Louisiana presents a particular suite of difficulties to the conduct of the field work essential to geologic mapping. Some of these are difficulties that affect areas across much of the U.S., e.g., the problems of access generally that have increased over the last several decades owing to (1) partitioning of land into ever smaller parcels with different owners via multiple heirs to successions, (2) control of access to larger areas by timber companies and hunting clubs, and (3) overprinting of the natural terrain by encroaching development in urbanizing areas. Other difficulties that derive from Louisiana's coastal-plain setting and humid-subtropical climate comprise widespread and locally thick (>6.6 ft or 2 m) surficial deposits, extensive soil development, and dense vegetation, such that exposures tend to be scarce, and those that do occur tend to be ephemeral (Figure 1). Although road cuts probably are the most common exposures in the state, Harold V. Andersen, who accumulated nearly a half century of geologic-mapping experience in Louisiana, observed that "almost all outcrops along highways are ephemeral" (Andersen, 1993, p. 63).

As a result of the obscuring effects of these intrinsic aspects of climate and geologic setting, aerial photography, which has been a standard tool for geologic mapping generally since the 1930s, is of very limited use to geologic-mapping efforts in this setting. The same obscuring effects limit the effectiveness for geologic mapping of many newer satellite-borne remote-sensing techniques as well.

Since the late 1990s, the LIDAR imagery increasingly available for parts of Louisiana has developed into the basis of a new and more effective remote-sensing tool for geologic-mapping applications. The vertical instrumental precision of these LIDAR-based digital elevation models (DEMs) is listed in the metadata as 0.01 ft (0.003 m); their effective vertical precision following corrections for vegetation is approximately 0.1 ft (0.03 m) according to 3001, Inc. (New Orleans), which flew the LIDAR. In low-relief coastal-plain regions, wherever access restrictions create a need to project geologic map units from adjacent areas that have yielded more ground truth, imagery with such vertical detail generally permits much more confident projection and interpolation than older kinds of imagery. In Louisiana specifically, such increased precision in the perception of geomorphic attributes has great utility because (1) Pliocene and Quaternary strata here show progressive incision of older units by younger units, and (2) in south Louisiana at least, reactivated surface faults, many with small surface displacements (≤6.6 ft or 2 m) scarcely perceptible on standard U.S. Geological Survey topographic quadrangles with a contour interval of 5 ft (1.5 m), show up with unprecedented clarity at effective vertical resolutions of less than 1 ft (0.3 m).

EXAMPLES

Figures 2–5 offer comparisons for several 7.5-minute quarter-quadrangle areas of views of standard DEMs and LIDAR DEMs, with the LIDAR permitting increased discrimination of fine terrain detail, some of which is pertinent to recognition criteria for surface-geologic mapping tasks.

Clearly, this enhanced topographic (and hence geomorphic) detail afforded by LIDAR imagery relative to standard 7.5-minute topography in the figured areas enables a more-detailed interpretation and delineation of the surface geology than was possible before. LIDAR imagery is extremely useful in geologic mapping of the Quaternary units predominant in Louisiana because it provides a detailed and uniform view of the morphology of their surfaces. As a result, it is relatively easy to observe and compare the degree of degradation of the construction landforms, i.e., natural levees, relict channels, beach ridges, ridge-and-swale topography, and so forth, that their terraces might exhibit and the degree that these terraces have been dissected by erosion. These observations, which can be used to infer relative age and correlate terraces and their underlying depositional units, are often difficult to make using other imagery because temporal and areal variations in moisture content of soils, vegetation, land use, and other factors drastically change how well construction landforms can be seen. Differences in the contour intervals between adjoining topographic maps also can make comparison of the degree of dissection of terraces by erosion difficult if not impossible. Such differences and variations are absent from LIDAR imagery, which together with the enhanced detail it affords greatly facilitate the perception, discrimination, and interpretation of the *meaningful* differences in the surfaces of Quaternary geologic map units, i.e., those considered diagnostic of them. This experience echoes that chronicled by Haugerud and others (2003) for the mapping of geologic hazards in the Puget Lowland of Washington state.

While this voluminous LIDAR-based surface detail can "cut both ways" in certain geologic-mapping contexts by obscuring and overwhelming the limited number of surface criteria that bear on a geologic issue or problem being interpreted (McCulloh, 2005), as a rule the much-improved resolution of the surface readily facilitates an improved and refined interpretation of its exposed geology.

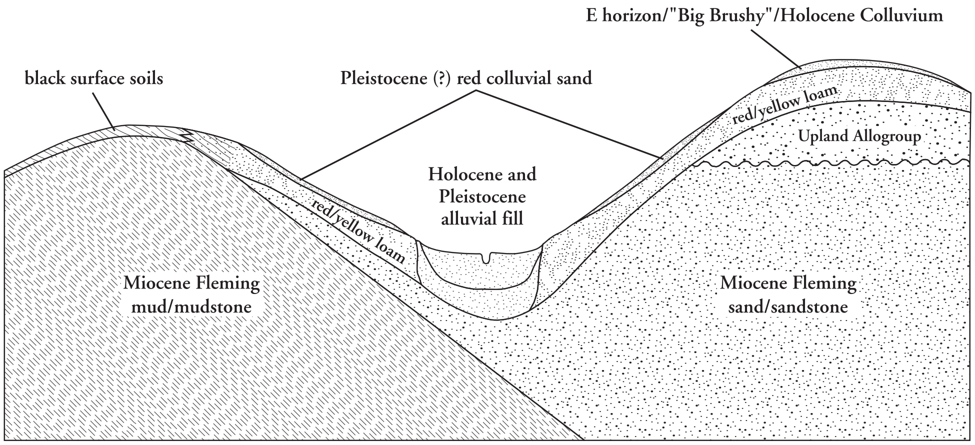

***Figure 1.** Over much of Louisiana the "bedrock" geology is mantled by widespread and locally thick surficial deposits and by extensive soil development, which in combination with dense vegetation effectively obscures and conceals the units of interest to geologic-mapping efforts. In this schematic cross-sectional diagram of a representative portion of the surface and shallow subsurface of the Fort Polk region in west-central Louisiana, the Upland allogroup (Pliocene) and the two Miocene units are the bedrock units of geologic interest. In the natural landscape they are covered nearly uniformly by surficial materials developed in place (from McCulloh and Heinrich, 2002, their figure 5).*

CONCLUSION

Following its debut in Louisiana in the late 1990s LIDAR quickly became a boon to geologic-mapping efforts, and in the ensuing decade it has become an essential tool for geologic mapping because aspects of the geologic and climatic setting in this humid-subtropical coastal-plain region compromise the effectiveness of most other remote-sensing techniques in geologic-mapping applications. Although in some instances the wealth of terrain detail afforded by LIDAR may overwhelm the particular criteria employed to resolve a geologic-mapping problem and initially complicate its resolution, generally speaking the availability of LIDAR imagery makes possible a great degree of improvement and refinement of geologic interpretation. Where it is available in other humid-subtropical and coastal-plain regions, LIDAR imagery is likely to prove similarly useful and essential for geologic mapping.

ACKNOWLEDGMENTS

Investigation of the surface geology of the Bon Wier 7.5-minute quadrangle (Figure 3) was conducted for a project supported by the U.S. Geological Survey (USGS), STATEMAP program, in fiscal year 1994 under cooperative agreement number 1434-94-A-1233. Investigations of the surface geology of the Brimstone 7.5-minute quadrangle (Figure 2), Greensburg 7.5-minute quadrangle (Figure 5), and Madisonville 7.5-minute quadrangle (Figure 4) were conducted for a STATEMAP project supported by the USGS in fiscal year 1996 under cooperative agreement number 1434-HQ-96-AG-01490. Both of the above projects were conducted prior to LIDAR availability. A subsequent and more detailed investigation of the surface geology of the Greensburg 7.5-minute quadrangle that utilized LIDAR

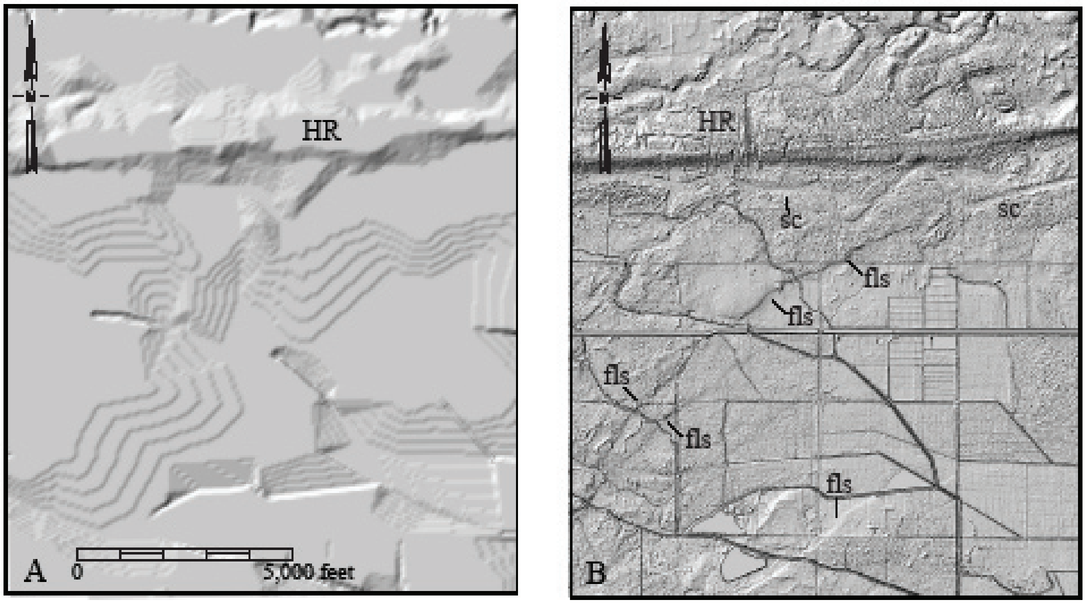

Figure 2. Southwest quarter of the Brimstone 7.5-minute quadrangle, Calcasieu Parish, Louisiana. Left, A, relief map made from 30 meter DEM derived from 1:24,000 topographic map. Right, B, relief map made from 5 meter LIDAR DEM. Both relief maps have 15X exaggeration. fls = fault-line scarp; HR = Houston Ridge; and sc = relict stream channel.

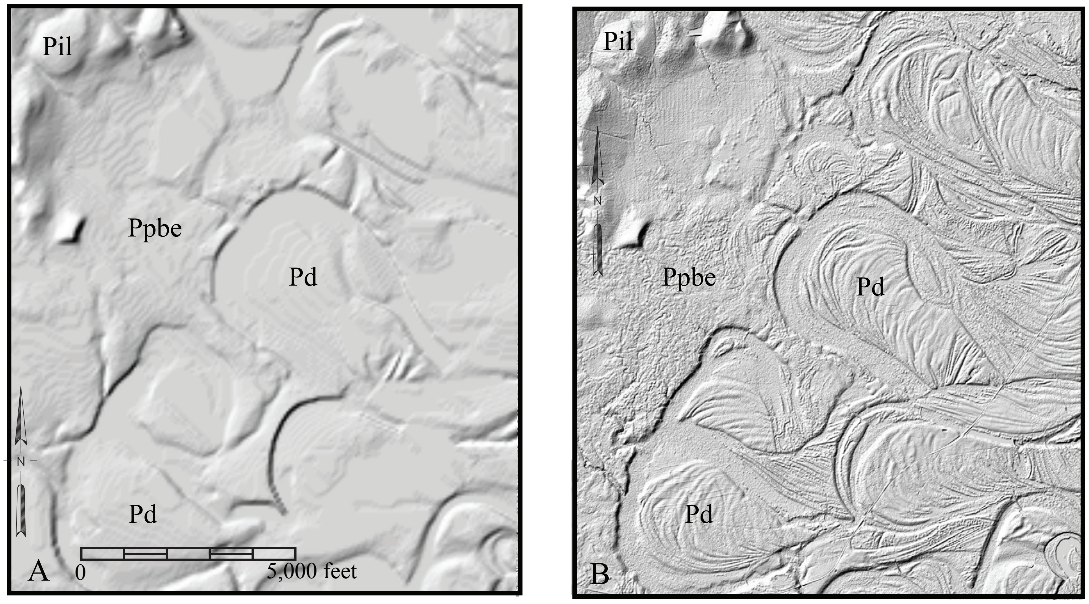

Figure 3. Southwest quarter of the Bon Wier 7.5-minute quadrangle, Jasper County, Texas, and Beauregard Parish, Louisiana. Left, A, relief map made from 30 meter DEM derived from 1:24,000 topographic map. Right, B, relief map made from 5 meter LIDAR DEM. Both relief maps have 15X exaggeration. Pil = Lissie Alloformation (Formation); Ppbe = Beaumont Alloformation (Formation), and Pd = Deweyville Allogroup (Group).

imagery was conducted for a STATEMAP project supported by the USGS in fiscal year 2007 under cooperative agreement number 07HQAG0137.

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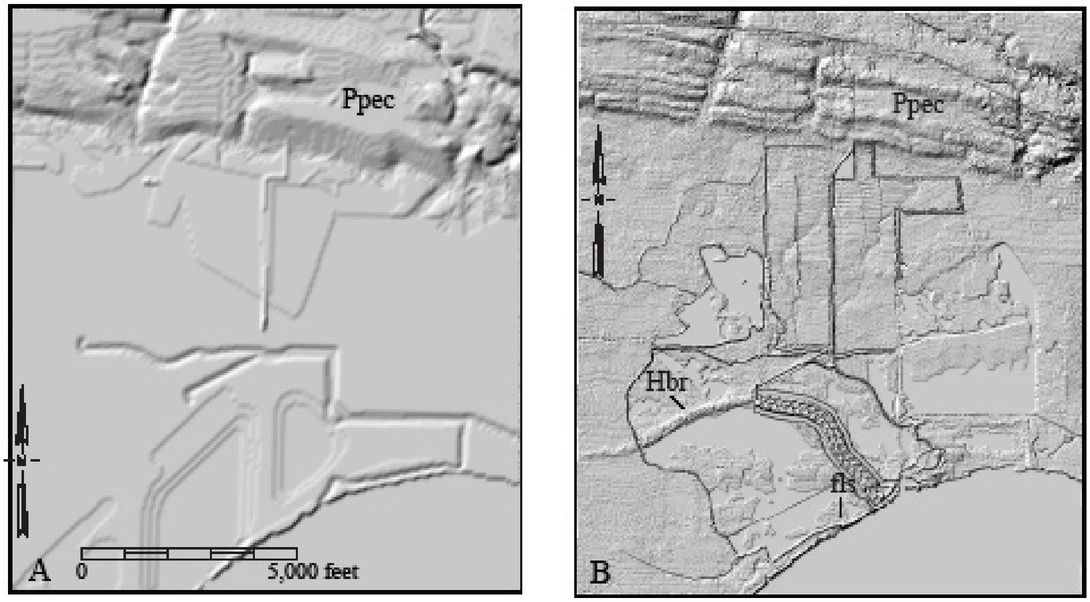
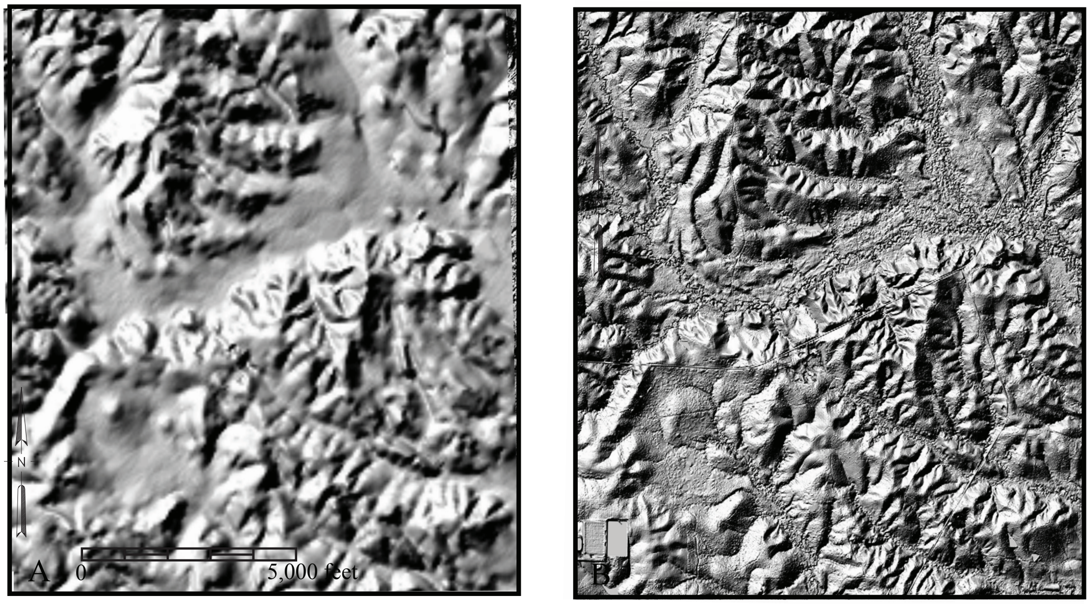


Figure 4. Southwest quarter of the Madisonville 7.5-minute quadrangle, St. Tammany and Tangipahoa parishes, Louisiana. Left, A, relief map made from 30 meter DEM derived from 1:24,000 topographic map. Right, B, relief map made from 5 meter LIDAR DEM. Both relief maps have 15X exaggeration. Ppec = relict Pleistocene coastal ridges (Ponchatoula strandplain) and Hbr = Holocene beach ridge (Miltons Island trend).



5. Southwest quarter of the Greensburg 7.5-minute quadrangle, St. Helena Parish, Louisiana. Left, A, relief map made from 30 meter DEM derived from 1:24,000 topographic map. Right, B, relief map made from 5 meter LIDAR DEM. Both relief maps have 15X exaggeration. Brushy Creek crater lies in southwest corner of figures.

A Paleochannel Palimpsest within Spanish Lake Area, Southeast Louisiana, and its Archaeological Significance

Paul V. Heinrich

INTRODUCTION

Historians first used term "palimpsest" to refer to a manuscript page typically parchment and from either scroll or book which has been written on, scraped off, and reused for writing on again. Frequently, the scraping only partially erased the earlier writing, which may re-emerge as the newer writing fades. In terms of landscapes, geologists and geomorphologists use this term to describe landforms in which previous processes and stages of development can be recognized (Bloom, 1991, Jackson, 1997). In the case of the alluvial valleys of the Mississippi, Ouachita, and Red rivers, the palimpsests are landforms, not related to the active accumulation of sediments within the modern backswamp but are inherited from buried alluvial surfaces at depth. Much like literary palimpsests, the geomorphic palimpsest is a complex assemblage of older features buried and overprinted by younger ones. This article discusses a prominent and potentially archaeologically significant palimpsest that was mapped by Heinrich and Autin (2000) within a backswamp occupied in part by Spanish Lake just south of Baton Rouge, Louisiana.

SPANISH LAKE AREA

At this time, the Spanish Lake area is a small isolated patch of cypress-dominated floodplain located in Ascension, East Baton Rouge, and Iberville parishes about 13 miles (22 km) southeast of Baton Rouge, Louisiana (Figure 1). This area lies east of the Mississippi River. It ranges in elevation from just below 5 feet (1.5 meters) above mean sea level adjacent to the eastern valley wall of the Mississippi River alluvial valley to about 10 feet (3 meters) above mean sea level where it merges with the natural levees of the Mississippi River. This segment of Mississippi River floodplain is flooded naturally by floodwaters of the Mississippi River during the months of March, April, and May. These floodwaters enter this area through Bayou Manchac, a distributary, with distinct natural levees, of the Mississippi River. During non-flood periods, Bayou Manchac drains the floodplain in which Spanish Lake is located (Reese and Liu, 2001).

Geotechnical and lithologic logs of geotechnical borings (Louisiana Department of Transportation and Development Office of Highways 1981) drilled just southwest of Little Fountain Bayou in East Baton Rouge Parish indicate that the surface of this isolated patch of floodplain adjacent to the eastern valley wall of the Mississippi alluvial valley is underlain by over 95 feet (29 m) of grey clay. This grey clay contains wood fragments, organic matter, and uncommon beds of silty clay, silty loam, and interlaminated silt and sand. Since none of these boring completely penetrate the Holocene backswamp and natural levee sediments, the full thickness of sediments underlying the surface of this patch of floodplain is unknown. An excavation for a pond examined by the author in an area adjacent to the BREC Burbank Soccer Complex revealed a buried cypress forest lying beneath the distal natural levee deposits of Mississippi River meander belt no. 1 (Figure 2). Individual stumps of this undated buried cypress forest were just over 5 feet (1.5 m) high.

SPANISH LAKE PALEOCHANNEL

Heinrich and Autin (2000) mapped a well-defined 6 km (10 mile) long fluvial palimpsest which lies within an isolated patch of floodplain containing Spanish Lake and Bluff Swamp south of Baton Rouge, Louisiana (Figure 1). It is a dark, sinuous tonal pattern and depression which meanders southeastward across the floodplain from southernmost East Baton Rouge Parish, through the northeast corner of Iberville Parish, and into northwest Ascension Parish (Figure 3). This sinuous channel-like feature wraps around Spanish Lake (Figure 1). Within Ascension Parish, it disappears beneath Mississippi River crevasse distributaries in the northeast corner of Sec. 20, T.9S., R.2E. LIght Detection And Ranging (LIDAR) digital elevation models (DEMs) show that the ghost channel continues as a sinuous depression westward, from its northwest end of the sinuous tonal in southernmost East Baton Rouge Parish, for a few more miles before crossing into and disappearing beneath the edge of the natural levee of the Mississippi River.

The sinuous tonal feature is interpreted to be the palimpsest of a paleochannel of a relict river course buried beneath backswamp and natural levee sediments that form the modern surface of this isolated patch of floodplain. It exhibits a broad simple symmetrical meandering pattern with a wavelength of 1.8 to 4.3 miles (3 to 7 km) and amplitude of 1.8 to 2.1 miles (3 to 3.5 km). The radius of curvature of the meanders of this apparent relict river course ranges from 1300 to 2300 feet (400 to 700 meters). As measured from LIDAR DEMs, these dark channel-like tonals generally lie about 0.6 to 3 feet (0.2 to 1 m) below the level of the adjacent backswamp and range 100 to 400 feet (30 to 120 m) in width. Based upon its morphology, the tonal pattern and associated depression it is hypothesized to be a palimpsest of a prehistoric abandoned river course. This depression is not the actual river course. Instead it is hypothesized to be a depression within the surface of the floodplain caused by the compaction of fine-grained sediments filling the channel of a buried course of a long abandoned prehistoric river (Figure 4).

The size of the amplitude and radius of curvature of the meanders of this paleochannel indicates that it would have had a large discharge and drained a significant portion of the Mississippi alluvial valley. Thus, it was not a local drainage, but most likely part of a prehistoric river that flowed southward along the eastern wall of the Mississippi alluvial valley for an unknown distance before it either emptied into either the Gulf of Mexico or another river. It would have drained both backswamps within the Mississippi River alluvial valley and drainages entering it from the east. This hypothetical river is analogous to the hypothetical Middle Holocene course of the Homochitto River shown in Plate 28, Sheet 3 of Saucier (1994). However, the presence of this buried abandoned river course south of Baton Rouge indicates that the Middle Holocene embayment of the Gulf of Mexico had been filled by alluvial sediments farther south during the Middle Holocene than shown in Plate 28, Sheet 3 of Saucier (1994).

AGE

The age of this buried prehistoric paleochannel is constrained within this part of the Mississippi River Alluvial Valley. The lack of any sediment indicative of adjacent fluvial channel in the cores of Reese and Liu (2001) suggests that this paleochannel is certainly older than 900 BP C14. It also definitely predates the occupation of Mississippi River Meander Belt no. 1, which is argued to have occupied it present course adjacent the eastern valley at Baton Rouge, Louisiana, about 4,500 BP C14 (Saucier, 1994). This paleochannel post-dates 5,400 BP C14, the age of a natural *Rangia* bed that was dated by Weistein (1994) and indicates brackish water conditions associated with the flooding of this part of the Mississippi River Alluvial Valley by the Gulf of Mexico as the result of rising sea levels (Saucier, 1994).

POSSIBLE ARCHAEOLOGICAL ASSOCIATIONS

As illustrated in Weinstein (1994), the Lee Site (16EBR51) lies on the edge of the Mississippi River Alluvial Valley wall adjacent to where this paleochannel is closest. Although the Lee Site was occupied

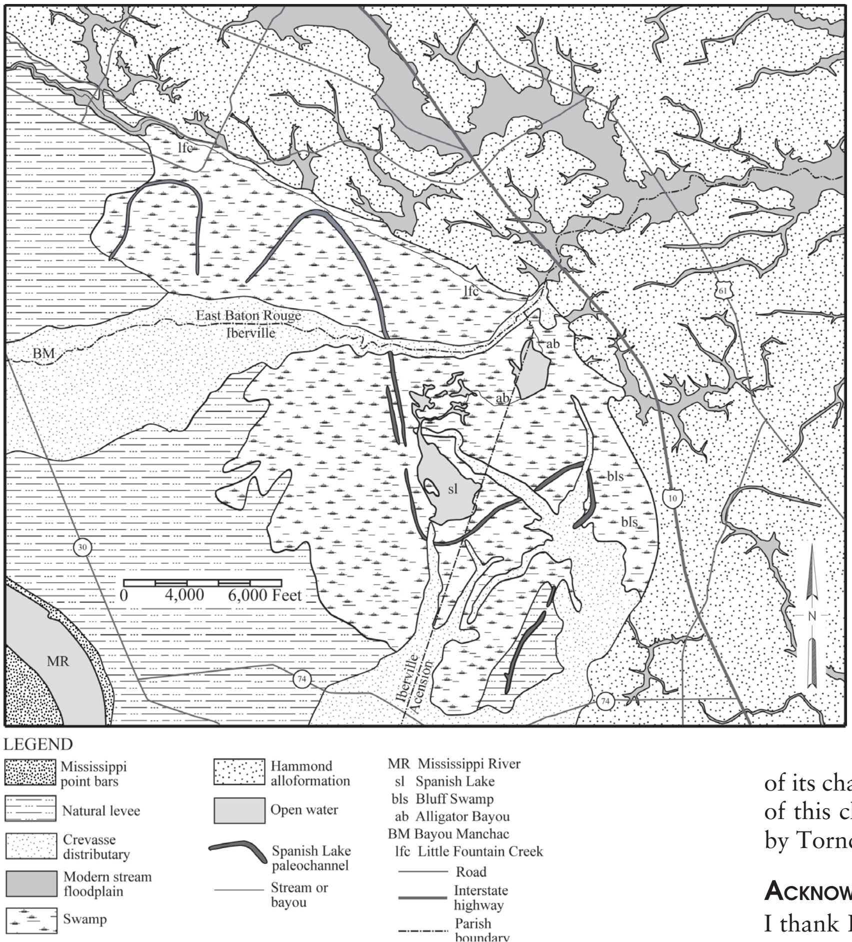


Figure 1. *Geomorphic map of the Spanish Lake area.*

from 2,200 to 900 BP C14 (Weinstein, 1994), which is long after the paleochannel was reduced to an abandoned course segment by the destruction of the majority of its course by the formation of Mississippi River Meander Belt no. 1, this proximity suggests a relationship between the abandoned paleochannel and the site location. Possibly, this abandoned course segment was still an open navigable bayou between 2,200 and 900 BP C14, which the prehistoric inhabitants of the Lee Site could have used for transportation and subsistence.

It is a curious that the hypothesized river, of which the Spanish Lake paleochannel was a part, along the eastern side of the Mississippi River Valley and the LSU Mounds Site (16EBR6) and the Archaic mound at the Monte Sano Site (16EBR17) are contemporaneous in time (Homberg, 1991, 1993). Such a river would have provided a readily navigable waterway for transportation and subsistence for the inhabitants during the period these sites were utilized. Quite possibly, the locations of each site, like the much younger Lee Site, represent locations where the course of a river, which was destroyed by the development of Mississippi River meander belt no. 1, was closest to eastern valley wall of the Mississippi River Alluvial Valley.

SUMMARY

An isolated patch of floodplain, in which Spanish Lake lies, contains a well-defined, narrow sinuous tonal feature and depression. This feature is interpreted as a fluvial palimpsest created by the subsidence of the floodplain surface as the result of the compaction of fine-grained sediment filling a buried abandoned river course. The location and geomorphology of the of this paleochannel indicates that it was part of a prehistoric river that flowed along the eastern valley wall of the Mississippi Alluvial Valley around 5,400 to 4,500 BP C14 as postulated by Saucier (1994). The existence of the Spanish Lake paleochannel and the prehistoric river of which it might have been a part has implications for subsistence patterns associated with and the site locations of the Lee Site (16EBR51), LSU Mounds Site (16EBR6), and Monte Sano Site (16EBR17).

FUTURE RESEARCH

Within the segment of floodplain, in which Spanish Lake lies, there is one location where the nature and age of the hypothesized paleochannel underlie it can be readily verified and dated. This location is where natural levees of Bayou Manchac provide relatively dry and stable ground at which coring can be conducted. Given the lack of channel meandering by Bayou Manchac, its natural levees should extend out over sediments undisturbed by the growth and entrenchment of Bayou Manchac as it developed as a major distributary channel of the Mississippi River. On the distal edges of the natural levees of Bayou Manchac, it should be possible to recover cores through its natural levees and through the buried channel fill and natural levees of the hypothesized Spanish Lake paleochannel. The sediments recovered in such cores would either prove or disprove the existence of this hypothesized paleochannel. Radiocarbon dating of organically-rich sediment recovered from the base of its channel and just beneath and above the natural levee deposits of this channel would determine its period of activity as discussed by Tornqvist and Van Dijk (1993).

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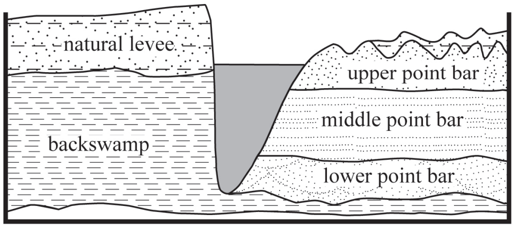
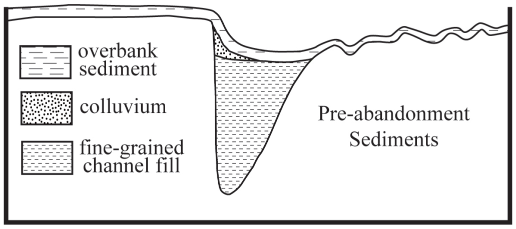
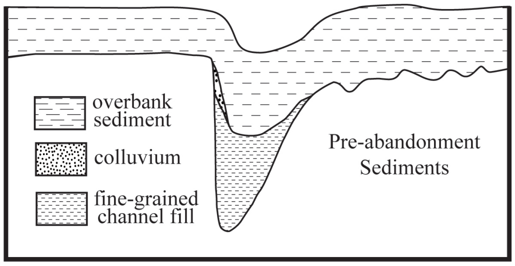


Stage 1, Active migration of Spanish Lake channel creates typical floodplain with levees and ridge and swale topography.



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



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

Figure 4. *Diagram illustrating the generalized development of a sinuous depression and associated dark tonal pattern above buried paleochannel. "SLP" is the sinuous dark tonal marking a buried channel of Spanish Lake paleochannel.*

Figure 2. *Photograph of the author standing by an upright buried cypress stump uncovered by excavation adjacent to BREC Burbank Soccer Complex and Burbank Drive, Baton Rouge, Louisiana.*

Figure 3. *Modified 1941 black and white Agricultural Stabilization and Conservation Service aerial photograph showing dark sinuous tonal feature interpreted to be a buried paleochannel. SLP = Spanish Lake paleochannel. Aerial photograph courtesy of Cartographic Information Center, Department of Geography and Anthropology, Louisiana State University, Baton Rouge, Louisiana.*

Reevaluation of Tektites Reported from Rapides Parish, Louisiana

Paul V. Heinrich

INTRODUCTION

Tektites typically are gravel-size, chemically homogeneous, and often spherical symmetrical pieces of natural glass, which are nonvolcanic in origin. The natural glasses that comprise tektites characteristically have a very low water content in the range of 0.02 to 0.002%/wt (weight percent). Currently, they are regarded as being the result of the melting and quenching of terrestrial rocks during hypervelocity extraterrestrial impacts by either comets or asteroids with the Earth (Montanari and Koeberl, 2000).

Tektites are currently known to occur in one of four known geographically extended areas, called "strewn fields." The four known strewn fields are the Australasian, Central European, Ivory Coast, and North American strewn fields. The Australasian strewn field extends from southern China to Indochina southwest across the Indian Ocean to Madagascar and, as recently noted by Folco et al. (2008), southward past Australia and into the northern Victoria Land Transantarctic Mountains. The tektites of the Australasian strewn field have been dated about 0.77 million years ago (Mya) and lack any known source craters. The Central European strewn field covers central Europe from the Czech Republic to the area of Dresden, Germany. The tektites in it are approximately from 15 Mya and are regarded as having been created by the impact that created the Ries impact crater in southern Germany. The Ivory Coast strewn field comprises tektites found within a restricted area along the Ivory Coast (Cote d'Ivoire) and deep-sea sediments recovered in cores from the Atlantic Ocean southwest of its coast. The tektites in this strewn field formed about 1.07 Mya with the creation of the Bosumtwi impact crater in Ghana. Finally, the North American strewn field extends from Chesapeake Bay southward to Cuba and southwestward to central Texas (Figure 1). The tektites in the North American strewn field are about 35 million years old and may have been formed by the impact that created the Chesapeake Bay impact crater that lies buried beneath Chesapeake Bay (Montanari and Koeberl, 2000).

RAPIDES PARISH, LOUISIANA, TEKTITES

In the late 1960's, Dr. Elbert A. King of the University of Houston, Texas, received two rock specimens from an unnamed Louisiana "rancher" as possible meteorites. One of these specimens turned out to be a tektite, of which the rancher reported in correspondence that he possessed two additional specimens. According to the rancher, he found them as early as 1965 in gravel pits near Glenmora, Rapides Parish, Louisiana while searching for petrified wood and other fossils (Figure 1). Dr. King and "three field assistants" spent three days searching for additional specimens at locations where the rancher reportedly found his tektites. Despite their efforts, no more tektites were found (King, 1970).

Dr. King had the largest tektite, which weighed 33 grams, subjected to chemical analysis and potassium-argon dating by other researchers. A chemical analysis by Dr. Jun Ito of Harvard University found that this tektite is comprised of the following in the specific weight percents: SiO2, 74.8%/wt; Al2O2, 12.6%/wt; TiO2, 0.99%/wt; FeO, 4.13%/wt; MnO, 0.08%/wt; MgO 1.67%/wt; CaO, 1.70%/wt; Na2O, 1.43%/wt; K2O, 2.61%/wt; and P2O5, 0.03%/wt for a total of 100.04%/wt. At King's request, Potassium-Argon (40K/40Ar) radiometric dating by Dr. Clifford M. Polo and Dr. David Smith of the Lunar Receiving Laboratory, National Aeronautics and Space Administration, yielded a date of 0.60 ± 0.15 Mya (King, 1970).

As King (1970) noted, the composition of this tektite is unlike any tektite known from the North American strewn field. He further noted that it is virtually identical in composition to some tektites known from the Australasian strewn field. In addition, this tektite is clearly younger than the 35 million year-old North American Strewn Field. However, the Potassium-Argon date of 0.60 ± 0.15 Mya overlaps the range of Argon-Argon (40Ar/39Ar) dating radiometric dates obtained from tektites of the Australasian strewn field found in Indochina by Izett and Obradovich (1992). Thus, the tektite described by King (1970) is distinctly different in composition and age from tektites found in the North American strewn field and very similar in composition and age to those found in the Australasian strewn field.

Based upon the similarities in composition between the tektite that he examined and some found in the Australasian strewn field, King proposed three explanations for their reported occurrence within Louisiana. First, these tektites could be part of a previously unknown strewn field of about the same age as the Australasian strewn field. Second, these specimens could be tektites from the Australasian strewn field that have been transplanted by man. Finally, these tektites could be an extension of the Australasian strewn field. King (1970) concluded that there were insufficient data to come to any conclusion about their origin. Unless other investigators find additional specimens in place, he warned that the validity of these tektite finds should be viewed with caution.

LOCAL GEOLOGY

Glenmora, Louisiana, lies on a large "peninsula" of the Lissie Alloformation lying between the younger terrace surfaces of the Oakdale Alloformation along the Calcasieu River to the west and surrounding Cocodrie Lake on the east (Snead et al., 2002). The surface of the Lissie Alloformation consists of gently rolling hills created by the moderate dissection of it. It lacks any definable relict constructional landforms such as paleochannels and ridge-and-swale topography. It is comprised of graveliferous fluvial deposits that remain largely unstudied. A very limited number of descriptions of sediments exposed in gravel pits suggest that the upper part of the Lissie Alloformation consists of interbedded sand, gravelly sand, and sandy gravel. Beds of sandy clay appear to be uncommon (Woodward and Gueno, 1941).

Although undoubtedly of Pleistocene age, the exact age of the deposition of the Lissie Alloformation is poorly constrained. Within Texas, the Lissie Formation, which is the same stratigraphic unit as the "Lissie Alloformation" of Louisiana according to Snead et al. (2002), was originally called the "Equus beds" by Dumble (1894) because two species of horse, *Equus francisci* and *Equus complicatus*, have been found within it. As noted by Duessen (1924), many Early Pleistocene vertebrate fossils (i.e. *Trucifelis fatalis, Elephas imperator, Bison latifrons,* and *Glyptodon spp.*) have also been found in the Lissie Formation within Texas. Kukla and Opdyke (1972) found that samples of the Lissie Alloformation exhibited reverse magnetic polarity. The reverse magnetic polarity of its sediments indicated to Winker (1982) that the Lissie Alloformation dated between 0.79 and 2.48 Mya. Winker (1982) also assigned an early Pleistocene age to the Lissie Alloformation based on the downdip projections to biostratigraphic markers encountered in offshore wells. Thus, an early Pleistocene age was argued for the Lissie Alloformation.

Optically stimulated luminescence (OSL) dates published in Otvos (2005) fail to provide any indication of the age of the Lissie Alloformation. Otvos (2005) obtained OSL dates of greater than 0.114±0.0009 Mya before present (BP) from near Glenmora, Louisiana, and greater than 0.277 Mya from near Longville, Louisiana.

Given the complete lack of any detail information about the precise stratigraphy, location, and lithofacies of the dated samples provided by Otvos (2005), it is unknown whether these samples came from either the Lissie Formation, colluvial sediments overlying it, the surficial zone of bioturbation, called a “biomantle”, developed in it, or some combination of these. Similarly, Otvos (2005) reports an OSL date from the Lissie Formation near Buna, Jasper County, Texas, of 0.216±0.089 Mya. Again, because of insufficient background data provided by Otvos (2005) and the shallow sample depths, it is unknown whether this sample actually came from the Lissie Formation. This is a valid concern given the often thick surficial sand mantle either collivium, biomantle, or combination of the two characterizes this part of Texas as discussed by Johnson et al. (2008). In addition, the lack of the detailed data, such as radionuclide content of the samples, water content of the sample, saturation history, sample lithology, and so forth, that normally accompanies published OSL and TL dates prohibits any interpretation of their reliability.

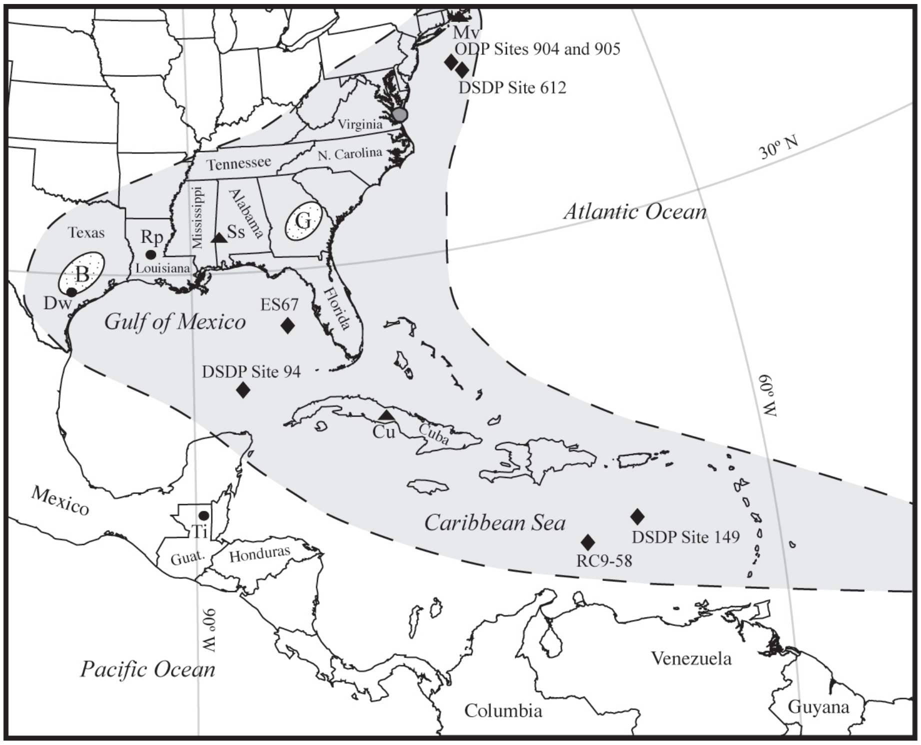


Figure 1. Approximate distribution of North American Strewn Field. Based data from figures of Koeberl (1989), King and Petruny (2008), and McCall (2000).

LEGEND

● Chesapeake Bay Impact Crater (actual size)

◌ North American tektite finds. G = Georgiaites and B = Bediasites.

▲ Isolated North American tektite finds. Cu = Cuba; Ss = St. Stephens Quarry, Alabama; and Mv = Martha’s Vineyard, Massachusetts.

◆ Location of cores containing Eocene microtektites.

• Reported isolated finds of tektite too young to belong to the North American Strewn Field. Dw = DeWitt County, Texas Rp = Rapides Parish, Louisiana, and Ti = Tikal, Guatemala.

Thermoluminescence (TL) dates from the Beaumont Alloformation demonstrates that the Lissie Alloformation is definitely older than 0.3 million years in age. From a Jackson County, Texas, exposure of unaltered point bar sands that are part of the Lolita valley fill of the Beaumont Formation, Blum and Price (1998) and Blum and Alsan (2006) obtained two reliable TL dates of 0.323±0.051 Mya (W-1689) and 0.307±0.037 Mya (W-1699). Since a substantial thickness of the Beaumont Formation overlies the Lissie Formation in this region, the Lissie Formation must be significantly older than 0.3 million years in age. Furthermore, as noted by Mandel and Caran (1992) and Caran (1992), the Lava Creek B Ash occurs within the alluvial fill underlying the Capitol Street Terrace along the Colorado River at the Rehmet locality near Smithville, Texas. The Lava Creek B Ash has been dated as being about 0.62 million years old (Izett and Wilcox, 1982). In addition, fluvial sediments underlying it are reversely magnetized and thus predate 0.78 million years ago (Baksi et al., 1992). Given that the fluvial fill underlying the Capitol Terrace is correlated with the Beaumont Formation of Texas (Doering, 1956), then the oldest sediments of the Beaumont Formation and the youngest sediments of the Lissie Formation in Texas, and presumably the correlative Lissie Alloformation of Louisiana, predate 0.78 Mya.

If the Lissie Alloformation is early Pleistocene in age, it predates the age of the tektites described and dated by King (1970). Thus, any tektites, if they exist, would not occur within the gravelly sediments of the Lissie Alloformation. Instead, any such tektites would occur buried within the profiles of soils developed within the Lissie Alloformation and buried beneath younger colluvial and aeolian sediments blanketing this surface.

Churning by animals and plants, called “bioturbation”, of soils developed within the surface of the Lissie Alloformation would have quickly buried any tektites that fell on its surface (Johnson et al., 2005). Bioturbation of the surface of the Lissie Alloformation would have caused tektites and any other granule-, pebble-, and cobble- size particles to sink within soils developed in the sediments of Lissie Alloformation until they reached the depth at which bioturbation no longer disturbs these sediments. At this depth, these particles, including tektites, would accumulate as a layer of sand and gravel known as a “carpedolith.” This layer of gravel when observed in an exposure would appear as either a continuous or discontinuous two-dimensional line of stones parallel to the ground surface known as a “stone line” (Johnson et al., 2005).

Attempts to Relocate King’s Specimens and Data

As part of reevaluating the significance of the tektites report by King (1970) from Rapides Parish, Louisiana, the author attempted to locate the original notes, pictures, analyses, and data concerning these tektites and the original specimens. The author hoped to find specific details as to the identity of the person who found them and the location of the gravel pit in which they were found. In search of these materials a number of institutions and persons involved in this research were contacted. Inquiries were made with the Special Collections and Department of Earth and Atmospheric Sciences at University of Houston, Harvard University Archives and the Lunar Receiving Laboratory of the National Aeronautics and Space Administration where the tektites were dated. These institutions lacked any field notes, pictures, laboratory analyses, or any other record of any research by Dr. King, Dr. Jun Ito, Dr. Clifford M. Polo or Dr. David Smith. The Department of Earth and Atmospheric Sciences at the University of Houston searched Dr. King’s tektite collection and did not find the Louisiana tektites in this collection. Overall, the effort to find any of the original records and specimens related to the Rapides Parish tektites reported by King (1970) failed to find anything.

During the course of my search for information, I contacted Mr. Steve Arnold, who had acquired his meteorite collection and some of his papers from Dr. King's estate, and Mrs. Lisa King, Dr. King's daughter. Mr. Arnold informed me that Dr. King's tektite collection had been donated to the University of Houston. Mrs. Lisa King remembered searching for the tektites at a gravel pit in Rapides Parish with her father and another person. However, it had occurred too long ago for her to remember any details about where the gravel pit was located. Again, I was unable to find any information about either the exact location where the tektites were found; the identity of the unnamed Louisiana rancher who found them; and the whereabouts of any of the specimens.

Examination of aerial photography and recent (2004 and 2005) Digital Orthophoto Quarter Quadrangles indicated that relocating the original gravel pits, where the tektites were reportedly found, likely would not help. An examination of this imagery showed that the gravel pits, which are visible in 1968 Agricultural Stabilization and Conservation Service aerial photographs, in the Glenmora area either had been reclaimed or become naturally re-grown with vegetation. Even if the gravel pit, where the tektites had reportedly been found, had been relocated, it likely would have been impossible to search it again for tektites.

PROXY "FIELD SEARCH"

Because of the inability to relocate any information about the original research concerning the tektites that King (1970) had reported from Louisiana, a proxy "field search" was conducted for them. This proxy "field search" consisted of contacting knowledgeable people, who have spent decades either as a hobby or for research either searching the gravel pits or studying surficial sediments of southwest and south-central Louisiana.

First, I contacted Dr. Bridget Joubert, member both of the DeRidder Gem and Mineral Society, Leesville, Louisiana and the Gem, Mineral, and Lapidary Society of Central Louisiana, Alexandria, Louisiana. Dr. Joubert reported that the tektites described in King (1970) have "...never been reported by any of our members (in either club to which my husband and I belong) in all the years we have been active." She also printed out several copies of a "request for information," which I prepared, and handed them out at meetings of both of these clubs. According to her, the response of rockhounds, who had been digging in and collecting rocks from these and other gravel pits within Rapides and other parishes for decades, was that they never saw anything remotely resembling a tektite.

Additionally, I contacted archaeologists, who have been active within Rapides Parish and adjacent parts of southwest and south-central Louisiana. Within southwest and south-central Louisiana, archaeologists have conducted numerous excavations and surface surveys. Given the strong interest in using the different lithic types used by prehistoric Native Americans to determine trade and seasonal variations in settlement patterns, they studied the distribution of the different lithic types that occur naturally within gravels found in soils, Pleistocene sediments, and Holocene alluvium and were used by prehistoric Native Americans (Gibson, 1998, 2006; Jolly, 1982). Natural glasses of any type, i.e. obsidian, fused glass, and tektites, are specifically noted because of their potential for tracing discrete lithic sources and for hydration dating. In collecting information, I had correspondence and personal discussions with Mr. Tim Phillips (US National Forest Service Kisatchie National Forest), Jeff Girard (Northwest Region Regional Archaeology Program), and Dr. Charles "Chip" McGimsey (Louisiana State Archaeologist and Director). None of them had observed any natural glasses, either as pebbles or artifacts, which could be interpreted as being tektites. In addition, regional studies of lithic resources by Banks (1990), Heinrich (1984), and Anderson (2003) lack any mention of any identifiable natural glass as naturally occurring in southwest and southcentral Louisiana. In sharp contrast, the occurrence of natural glass created by prehistoric coal fires, called Manning Fused Glass, is well documented in adjacent parts of East Texas by Brown (1976) and Banks (1990). The Manning Fused Glass is easily distinguishable from other types of natural glass (Banks, 1990).

DISCUSSION

Any association with the North American strewn field can be dismissed on the basis of the composition and age of the tektite examined by King (1970). It is far too young be from the 35 million year-old North American strewn field. In addition, it differs too much in composition, as noted by King (1970), from the typical composition of the North American strewn field tektites (Koerbel, 1988), to have come from it. As a result, it is entirely unlikely that these specimens were eroded from the Eocene Yazoo Clay and transported southward by an ancient Pleistocene fluvial system.

The similarity in age and composition to the Australasian strewn field does not disqualify the natural presence of these tektites within Louisiana. In the ruins of Tikal, Guatemala (Figure 1), possible tektites of unknown origin have been recovered during archaeological excavations from Pre-Columbian age archaeological deposits (Hildebrand, 1994; Hildebrand et al., 1994; Senftle et al., 2000). They, like the tektite from Rapides Parish, overlap in age with the Australasian strewn field although their composition seems to preclude such an association. Although their source is unknown, their recovery from in situ prehistoric archaeological deposits precludes the possibility that they were introduced into Guatemala within historic times. In addition, Johnson et al. (2008) reported that Dr. L. E. Morgan and P. R. Renne of the University of Berkeley have dated tektites found in DeWitt County, Texas (Figure 1), as being about 2.3 Mya. Thus, isolated finds of tektites of unknown source do occur within the western hemisphere. However, the Dewitt County tektites are too old to be related to the tektites reported from Rapides Parish, Louisiana.

The main problem with the tektites reported by King (1970) is that similar reports of Louisiana tektites by both rockhounds and archaeologists are lacking despite having made numerous inquiries. Given that both groups have members who would have noticed anything as unusual as tektites and who have intensively examined both local and regional gravel pits, it is quite unlikely that tektites could naturally occur in these sediments and have remained unnoticed. If tektites had been present in any quantities in southwest and south-central Louisiana, some of the numerous archaeologists and rockhounds, who had either studied or collected from the local gravel pits, should have noticed the presence of pebbles of natural glass, such as tektites, among the gravels of the Lissie Alloformation. Furthermore, if pebbles of natural glass in the form of tektites were present in south-central and southwest Louisiana, the local Native Americans certainly would have noticed and used the tektites to manufacture artifacts given the poor quality of rock for the manufacture of artifacts that is typical of the Glenmora region. In Georgia, despite the rarity of Georgia tektites (georgiaites) of the North American strewn field (Figure 1), several artifacts manufactured from georgiaites have been reported from the area in which they are found in Georgia (Povenmire, 2002; Povenmire and Cathers, 2004).

Another problem is the reliability of the provenance of specimens of private rock collections. Although studies of the reliability of the information concerning the provenance of specimens is lacking, archaeologists have become increasingly concerned about the contamination of prehistoric artifact collections with modern replicas (Whittaker and Stafford, 1999). The degree of record keeping varies widely among the amateur collectors of artifacts, rocks, minerals, and fossils. As noted by King (1970) for artifact collectors, some keep meticulous notes and others rely largely on memory to reconstruct where specimens were found. In the later case, Whittaker and Stafford (1999) found that modern replicas of prehistoric artifacts were becoming mixed into collections of authentic prehistoric artifacts. In a similar process, it is quite possible that the unnamed rancher acquired the Rapides Parish tektites as either a gift or purchase and, later relying solely on memory, confused them with material that he found in gravel pits around Glenmora, Louisiana. Unfortunately, the identity of the unnamed rancher could not be determined. As a result, he could not be traced and the reliability of his record keeping and specimen curating could not be evaluated.

Given that the original laboratory and field notes; the tektites studied by King (1970) the exact location at which they were reportedly found and the identity of the "Louisiana rancher," who originally found them, have been lost, it is impossible to come to a definite conclusion as to the validity of the existence of Louisiana tektites. Overall, it appears that the most likely explanation for the tektites is they were imported into Louisiana from Indochina. However, the absence of evidence for the existence of naturally occurring tektites within the Glenmora, Louisiana, region cannot be regarded as complete and absolute proof that tektites do not naturally occur within south-central and southwest Louisiana.

CONCLUSIONS

Judging from the information gathered for this article, it appears that the tektites do not naturally occur in the Glenmora region. Of the three hypotheses proposed by King (1970) for the occurrence of tektites found near Glenmora, the most likely explanation is that they "have been transplanted by man." Had any tektites naturally occurred within the Glenmora region, it is almost certain that in the almost four decades since King (1970) was published, some of the numerous rockhounds, who have collected rocks and fossils from local gravel pits, and archaeologists, who have studied local sources of lithic materials, would have found them and noted the occurrence of natural glass in this region. However, the possibility that the tektites reported by King (1970) were native to the Glenmora region cannot be completely refuted with absolute certainty.

Therefore, geologists, archaeologists, soil scientists, and rockhounds still should keep their eyes open for what looks like pebbles of natural glass within large parts of southwestern and south-central Louisiana underlain by the Lissie Alloformation and, to the north, the older Pliocene age Willis Formation. In those areas, specific attention should given to gravel-size clasts that form stone lines seen within exposures of soil profiles developed in sediments of both units. Given the age of both units, if they are present within southwestern and south-central Louisiana, any naturally occurring tektites would be most likely found in these stone lines. The stone lines within soils developed in Willis Formation should not only contain any Pleistocene tektites, if they exist, but also might contain any tektites associated with the 2.3 Mya tektites found in Texas.

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Preliminary Results of Sparta Aquifer Sampling in North Central Louisiana

Douglas Carlson and Thomas Van Biersel

Introduction

The Sparta aquifer lies in northern Louisiana (Figure 1) and supplies over 90% of the groundwater used within the seven parishes of Bienville, Claiborne, Jackson, Lincoln, Ouachita, Union and Winn. In addition, for three regions approximately centered near the cities of Hodge, Monroe and Ruston, the Sparta Aquifer was designated in 2005 as an "area of ground water concern" by the Office of Conservation of the Louisiana Department of Natural Resources (2005). There are three reasons for the concern: (1) falling water levels; (2) zones where dewatering is possibly occurring; and (3) the advance of a saltwater front. Our study focuses on the last concern, of the saltwater front encroachment.

A series of reports have noted that a boundary zone between saltwater and freshwater exists along the edge of the Sparta Aquifer as a diffuse line that trends roughly northeast to southwest through Morehouse, Richland, Caldwell, Winn, Natchitoches, and Sabine Parishes (Tomaszewski, 1992; Brantly et al., 2002; and Tomaszewski et al., 2002). In general, the saltwater boundary is further west for lower sands than upper sands (Sanford et al., 1973, and Brantly et al., 2002).

This saltwater boundary is most likely advancing as a result of the water demand on the Sparta Aquifer exceeding a sustainable rate. The rate of the saltwater front encroachment has been estimated from hydraulic gradients to be 185 ft/yr in Morehouse Parish (Sanford, 1973). Another set of estimates of saltwater front encroachment rates were determined from running current conditions for a series of possible future scenarios of gradient in a groundwater model developed by Trudeau and Buono (1985). The rate of saltwater front encroachment depends on the rate of groundwater use. The range of different ground water use scenarios yield a range of encroachment from 96 ft/year to 167 ft/year (Trudeau and Buono, 1985). However the rate of movement in individual sands due to range of permeability is likely to be slower (Sanford, 1973).

The movement of this saltwater appears to have an impact in parts of the Sparta Aquifer. Chloride concentration has been fairly constant for parishes distant (e.g. Ouachita Parish) from the saltwater front (Figure 2). By contrast nearer to the saltwater front (Winn Parish) there has been a consistent increase in chloride concentration for nearly 20 years (Figure 3). This evidence indicates a need for a comprehensive regional study of the Sparta Aquifer that includes sample collection and analysis of water (from over 100 wells) to see where chloride and/or total dissolved solids (TDS) concentration increases are occurring and is the extent of chloride and/or TDS concentration increases.

Methods

Groundwater samples were collected after obtaining permission from the property owners during November and December 2008 and March and April 2009. The water samples were collected from the sampling port nearest to the water well. Each water sample was collected in an unpreserved 1-liter (L) or 500 milliliter bottle for later analysis for the concentration of chloride and TDS. The sample bottles were stored and cooled to 4 0C in the field, and transferred to a refrigerator in the lab. The water samples were then analyzed in the lab using LGS's Dionex ICS-1000 Ion Chromatography System for chloride, and by gravimetric determination for TDS. Results from the study's collection of chloride and TDS values were compared with previous studies to determine if there are wells with significant changes of chloride and/or TDS concentration values indicating that the saltwater front is advancing towards the well considered.

Results

Results from this study's collection of water samples from 137 wells indicate that in terms of chloride concentration there has been little change to the region of high concentration in Morehouse, Ouachita and Union Parish. However, areas of high chloride concentration are starting to appear elsewhere in central Union, central Ouachita and parts of Winn Parish (Figure 4). In the three months between November/December 2008 and March and April 2009, change of chloride concentration in 53 wells at both times has generally been small. However, change near the saltwater front for 26 wells has been fairly consistent (Figure 5), an average increase of 4.3 mg/L. Increase of chloride concentration during the three month period was observed for 17 of the 26 wells near the saltwater front. By comparison for 27 wells farther from the saltwater front the change is nearly zero, an average decrease of 1.2 mg/L. For these wells the change probably reflects random measurement variations, which yields an almost equal number of wells with chloride concentration increase (13 wells) as wells with chloride concentration decrease (14 wells). This result is similar to U.S. Geological Survey data displayed in Figures 2 and 3.

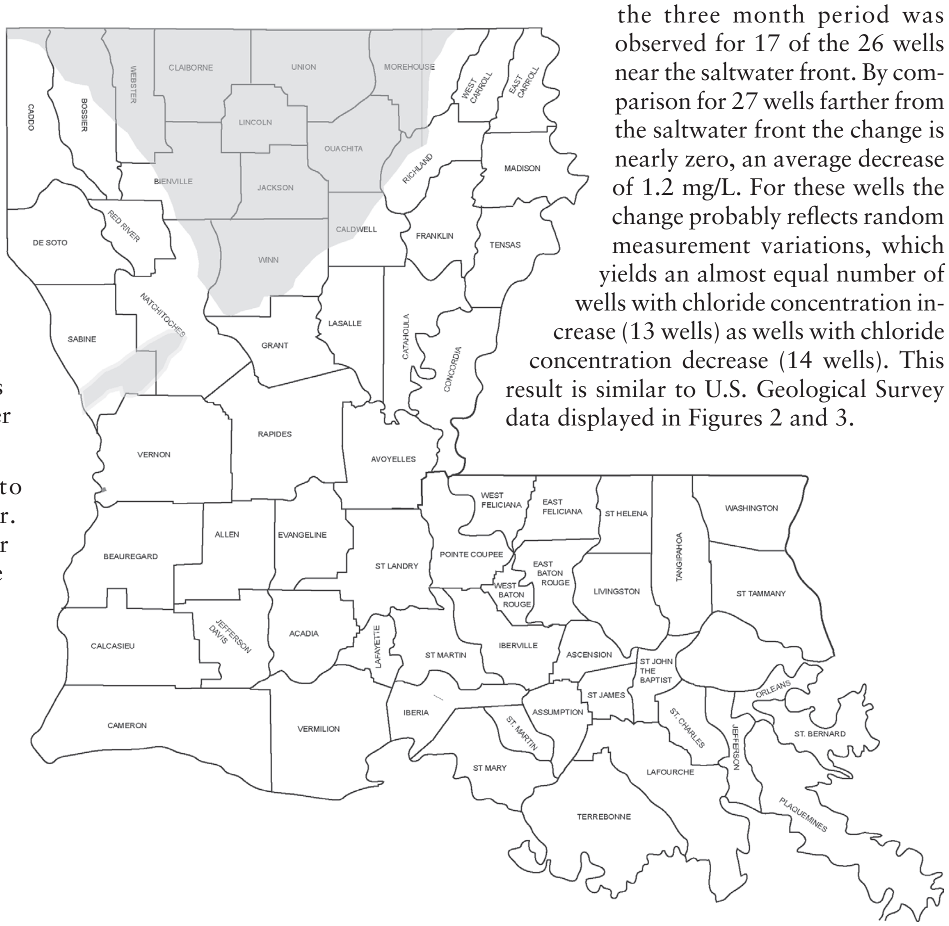

Figure 1. *Extent of the Sparta Aquifer (modified from Stuart et al, 1994)*

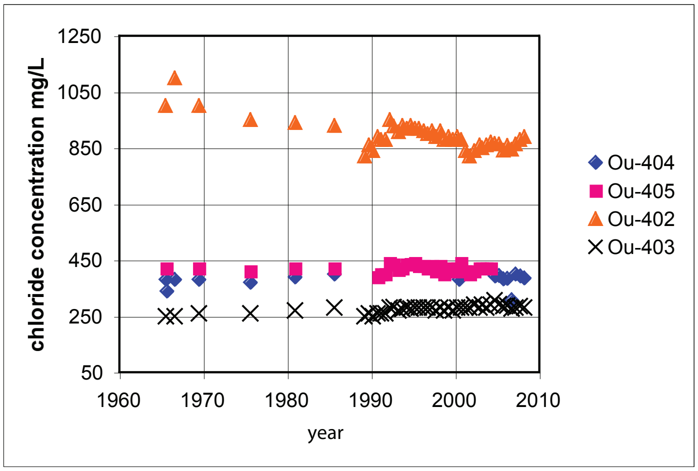

Figure 2. Chloride concentration in the Sparta Aquifer for selected USGS monitoring wells in Ouachita Parish (USGS, 2008)

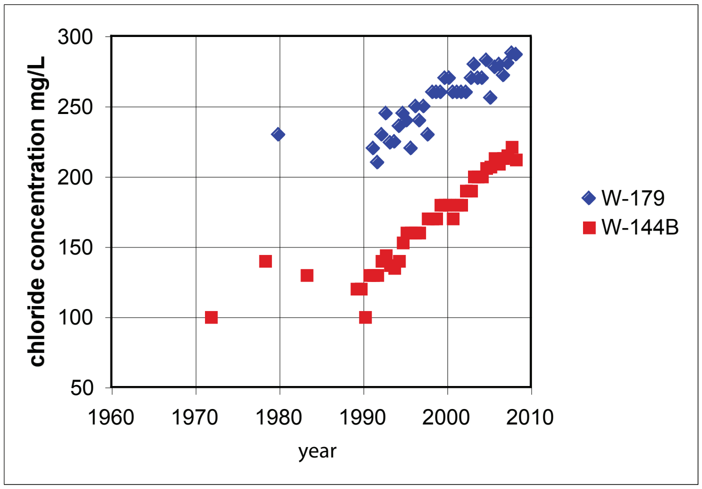

Figure 3. Chloride concentration in the Sparta Aquifer for select USGS monitoring wells in Winn Parish (USGS, 2008).

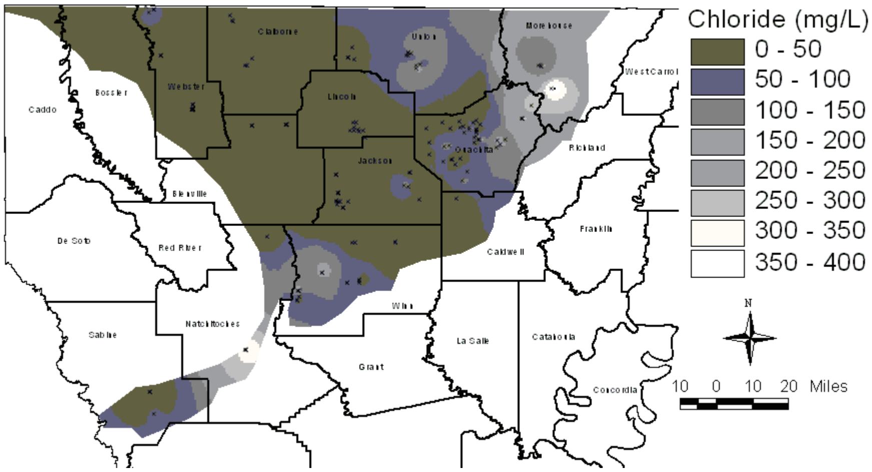

Figure 4. Distribution of chloride concentration during November and December 2008 and March and April 2009 within the Sparta Aquifer of Louisiana.

This study's set of 26 wells near the saltwater front and 27 wells distant from the saltwater front reveals little change of chloride concentration for wells distant from the saltwater front and a systematic increase of chloride concentration from wells near the saltwater front.

The TDS data shows there has been an expansion of the 500 mg/L zone between Louisiana Department of Environmental Quality's (1996) study (1994-1995) and this study (2008-2009). Mainly, there has been an expansion into Winn Parish while areas to northeast are roughly the same (Figure 6). The change in TDS concentration between samples collected November and December 2008 and March and April 2009 indicates that apparently measurement variability exceeds change from TDS over the three month interval (Figure 7). For TDS change may be apparent only over longer intervals of time.

CONCLUSIONS

One usually thinks of saltwater front intrusion as a front laterally moving towards a central cone of depression. However, the Sparta Aquifer in north-central Louisiana is composed of 3 to 5 sands (Brantly et al., 2002). Therefore within the Sparta, saltwater intrusion is perhaps not a lateral movement, but a vertical movement upward through silty beds that separate sands. This movement may explain the appearance of both high concentration spots of chloride and TDS values that appear remote from the main front and even separated by a region of lower concentrations. This is probably a result of changes in vertical gradient from downward to upward as lower sands are abandoned as sources of water as demand shifts upward within the Sparta.

ACKNOWLEDGMENTS

The Louisiana Department of Transportation Water Resources Section provided support (SPN 750-99-0154) for this study, which was approved of by Bo Bolourchi, Director of Water Resources Program of LA Department of Transportation and Development and Michael Boudreaux, LA Transportation Research Center. Thanks are also extended to the thirty-eight utilities for granting access to their wells and to their staff members who were very helpful in the collection of data.

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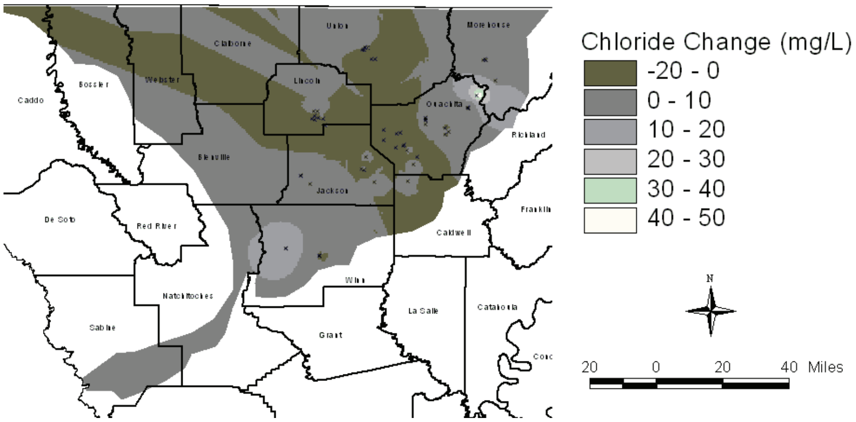

Figure 5. Change of chloride concentration between November/December of 2008 and March/April 2009 within the Sparta Aquifer of Louisiana.

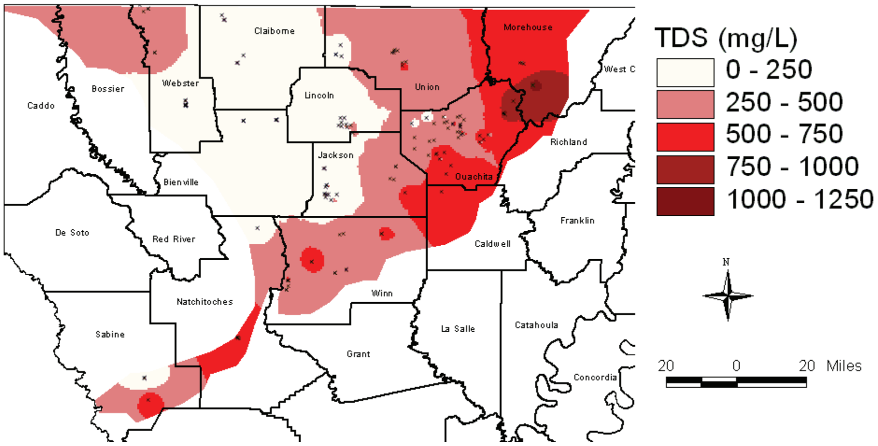

Figure 6. Distribution of TDS concentration during November and December 2008 and March/April 2009 within the Sparta Aquifer of Louisiana

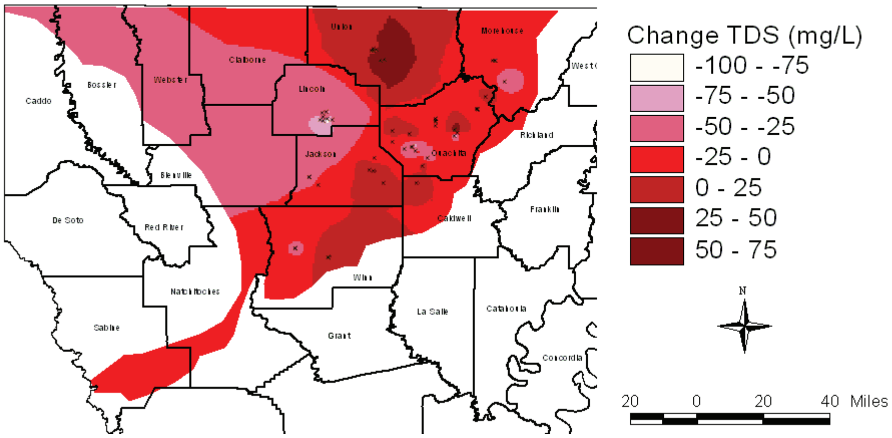

Figure 7. Change of TDS concentration between November/December of 2008 and March/April 2009 within the Sparta Aquifer of Louisiana.

New LGS Publications

Long-term Hydrogeologic Characterization of Water Supply Wells affected by Hurricanes Katrina and Rita along the North Shore of Lake Pontchartrain by Thomas P. Van Biersel, L. Riley Milner, Douglas A. Carlson, and Elizabeth K. Mier: Report of Investigation No. 09-01, Louisiana Geological Survey, March 2009, 56p. Louisiana Shoreline Change 1937-2000. Snead, John, R. Hampton Peele, and S. Ahmet Binselam, 2008. 26 x 60-inch multicolored thematic physical relief map, scale: 1:380,160. $10.00

Please contact Patrick O'Neill (poneil2@lsu.edu or 225-578-8590) for LGS publications.

LGS Participates in the International Astronomy Day Celebraations

Saturday, May 2, 2009 the Louisiana Geological Survey participated in the BREC-LSU Highland Road Park Observatory's 3rd Annual celebration of International Astronomy Day. Riley Milner and Paul Heinrich manned the LGS display.

The presentation of the discovery of a meteorite impact crater in St. Helena Parish was a very big surprise to all attendees as well the coordinators for the celebration. LGS also had a scope-on-a-rope with a petrographic microscope showing thin sections of the Greenwell Springs Meteorite found in East Baton Rouge Parish in 1987 by Mr. Frank Rapuana in his yard about 8m from his house. Other slides shown were evidence of bolide impacts between 3.2 and 3.5 billion years ago from the Archean Era in South Africa, and slides from the Reis impact crater in Germany showing shock quartz grains. The scope-on-a-rope was a big hit with all attendees while viewing just about everything available (i.e. finger prints, computer chips, candy mints, dirt etc).

The celebrations were from 3:00pm to 11:00pm with numerous telescopes set up to view the sun, before sun set, and the moon and Saturn and other celestial bodies after dark. The Baton Rouge Amateur Radio Club, Louisiana Wing of the Civil Air Patrol, Earth Scan Laboratory, Louisiana Solar Energy Society and the Baton Rouge Zoo also had displays and activities through out the day and evening.

Museum Experts Visit LGS Resource Center

Dr. Michael Mares and Peter Tirrell from the nationally known Sam Noble Oklahoma Museum of Natural History visited the LGS Resource Center (Core Repository and log library) on May 7th during their visit to LSU. The purpose of their visit, arranged by the "Build-a-Museum" team, headed by Ed Picou and Judith Schiebout, was to do a report on the potential for a Louisiana Museum of Natural History at LSU as a unified, accredited full service museum with research, teaching, display and outreach capabilities. The LGS Research Center is an integral part of the Louisiana Museum of Natural History. The current building where the LGS Resource Center is located is scheduled to be demolished shortly to make way for the proposed new Business School building. The Resource Center is expected to be moved to a new location behind the LSU Graphic Services building on River Road after some required renovation to the existing structure. Currently museum collections at LSU are located at various sites on Campus.

NOAA Training, March 25

Louisiana Geological Survey Co-Sponsors and Hosts NOAA Training

The Louisiana Geological Survey, working with NOAA and the US Army Corps of Engineers, teamed up to co-sponsor a series of three one day training seminars in Louisiana last week on tides, water levels, sea level rise, and NOAA products, services and applications in New Orleans, Baton Rouge, and Lafayette. These NOAA training seminars were presented by the experts from the Center for Operational Oceanographic Products and Services, Office of Coast Survey, National Geodetic Survey and the Louisiana State University Center for Geoinformatics. The Baton Rouge seminar, co-ordinated by LGS Research Associate Hampton Peele was held on March 25th at the Dalton Woods Auditorium in the Energy, Coast & Environment building was hosted by the Louisiana Geological Survey and had over 200 attendees. The seminars covered overview topics on basic tidal theory, the use of tide and water level data for coastal restoration, coastal protection, hydrographic surveying, tropical storm surge projects and programs, and sea level rise (observed trends and forecasts). Specific topics included basic operation of tide and water level stations, computation of tidal datums and tidal epochs and the relatation of tide and water level data to geodetic datums such as NAVD88. The training also qualified as a day-long, professional development workshop for Professional Land Surveyors from Louisiana. Louisiana Sea Grant produced an Internet accessible recording of the seminar, which is available at the NOAA Tides and Water Levels site .

Papers Published

Van Biersel T., Carlson D. and Milner L.R. (2009) Sustainability analysis of the Red River Alluvial and Wilcox Aquifers freshwater resources for the Haynesville Play Development: Transaction of the Baton Rouge Geological Society's 2009 Louisiana Oil and Gas Symposium.

Johnston J. (2009) Coastal Management Division's new general permits: Transaction of the Baton Rouge Geological Society's 2009 Louisiana Oil and Gas Symposium.

Carlson D. and Van Biersel T. (2009) Influence of Facies, Fractures and Weathering on the Hydraulic Properties of the Monroe Gas Rock and Impacts on Units Above: Transaction of the Baton Rouge Geological Society's 3rd Annual Louisiana Groundwater Symposium vol. 3, p. 10-14.

Carlson D. and Van Biersel T. (2009) Water Quality throughout the Wilcox Group, a function of location and sand in northern Louisiana: Transaction of the Baton Rouge Geological Society's 3rd Annual Louisiana Groundwater Symposium vol. 3, p. 27-30.

Van Biersel T. and Carlson D. (2009) Distribution of Selected Water Nuisance Chemicals and Brine Tracers in Sparta Aquifer Wells in Louisiana: Transaction of the Baton Rouge Geological Society's 3rd Annual Louisiana Groundwater Symposium vol. 3, p. 17-22.

Carlson D. and Van Biersel T. (2009) Is Chloride and/or Total Dissolved Solids Concentration Increasing in the Sparta Aquifer of North Central Louisiana?: Transaction of the Baton Rouge Geological

Society's 3rd Annual Louisiana Groundwater Symposium vol. 3, p. 31-35.

Carlson D. and Van Biersel T. (2008) Can Mississippi River Flooding Save the Delta Parishes of Louisiana?: Transaction of the Baton Rouge Geological Society's 2nd Annual Louisiana Subsidence and Land Loss Symposium vol. 2, p. 25-28.

Van Biersel, T. P., L. R. Milner, D. Carlson and E. Mier (2009), Long-term hydrogeologic characterization of water supply wells affected by Hurricanes Katrina and Rita along the north shore of Lake Pontchartrain: Louisiana Geological Survey Report of Investigation 09-01, 56p.

Conferences

LGS Sponsors Symposiums

LGS COHOSTS LOUISIANA GROUNDWATER AND WATER RESOURCES SYMPOSIUM

The third annual Louisiana Groundwater and Water Resources Symposium was hosted by the Louisiana Geological Survey (LGS) and Baton Rouge Geological Society (BRGS) on March 26, 2009. The symposium was held in the Dalton Woods Auditorium of the Energy, Coast and Environment Building at Louisiana State University. There were ten oral presentations and one poster presented by authors from LGS, U.S. Geological Survey, Louisiana State University, University of Louisiana-Lafayette, and industry. This well attended symposium had attendees from a variety of Louisiana state agencies, Louisiana universities, federal agencies and industry. LGS staff presented three oral talks and one poster **"Influence of Facies, Fractures and Weathering on the Hydraulic Properties of the Monroe Gas Rock and Impacts on Units Above", "Is Chloride and/or Total Dissolved Solids Concentration Increasing in the Sparta Aquifer of North Central Louisiana"** and **"Water Quality Throughout the Wilcox Group, a Function of Location and Sand in Northern Louisiana"** by Douglas Carlson and Thomas Van Biersel and **"Distribution of Selected Water Nuisance Chemicals and Brine Tracers in Sparta Aquifer Wells in Louisiana"** by Thomas Van Biersel and Douglas Carlson. Abstracts and expanded abstracts can be viewed on the BRGS website at http://www.brgs-la.org/web-content/archives.htm.

GCAGS CONVENTION (2009)

The 59th Annual GCAGS –GCSSEPM Convention will be held from September 27-29 at Shreveport, Louisiana. As in previous years, LGS plans to have an exhibit booth at this convention. LGS Staff will be presenting the following research papers at this convention:

Douglas Carlson and Thomas Van Biersel:

1) "Dependence of the Wilcox Aquifer Water Chemistry on Stratigraphy, Spatial Distribution, and Proximity to Lignite in Southern Caddo Parish, Louisiana"

2) "Influence of facies, fractures and weathering on the hydraulic properties of the Monroe Gas Rock"

3) "Is chloride concentration increasing in the Sparta Aquifer of north central Louisiana?"

4) "Overview of the Wilcox, a Unique Group in Louisiana"

5) "Is Mississippi River Sediment Supply Adequate to Save the Delta Parishes of Southeast Louisiana?"

Thomas Van Biersel and Douglas Carlson: "Distribution and Source Analysis of Elevated Chloride Concentration in the Wilcox Aquifer of Northwestern Louisiana".

Bobby Jones, Chacko John, Brian Harder and Reed Bourgeois: "Field Production and Potential for Deeper Hydrocarbon Resources in the Main Pass area, Louisiana State Waters".

Marty Horn: "Stratigraphic Relationships and Nomenclature of Cotton Valley and Louark Groups, Northwest Louisiana Subsurface".

LGS PARTICIPATES IN "TRIMBLE DIMENSIONS 2009" USERS CONFERENCE

A technical research presentation describing data collection methods and Geographic Information System (GIS) development for petrochemical pipelines in Louisiana was presented at the "Trimble Dimensions 2009" Users Conference in Las Vegas, Nevada on February 24, 2009 by LGS research associate Robert Paulsell. More than 2,400 attendees gained valuable insight into Global Positioning Systems (GPS) and other positioning technologies and how advanced application solutions can increase productivity and project deliverables. There were more than 300 unique specialty track sessions that focused on positional accuracy, 3D scanning, aerial mapping technology, and a wide range of other technological advancements that have made geospatial work more productive. A presentation "Utilizing GPS Technology to Enhance Spatial Accuracy of Pipeline Features in a GIS" was presented by Robert in the "Mapping and GIS track sessions". This session was eligible for Professional Development Hours credit from the Missouri University of Science and Technology.

The presentation described how the use of Global Positioning System (GPS) technology can enhance the spatial positioning of pipeline features in a GIS. The development of digital petrochemical pipeline data is vital for energy planning, environmental monitoring, disaster prevention, and especially emergency preparedness/response. Much existing digital pipeline data have not been field verified and are spatially offset. The compilation and spatial analysis of pipeline data for the state of Louisiana is a complex process. Data sources have unique geographic parameters which inhibit the rapid development of a full scale pipeline GIS. Assessment of digital data, field investigations, and the development of undocumented data are important to the development of the Louisiana Pipeline Inventory GIS (LaPIGIS). This research is focused on collecting all pertinent pipeline documentation (maps, "as builts", and diagrams). The collection and compilation of GPS point data on transmission pipelines is an integral part of the GIS development and was discussed in detail in the presentation. GPS data collection techniques and safety issues were reviewed. Pipeline feature development techniques in ArcGIS (ESRI, Redlands, CA) were also presented.

DIGITAL MAPPING TECHNIQUES WORKSHOP 2009

Louisiana Geological Survey Research Associate Robert Paulsell attended the annual Digital Mapping Techniques Workshop. This year the workshop was held in Morgantown, West Virginia, on the beautiful campus of West Virginia University. The DMT was hosted by the West Virginia Geological Survey and was co-sponsored by the United States Geological Survey (USGS) and the Association of American State Geologist (AASG). The DMT brings international, federal, and state geologists, GIS specialists, and cartographers together to discuss computer geologic mapping. Workshop topics ranged from data management, citation, and production to new methods of surfical geologic mapping. Strong emphasis was put on national mapping standards development.

The *U.S. National Geologic Map Database*, a national geologic archive, and the *National Map*, a national data repository, were reviewed by the USGS during the workshop. Base map development and geologic standards development were discussed at length. Several different approaches to base map development are utilized by state geologic surveys.

Environmental Systems Research Incorporated (ESRI) representatives presented their new Federal Geographic Data Committee (FGDC) digital cartographic styles for geologic map symbolization. Their GIS software, ArcMap, is used by most of the state geological surveys for geologic data development, cataloguing, and publication.

Other topics discussed were archival methodologies for map data and new mapping techniques that utilize LiDAR (Light Detection And Ranging) and DEM (Digital Elevation Models) data. Semi-automated mapping techniques of surficial geologic deposits from DEM and hydrologic network data were presented and LIDAR based DEM slope-shapes were discussed. The British Geological Survey presented on geoscience data information management and developing authorship and citation strategies for geologic maps.

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2009 Louisiana Oil and Gas Symposium

On May 19th and 20th, LGS co-hosted the 2009 Louisiana Oil and Gas Symposium at LSU with the Baton Rouge Geological Society, the Center for Energy Studies, Louisiana Oil and Gas Association and PTTC, in celebration of the 75th anniversary of the legislative establishment of LGS. The Symposium included 20 presentations ranging from oil and gas well permitting rules to technical presentation on the Haynesville Shale play. Approximately 100 attendees from industry, government and concerned citizens came to the symposium which was held at the Dalton Woods auditorium in the Energy, Coast & Environment Building at LSU. A write-up of the symposium by Ted Griggs entitled “Experts tout potential of Haynesville Shale” was featured in the May 21st copy of the Baton Rouge’s Advocate newspaper business section.The symposium included two presentations by LGS scientists: “Coastal Management Division’s new general permits” by John Johnston and “Sustainability analysis of the Red River Alluvial and Wilcox Aquifers freshwater resources for the Haynesville Play Development” by Thomas Van Biersel.

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