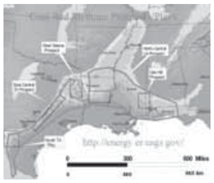

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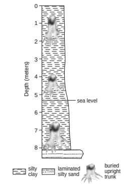

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Louisiana Geological Survey

NewsInsights

June 2005 • Volume 15, Number 2

Louisiana Aquifer Characterization, Aquifer Porosities

Douglas Carlson

Introduction

This article is the third in a series of articles which will appear in the Louisiana Geological Survey's newsletter considering the properties of aquifers within Louisiana. Aquifers are units of rock or sediment which provide an economically useful amount of water for consumers (Fetter, 2001). The determination of Louisiana aquifers' properties is part of a larger goal of the Louisiana Geological Survey (LGS) to develop a series of groundwater models of the major aquifer systems throughout Louisiana. These models will provide policy makers a tool for better understanding of how these various aquifers respond to possible future scenarios of groundwater demand.

However, before the construction of any conceptual and mathematical model can be started there is a need to gather and analyze existing geologic and hydraulic data and develop physical characterization of the aquifer. The result of aquifer characterization provides a reasonable range of hydraulic parameter values to create the model framework and/or test when calibrating a groundwater model. One of the most important properties of an aquifer is porosity. The start of any groundwater modeling project that may include advective flow and contaminant particle transport testing is necessary to gather a large set of porosity values for the aquifer and analyze these results.

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Porosity

Porosity is defined as that part of the bulk volume of an aquifer that is occupied by voids. This pore space, between the earth materials comprising the aquifer, can be isolated or connected (Bates and Jackson, 1980) can be partially or totally filled with a gas (for example air or methane) or a liquid (for example, water or oil). Porosity indicates how much, volume, water can be stored in an aquifer. Porosity is generally expressed as a percentage. The mean porosity of unconsolidated sediment (Figure 1) will decrease as grain size increases (Driscoll, 1986). Clay has a higher porosity than sand due to clay's crystallographic structure. This framework of plates oriented in a random manner, causes the porosity of clay to be greater than that for sand which is composed of roughly spherical grains (Domenico and Schwartz, 1990). Rocks tend to have lower primary porosity values than their source sediment due to the processes of lithification which involves compaction, consolidation and cementation of sediment into rock over time (Fetter, 2001). Porosity can be divided into primary and secondary porosity. Primary porosity forms during a sediments initial deposition (Choquette and Pray, 1970). Secondary porosity forms due to later physical and chemical processes (Fetter, 2001). Usually for silicate sands primary porosity accounts for most of a sand or sandstone's porosity (Grau, 2000). Lithification causes the pore spaces to be reduced. One example of this (Figure 2) is the decrease of porosity between sand lithified to sandstone (Driscoll, 1986). The decrease in porosity resulting from lithification is approximately 90% for clay to shale and 50% for sand to sandstone (Figure 2).

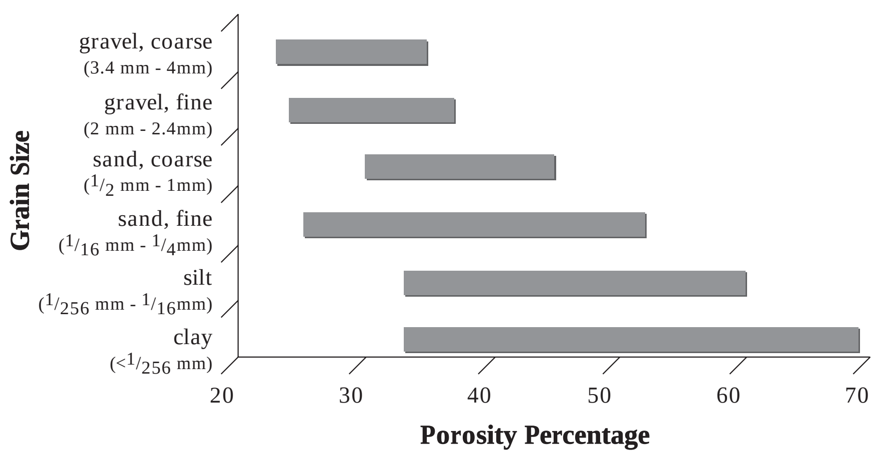

Figure 1. Porosity of common unconsolidated sediments (Table 5.1 of Driscoll, 1986; Tables 2.1 and 2.2 Domenico and Schwartz, 1990; and Tables 2.1 and 3.2 of Weight and Sonderegger, 2001 modified).

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.

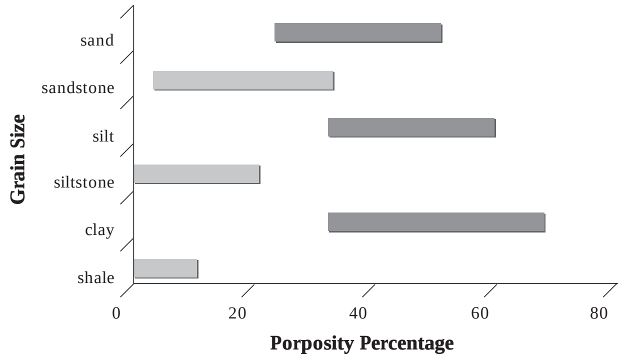

Figure 2. The impact of the lithification of loose sediment into a rock for common sediment-rock types (Table 5.1 of Driscoll, 1986; Tables 2.1 and 2.2 Domenico and Schwartz, 1990; and Tables 2.1 and 3.2 of Weight and Sonderegger, 2001 modified).

Porosity of Louisiana Sedimentary Units

Thie data set of porosity values presented here includes 35,430 results collected from the Louisiana Geological Survey's (LGS's) collection of permeameter tests that are stored within LGS's collection of geophysical logs and other data collected for hundreds of thousands of Louisiana petroleum boreholes. Raw permeameter results in LGS's collection were measured by the companies listed in the acknowledgements. In general, permeameter log reports do not include information of the stratigraphic unit(s) tested only: depth, ownership of well, field name, location, date of testing. The stratigraphic units were determined from interpollation of boring results relative to the cross-sections that appear in Bebout and Gutierrez (1982 and 1983) and Eversull (1984). These three sources have 10 north to south cross-sections that run from near the Louisiana-Arkansas border to the Gulf of Mexico and another 9 north to south cross-sections that run from near Louisiana-Mississippi border to the Gulf of Mexico. These three sources appear to have the most detailed and extensive network of cross-sections with a consistent stratigraphic nomenclature for Louisiana. However, this nomenclature is from the early 1980s and focused on oil bearing units, therefore, Figure 3 was developed to relate this nomenclature to the current stratigraphic nomenclature (Johnston et al., 2000) and hydrostratigraphic nomenclature of aquifers (Lovelace and Lovelace, 1995).

In general, porosity values for aquifers-sedimentary units of Louisiana are fairly similar to each other (Figure 4). The most porous and youngest unit, Pleistocene has an average porosity of 28.0%. The average porosity of the least porous and second oldest aquifer, Sparta, is 20.3%. The difference between smallest and largest porosity is about 40%. By comparison the difference of hydraulic conductivity from the least conductive aquifer, Wilcox, to the most conductive aquifer,

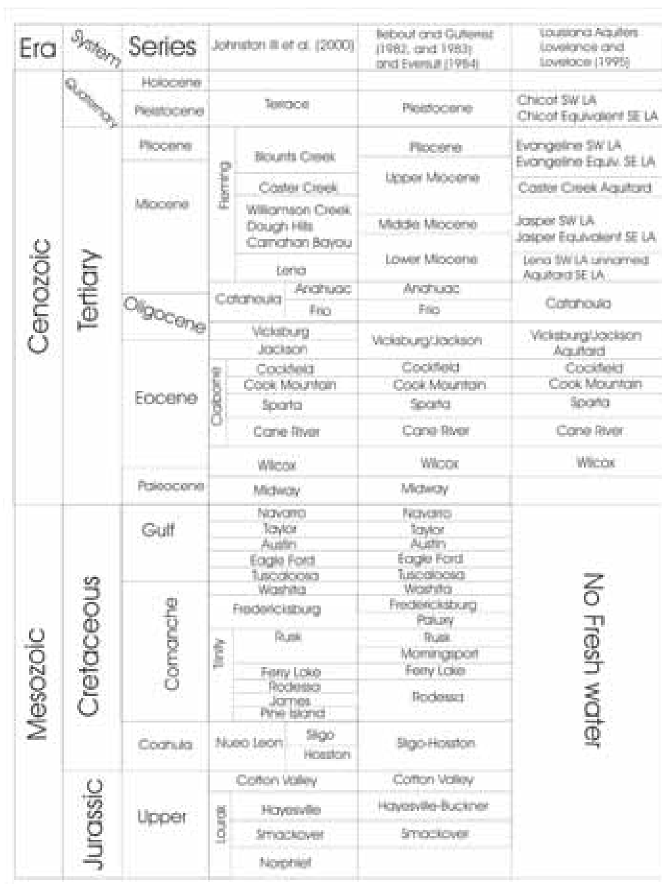

Figure 3. Stratigraphy and hydrostratigraphy of Louisiana. This study uses the Bebout and Gutierrez (1982 and 1983) and Eversull (1984) stratigraphy.

Mississippi River Alluvial, is about 26x (Carlson, 2004). In general, porosity is far less variable among Louisiana aquifers than hydraulic conductivity (Carlson, 2004) and in turn has a less variable impact on advective flow speeds through aquifers.

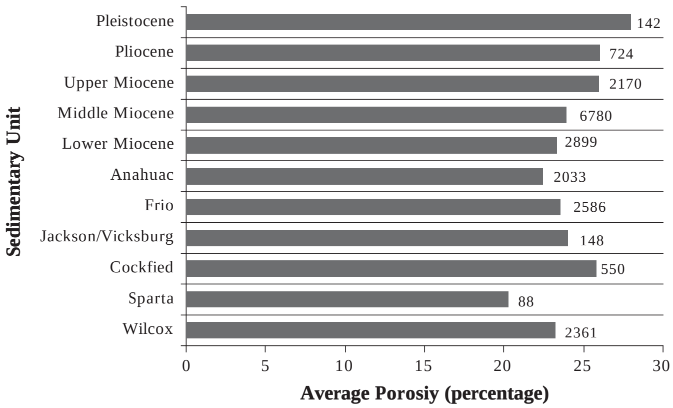

Figure 4. Porosity of Louisiana sedimentary units that are aquifers in parts of Louisiana where they exist. The number at the end of each bar is the number of observations included in the determination of the average porosity.

Distribution of porosity for a typical Sedimentary Unit

For any given sedimentary unit porosity has a range of values. No one value of porosity will define a unit. The porosity's distribution is on average normal: that is it fits roughly a standard bell shaped curve (Doveton, 1994). This normal distribution of porosity appears to exist for sands (Taylor, 1990; and Doveton, 1994). The major aquifer sands of Louisiana exhibit this approximate normal distribution of porosity, Wilcox is an example shown in Figure 5. The Wilcox distribution is a typical distribution, which shows a slight skewness. The Wilcox exhibits an excess of small porosity values as indicated by 4% of the samples having a porosity values that are more than 10% less porous than the mode, 25% to 27% (Figure 5). The mode is the most common range of porosities, for example, the tallest bar appearing Figure 5. By comparison only 1.45% of the samples have porosity values more than 8% more porous than the mode. This indicates that the Wilcox data is slightly negatively skewed, possibly the result of the mixing of sand and silt within the samples analyzed.

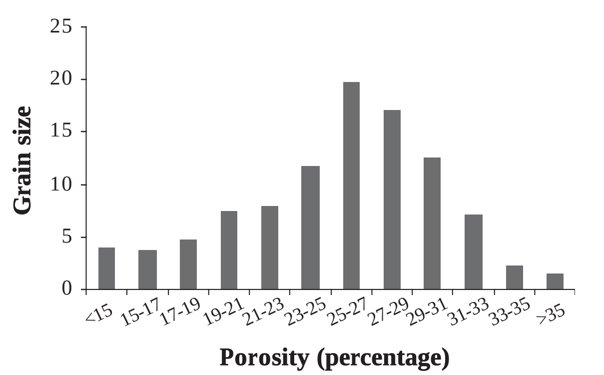

Figure 5. Distribution of porosity values of Wilcox in Rapides Parish was determined from the parish's set of 825 permeameter tests.

Porosity as a function of sediment age

As a result of geologic processes, as the age of sediments increases, porosity will decrease (Figure 6). As the elapsed time after deposition increases the processes of lithification will be more effective in reducing porosity of sediment. The results in Figure 6 include Louisiana sediments, which are both siliciclastic and carbonate sediments, from Pleistocene, 0.01 and 1.8 million years, to Smackover Formation which is upper Jurassic, 154 million years old (U.S. Geological Survey, 2005).

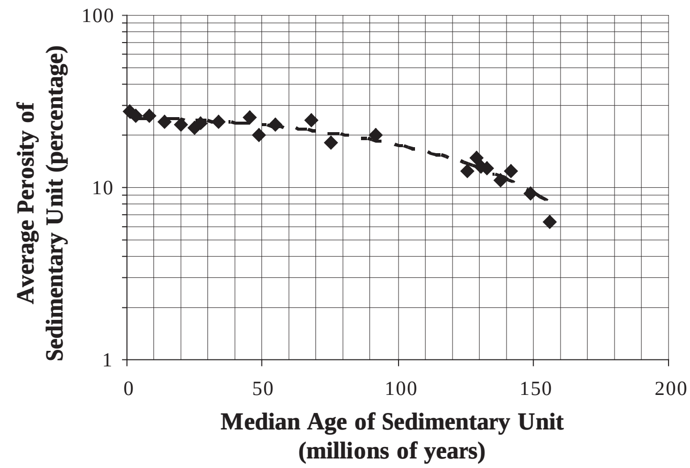

Figure 6. The graph above displays the average porosity of Louisiana sediments as a function of their median age as determine from examination of U.S. Geological Survey's (2005) geologic time scale and Johnston et al.'s (2000) stratigraphy of Louisiana.

Porosity as a function of depth

Porosity of sands generally decreases in a linear manner with depth (Selley, 1985). However, this decrease is slow, about 5% for every 3300 feet in depth (Selley, 1985). The Wilcox of Louisiana has a similar decrease in porosity of 4.95% for every 3300 feet in depth. This reduction is probably due to compaction, a result of the increasing pressure downward on sediment due to the increasing thickness weight of material overlying a given sample depth (Domenico and Schwartz, 1990) (Figure 7).

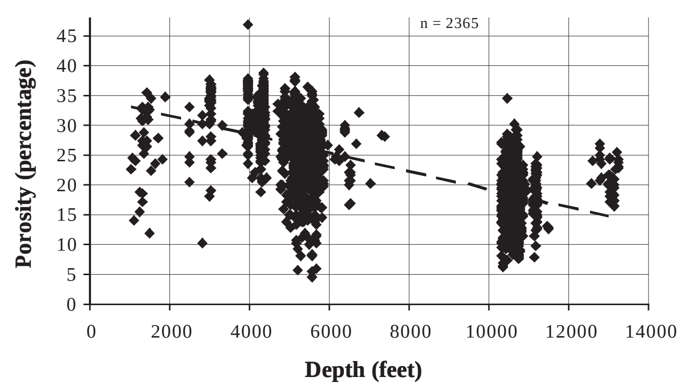

Figure 7. The display above shows Wilcox sands dependence on depth of burial.

Porosity as a function of sediment grain size

It appears that porosity to some extent is a function of sediment the typical grain size of the sediment. Middle Miocene age sand deposits of Louisiana is selected to examine the influence of texture on porosity because it has the largest number of observations with texture descriptions, 3,963, of which 98% are sands (Figure 8). Middle Miocene sands often lies at depths of 8,000 to 14,000 feet throughout southern Louisiana (Bebout and Gutierrez, 1982 and 1983). Two general observations can be made: (1), porosity decreases as grain size decreases and (2), porosity for less uniform sediment is less than for more uniform sediments (Figure 8). A more uniform sand as a narrower range of grain-sizes for sand grains than a less uniform sand.

For coarse sand to very fine sand, the average decrease of porosity is about 1.1% for one sand size category decrease. This is reasonable given that usually finer sediments will lose more porosity than coarser sediments under the same pressure (Beaumont and Fiedler, 1999). The more poorly sorted sediments (those described by two size categories) typically have a porosity that is about 2.4 % less than sediments which are more uniformly sorted (those described by one sand size category). This indicates that for sediments with a wider range of particle sizes there is a chance for smaller particles to fill spaces between larger particles (Montgomery, 2000).

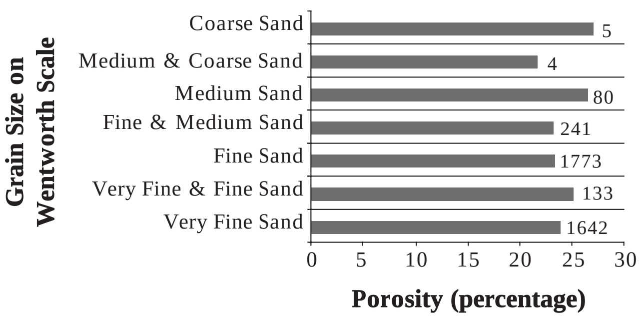

Figure 8. The above display is of average porosity as a function of grain size for Louisiana's Middle Miocene sand. Number at the end of each bar is the number of observations used to determine the average.

Summary

There are a number of general properties of Louisiana sand deposits in terms of their porosity.

1) The average porosity of Louisiana sands is a fairly narrow range of 20% to 28%.
2) The distribution of porosity values for Louisiana sands yields an approximately normal distribution.
3) The average porosity of Louisiana sands decreases with increase in age.
4) The porosity of Louisiana sands decreaes with increasing depth of burial.
5) The porosity of Louisiana sediments decreases as the typical grain size of the sediment decreases.
6) The porosity of Louisiana sediments decreases as the sorting of sediments becomes poorer.

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I would like to recongnize all the following corporations: A.C. Gauthier Jr., Analab Inc., Analog, Bell Coastal Laboratories Inc., Bell Core Laboratories, Ben A. Elmdahl Engineering, Continental Laboratories, Contract Coring Company, Coran Inc., Core Analysis Inc., Core Laboratories Inc., Delta Core Analysis Inc., Delta Well Logging Service Inc., Emrco Core Analysis, Erco Petroleum Services Inc., Exploration Service Company, Gulf Coast Well Logging Service Inc., Hart & Faul Laboratories, Hart & Kelley Laboratories, Humble Oil & Refining Company, Langford Core Analysis & Meredith Laboratories, O'Malley Laboratories, Parnell Core Laboratories, Petro-Core Service Co., Petroleum Reservoir Engineering, Petroleum Service Company, Petroleum Well Logging Service, Rig Time Inc., Shell Oil Company, Southern Mud-Logging Services Inc., Subsurface Evaluation, Texaco Inc., The Analysts, The Atlantic Refining Company, The Hycalog Company, Thigpen Core Laboratories, Union Producing Company,United Core Inc., United Gas Pipe Line Company, and Well Logging Baroid Service that collected and reported the basic analysis of the permeameter data found within LGS collection of permeameter test results.

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Coal Bed Methane (CBM) Research Project Update

Clayton F. Breland

LGS and the Energy Institute at the University of Louisiana at Lafayette have been jointly awarded a grant from the United States Geological Survey (USGS) to pursue CBM research in Louisiana. The project, titled "National Coal Resource Data System (NCRDS) North Louisiana Coalbed Methane Data Collection and Geological Assessment Program", is for a period of five years and is valued at $75K. The project is a continuation of a cooperative work on CBM in Louisiana between Dr. F. Clayton Breland, Jr., Principal Investigator at LSU and Dr. Gary L. Kinsland , Principal Investigator at ULL. The investigators will advise and assist in collection, interpretation, correlation, encoding, and verification of point-source coal and coal-related stratigraphic data from the state for the NCRDS databases. This program compliments work ongoing between LGS and the USGS to assess CBM potential in the state.

In March 2005, the Petroleum Technology Transfer Council, Central Gulf Region, LGS, Lafayette Geological Society and the Energy Institute at ULL sponsored a coalbed methane workshop,"Coalbed Methane Potential of the North-Central Gulf of Mexico Basin," at Northwestern State University in Natchitoches, Louisiana. The workshop consists of morning technical talks and an afternoon fieldtrip to the nearby Red River Mining Company, Oxbow Lignite Mine. Speakers for the morning session included Clayton Breland (LGS), Peter D. Warwick (USGS), Chad Hartman (Ticora Geosciences), Ed Ratchford (Arkansas Geological Commission), Dan Butler (Halliburton Energy Services), David Williamson (AL-TEC Environmental Consultants). Barry Wawak with Core Labs. The Lafayette Geological Society provided the attendees with an excellent fieldtrip guidebook and Don Goddard, PTTC, provided the workbook for the oral presentations. This workshop followed up on a similar meeting held in Lafayette, LA in June, 2004 titled "Coalbed Methane Resources in the Southeast."

Some interesting facts are beginning to fall out of the research on coals in Louisiana. Breland and Warwick have characterized the CBM in the state, using isotopic analysis, as being produced biogenically from bacterial reduction of carbon dioxide. This fact may have implications for carbon management potential for the Gulf Coast Basin coals in the future. Very little, however, is known about the bacteriological communities that reside on these coals. Breland and Warwick are working with Dr. Ralph J. Portier and Dr. Caroline Metosh-Dickey with the Department of Environmental Studies in the School for the Coast and Environment at LSU to characterize these bacteriological communities and perhaps try to understand the conditions under which the bacteria can convert carbon dioxide to methane.

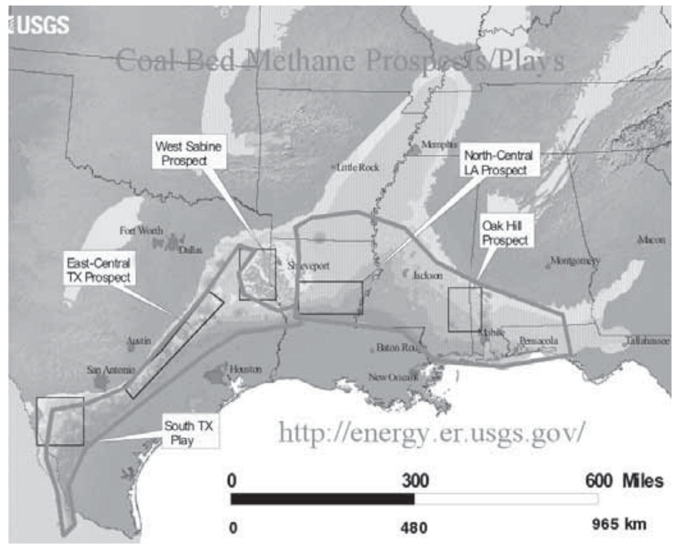


Diagram showing potential coalbed methane prospects and plays (boxes). Based on the current coal gas exploration efforts in north Louisiana and the occurrence of bituminous Cretaceous coal in southern Arkansas, the potential exploration areas have been expanded as indicated by the heavy blue lines.

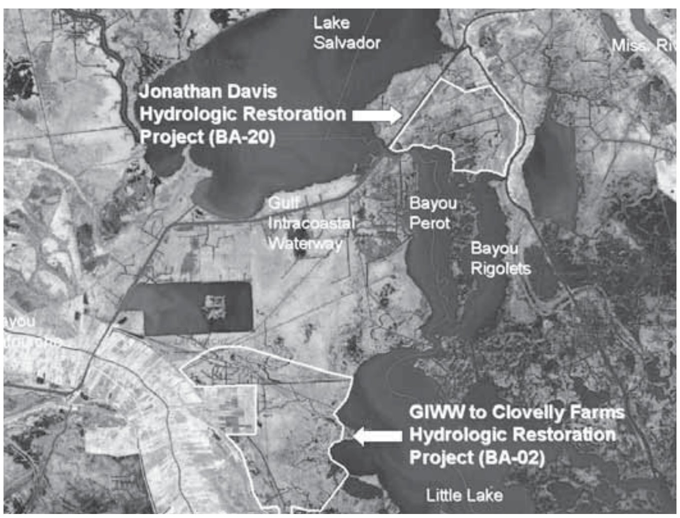
Coastal Research at LGS

Bill Good

On the coastal front, Dr. Bill Good has been pursuing research on coastal restoration projects that he hopes will assist in the advancement of project planning and design. He has currently been investigating two project types, hydrologic restoration and terracing.

The 2003 *CWPPRA Report to Congress* describes hydrologic restoration (HR) as follows, "Natural drainage patterns are restored as much as possible, either on a large scale by gating navigation channels and rebuilding natural ridges, or on a smaller scale by blocking dredged canals and cutting gaps in artificial levees." In practice, this frequently assumes three things: 1) that a major cause or contributor to accelerated land loss rates at the site is an increase in hydrologic connections between historically fresh/intermediate areas and areas characterized by higher tidal variability and salinity ranges, 2) this increased connectivity can be substantially reduced by closing off or restricting hydrologic exchange into the area through HR, and 3) that HR will result in an increased retention of freshwater. The basic concept is straightforward-repair hydrological features in order to return to a previously existing, more favorable set of environmental conditions.

The two projects reviewed were the GIWW-to-Clovelly HR Project and the Jonathan Davis HR Project. Both are near the mid-section of the Barataria Hydrologic Basin and are intended to will promote greater freshwater retention and utilization to prevent rapid salinity increases in the area.



The data reviewed were mainly in the form of monitoring reports from the La. Department of Natural Resources. Based on this review, Dr. Good suggests that there are fundamental questions regarding these projects that still need to be addressed. In particular, water exchange control at the level of the individual structure; at the level of the entire project perimeter; and control through time considering concomitant high water/high salinity events, inevitable extreme events, and operational mandates. Additionally, he presented an alternative conceptual model for HR projects based on an assumption that increasing relative sea level rise and decreased alluvial processes are the primary ecosystem drivers affecting land loss in the project areas rather than an increasing influence of hydrologic interconnections that allow increased marine processes. Based on these findings, Dr. Good suggests that some changes in monitoring strategy should be considered for HR projects in order to shed much-needed additional light on these issues. Field measurements of exchange and simulation modeling efforts for these two projects are currently lacking, although steps are underway to model at least one structure on the project GIWW-to-Clovelly HR Project (Dr. Ehab Mesehle, personal communication). This work was presented in a paper entitled "Questions Posed by a Review of Two Hydrologic Restoration Projects in Louisiana's Barataria Basin" on April 13, 2005 at the Coastal Restoration and Enhancement through Science and Technology Symposium in Lafayette.

Additionally, Dr. Good is studying the comparative success of terracing projects throughout the state. Terracing is a fairly new restoration technique in which a series of ridges are constructed to marsh elevation in shallow coastal ponds or bay bottoms. The first such project was built in Cameron Parish, Louisiana in 1991. The application of this technique has been increasing over time. Five projects were constructed between 1991 and 2000, while an additional 14-to-17 will have been completed by the end of 2005.

Dr. Good will evaluate the longevity of terraces as affected by the interactive effects of site conditions, project design characteristics and construction factors. He plans to use existing aerial photography and other data such as periodic project surveys in order to assess the longevity of terraces. Water level variations and other sources of error will be documented and quantified to the extent possible. Supporting information will include geotechnical data that describes foundation properties of the underlying substrate; as well as soils mapping data; design drawings; and as-built drawings showing the elevational profiles of the constructed terraces.

The following table lists most of the terrace projects constructed to date in Louisiana.

Program	Project Name	Construction Completion Date
LaDNR	Sabine Terraces	1991
LaDWF	Rockefeller Refuge	1997 Price Lake
CWPPRA	Plowed Terraces Demo.	July 1997, Aug. 31, 2000
CWPPRA	Little Vermilion Bay Sediment Trapping	1999
LaDWF	Rockefeller Refuge	2000 Unit 5
CWPPRA	Sweet Lake/Willow Lake	Oct. 2002
NGO et al.	Cameron Prairie DU Project	Spring 2002
Private	Rimco Mitigation Project	2002-2003
CWPPRA	Pecan Island Terracing	2003
LaDWF	Pointe-Aux-Chenes WMA Terraces	Sept. '03, Sept. '04
LaDWF	Rockefeller Refuge--Unit 4	'02, '03, '04
CWPPRA	Four Mile Canal	July 2004
CWPPRA	Grand-White L. Land Bridge	Sept. 2004
Private mitigation	Penny Rhodes Plaquemines P.	Nov. 2004
CWPPRA	Sediment Trapping at "The Jaws"	Dec. 2004
LaDNR	Rainey Refuge Terracing Project	2005
CWPPRA	Freshwater Intro S of Highway 82	2005 (ant.)
CWPPRA	East Sabine Hydrologic Restoration	2005 (ant.)

Renewed Activity in the Tuscaloosa Marine Shale

Bobby Jones

It has long been known by operators and drillers that the Tuscaloosa Marine Shale (TMS) lying between the sands of the upper and lower Tuscaloosa sections (Upper Cretaceous) contained hydrocarbons. This section varies in thickness from approximately 500 feet in southwestern Mississippi to more than 800 feet in the southern part of Louisiana. The primary zone of interest is a highly resistive zone at the base of the shale section which ranges in thickness from 0-325 feet and found below 10,000 feet. The first publication on the TMS and preliminary potential evaluation was done by the Louisiana Geological Survey researchers in 1997. They stated that the TMS may contain potential reserves of about seven billion barrels of oil covering an area of approximately 750,000 acres. Recently as a result of the prevailing high oil prices there has been an upsurge of interest in the exploratory drilling and exploitation of this resource.

Exploration activity in the Tuscaloosa Marine Shale has been dormant for some twenty years but since 1999 renewed activity has developed in the state of Mississippi just across the Louisiana-Mississippi state line in Amite and Pike counties. Worldwide Companies of Magnolia, Mississippi began this activity by successfully completing a horizontal Tuscaloosa Marine Shale well in the South Magnolia Field in 1999. Average monthly production has dropped from 177 barrels in 1999 to 103 barrels in 2004. They also completed a vertical TMS well in the South Magnolia Field that averaged 68 barrels per month from 2/1/02 to 12/1/04. In 2000 PetroQuest Energy, Inc. of Lafayette, Louisiana discovered the Orca Field in Pike County by completing a horizontal well in the Tuscaloosa Marine Shale. Average monthly production has dropped from 266 barrels in 2001 to 78 barrels in 2004. Worldwide Companies in 2004 successfully completed a vertical well in the Tuscaloosa Marine Shale in the Gillsburg Field, Amite County, utilizing the fracturing method performed so successfully in the Barnett Shale of Texas. The well was flowing 100 barrels per day. Worldwide Companies is actively recompleting and drilling more wells to the Tuscaloosa Marine Shale in the Gillsburg Field of Amite County and the South Magnolia and Tangipahoa River Fields of Pike County using the Barnett Shale completion method.

LGS Participating in DOE Carbon Sequestration Research

Byron Miller

The Louisiana Geological Survey is participating in federally funded research on the long-term underground storage of carbon dioxide gas. Referred to as “carbon sequestration”, this research initiative seeks to identify the most efficient technologies to reduce the amount of “greenhouse gases” in the atmosphere, through the capture, transport, and long-term storage of carbon dioxide.

One proposed method particularly attractive to Louisiana and other oil producing states, is to inject carbon dioxide into depleted reservoirs in abandoned oil and gas fields. For many years, operators have known that carbon dioxide gas, injected into a oil reservoir, increases the amount of oil recovered from the reservoir. Therefore, carbon sequestration in declining or depleted oil and gas fields not only holds the promise for job creation in a new environmental industry, but would also serve as a catalyst to revitalize Louisiana’s oil and gas industry.

The LGS is working in partnership with the Texas Bureau of Economic Geology (BEG) and other agencies to provide digital information on prospective oil and gas fields. This information will provide a regional picture of possible carbon sequestration sites and associated infrastructure. A pilot project to study the feasibility of carbon sequestration, through the monitoring of carbon dioxide injection and underground storage in a depleted oil reservoir, has been proposed for funding by the U.S. Department of Energy.

In addition, the Texas BEG, in partnership with LGS, has taken the lead in proposing a multi-year research project to evaluatecarbon sequestration options and technologies associated with a DOE initiated “clean energy” power generation plant. This ambitious pilot project proposed by DOE, dubbed “FutureGen”, will investigate the methods and technologies needed for the next generation of electrical power plants to utilize coal derived synthetic gas to generate electricity with zero emissions to the atmosphere.

Presentations

John Snead presented *“Digital Mapping and Field Investigation of the Pipeline Crossings of the Intracoastal Waterway in Louisiana”* at the May Symposium of the Louisiana Applied and Educational Oil Spill Research & Development Program (OSRADP). The symposium was hosted by the Louisiana Oil Spill Coordinator’s Office at the Pennington Biomedical Research Center in Baton Rouge.

Robert Paulsell presented *“Research and Development of a GIS of Petrochemical Transmission Pipelines in Lafayette, Louisiana”*, also at the May Symposium of the Louisiana Applied and Educational Oil Spill Research & Development Program.

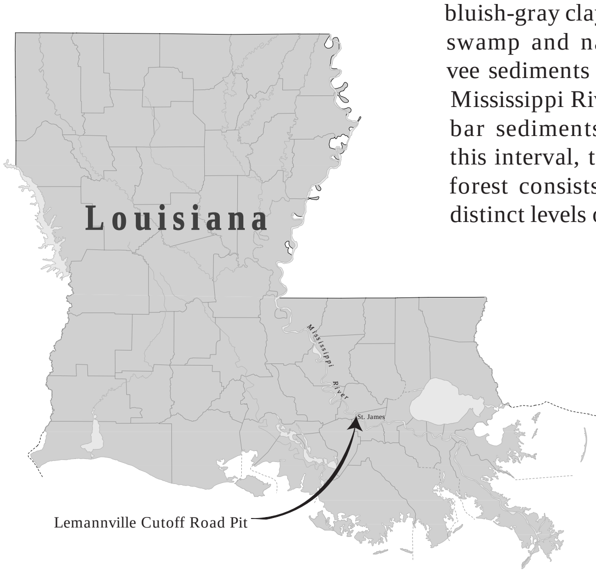
John Snead presented *“Development of Spatial Data, Maps, and Interactive Online GIS for the New Orleans Hurricane Health Project”* at the annual symposium and advisory board meeting for the LSU Center for the Study of Public Health Impacts of Hurricanes in May.

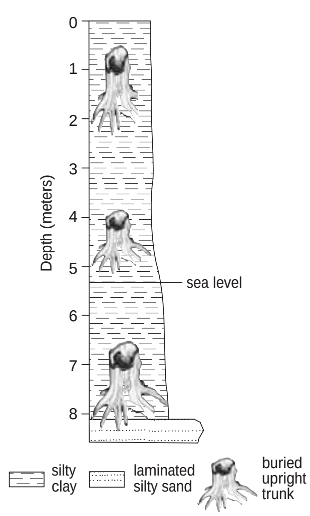
Paul V. Heinrich presented *“The Brushy Creek Impact Crater”* at the St. Helena Historical Society, Montpelier, Louisiana. The talk was followed with a field discussion on the rim of the Brushy Creek crater on the property of William A. McGehee.

Significance of Buried Forests Exposed in the Lemannville Cutoff Road Pit, St. James Parish, Louisiana

Paul Heinrich

The excavation of the Lemannville Cutoff Road Pit within Point Houmas of the Mississippi River just northwest of Lemannville in St. James Parish exposed three buried cypress forests beneath the modern floodplain of the Mississippi River as outlined in an earlier article by Heinrich. This borrow pit exposed 7 to 8 meters to (23 to 26 feet) of bluish-gray clayey backswamp and natural levee sediments overlying Mississippi River point-bar sediments. Within this interval, the buried forest consists of three distinct levels of upright standing trunks firmly rooted in the underlying sediments. The oldest forest was reported as consisting of the upright trunks of unidentified trees firmly rooted in the point bar sands exposed at the very bottom of the pit. Lying directly above the lowermost buried forests, two more levels of buried forests composed of cypress trees were found rooted in backswamp deposits. Each of these buried forests consists of upright buried trunks about 1.5 to 2 meters (5 to 6.5 ft) high separated by about 3 meters (9 ft) of clayey sediments. The trunks of the uppermost forest occur about two-thirds meters (1.5 to 2 feet) below the surface of the modern floodplain (Heinrich, 2000).





Although radiocarbon dates are currently lacking, maximum age of the lowermost forest can be inferred from the chronology of the Mississippi River delta lobes as described by Frazier (1967). Given that the lowermost buried forest lies on point bar deposits of the Mississippi River, it must postdate the establishment and meandering of this segment of the modern course of the Mississippi River. Therefore, the lowermost buried forest and the fine-grained sediments overlying the point bar deposits, in which it is rooted, must postdate 4,700 radiocarbon years BP (Frazier, 1967; Britsch and Dunbar, 1990).

The preservation of upright standing forests demonstrates that the rate at which the sediments exposed at the Lemannville Cutoff Road Pit accumulated has varied considerably during the last 4,700 years. As discussed by Gastaldo et al. (2004) and Waldron and Rygel (2005), the preservation of an upright standing trunk requires the relatively fast burial of the trunk before it decays. Each of the forests exposed in the Lemannville Cutoff Road Pit, in order to be preserved as well as they are, must have been buried to depths of 1.5 to 2 meters (5 to 6.5 ft) within a period of at least 100 years. After being buried to these depths, the rate of accumulation slowed to the point that the remaining part of the trunks of these trees decayed before they could be buried. The minimum rate at which sediments surrounding the buried trunks would have accumulated must have been 1.5 to 2 cm (0.6 to 0.8 in) per year to bury each of these forests to a depth of 1.5 to 2 meters (5 to 6.5 ft). Thus, the rate at which these forests were buried exceeded the average rate, 0.5 cm (0.2 in) per year, at which the fine-grained sediments covering the point bar deposits exposed in the Lemannville Cutoff Road. Since estimated burial rate for the buried upright trunks is only a minimum rate, the actual rate at which sediment buried these upright stumps could have been much higher. Therefore, the buried forests exposed in the Lemannville Cutoff Road Pit provide evidence of three periods of rapid above-average, sedimentation during the Late to Middle Holocene within the northern part of the Louisiana coastal plains.

The narrowness of the meander belt of the segment of the Mississippi River on which the Lemannville Cutoff Road Pit lies precludes lateral migration of the Mississippi River as an explanation for the creation of these buried forests. Sedimentation rates within a floodplain can vary as the course of a river shifts back and forth across it. As shown by Saucier (1969), the meander belt within the area of the Lemannville Cutoff Road Pit is quite narrow varying between less than 0.6 km (0.4 mi) to just over 3.2 km (2 mi) in width. The meander belt of the modern course of the Mississippi River is far too narrow for any shifting of the channel in the last 4,700 years to have made any difference in sedimentation rates within the area of this pit.

The location of the Lemannville Cutoff Road Pit makes delta switching problematic as an explanation for repeated periods of rapid sedimentation. The pit lies within a point bar of the Mississippi River at the westernmost end of the oldest lobe of St. Bernard delta complex. The location of this pit lies too far north of the main region of sediment accumulation associated with the lobes of the Lafourche delta complex for the formation of this delta lobe to have caused rapid sedimentation within it. At this location, the pit also lies far too west of the distributaries of the delta lobes of the St. Bernard complex for sedimentation associated with these lobes to have directly caused an abrupt increase in sedimentation at any time (Frazier, 1967; Britsch and Dunbar, 1990). It is possible that the eastward progradation of distributaries of the Bayou La Loutre lobe could have raised the base level of the Mississippi River along its channel and resulted in aggradation of its natural levees and floodplain. However, this cannot explain the multiple periods of rapid accumulation of sediment. Also, it is questionable whether the westward progradation of this delta lobe could raise base level fast enough to have caused aggradation rapid enough within the Lemannville, Louisiana area to have preserved the forests by burying them.

Another possible explanation is that changes in local base level resulted from periods of accelerated subsidence within the area of the Lemannville Cutoff Road Pit as was argued for the upright fossil trunks of lycopsids, calamites, and other plants found with coal-bearing Carboniferous strata of Nova Scotia, the Black Warrior Basin, and elsewhere (Gastaldo et al. 2004; Waldron and Rygel, 2005). Localized subsidence, as proposed for parts of the modern delta plain by Gagliano (2000) and Gagliano et al. (2003), resulting from reactivation of local faults by salt tectonics or gravity slumping could rapidly change base level locally. Such changes would not only create large depressed areas in which sediment would accumulate, but also low segments within natural levees where sediment-bearing flood waters could preferentially breach them. Subsidence would not only rapidly create depressions in which sediments can accumulate, but also allow for this sedimentation to take place. However, there is a lack of any obvious evidence for either faults or other structural features that can be the cause of such subsidence. Furthermore, a detailed study of sea-level history in the Gramercy - Lutcher area about 24 km (15 miles) southeast of the Lemannville Cutoff Road Pit by Tornqvist et al. 2004) found a lack of any indication of abrupt changes in sea-level rise that could be interpreted as representing significant variations in subsidence rates.

The rapid sedimentation responsible for creating buried forests with upright trunks, as exposed at the Lemannville Cutoff Road Pit might also have been the result of major changes in the regime of the Mississippi River. Excavations at the Raffman Site in northeast Louisiana and other ongoing research by Dr. Tristram R. Kidder (Washington University, St. Louis, Missouri) has uncovered what he regards as evidence of periods of massive flooding during the period of 2400 to 3200 BP far exceeding in magnitude any recorded historic flood. Such catastrophic flooding during the Late Holocene could certainly explain multiple periods of rapid deposition and in-place burial of forests by sediments exposed in the Lemannville Cutoff Road Pit. Unfortunately, the lack of radiocarbon dates from the buried forests make it impossible at this time to determine if the buried forests date to the period during which these floods are hypothesized to have occurred, and prevent any firm conclusion of their origin.

Regardless of their origin, it is apparent that these buried forests quite likely could provide useful information about the depositional and environmental processes that have played an important part in the formation of the Mississippi delta plain and continue to shape it at present.

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LGS Aids City Parish in West Nile Virus Control

In early 2004, Assistant Director John Johnston of the LGS and Matthew Yates of East Baton Rouge City-Parish Mosquito Abatement and Rodent Control were discussing the occurrence of West Nile Virus in East Baton Rouge Parish. During the conversation Johnston asked Yates what imagery tools were available to the City-Parish in the fight against the virus and was surprised by the answer.

The result was an immediate effort by the LGS to provide assistance to the City-Parish in the fight against West Nile Virus. High-quality aerial photography and LIDAR imagery were provided to the Mosquito Abatement and Rodent Control by the LGS, and members of the MARC staff visited the LGS to learn some of the ways to best use the new tools. The results have been significant. With the aid of the LIDAR and the aerial photography, MARC's staff has been able to determine that human cases of West Nile Virus in 2004 correlated with proximity to two types of features: drainage features with smaller laterals and moderate to large wooded lots. A possible explanation for this correlation may be the nesting and foraging opportunities these features provide to birds which are the enzootic hosts of West Nile Virus. MARC is already using this information to help control both the mosquito populations and the transmission of West Nile Virus in the identified areas.

The next step is to computerize the information and analyze it. Current plans are to combine the imagery with the 2004 West Nile Virus epidemiological information and other data and to perform geospatial analysis on the resulting data in order to identify the areas of significant risk in the city-parish. MARC will then use this information to improve the odds in the ongoing battle with West Nile Virus.

In Memory

David E. Pope, 84, who retired as Senior Research Geologist from the Louisiana Geological Survey (LGS) in December 1999 passed away on Sunday, May 29, 2005, after a short illness. Affectionately called "Dave" by most of his friends and colleagues he continued to work as a volunteer with LGS until the end. Dave began his career as a biostratigrapher and paleontologist with Union Producing Company in 1948 and worked with them for nineteen years in Houston, New Orleans, and Lafayette and retired in 1967 as District Paleontologist. He worked as a consultant from 1967 to 1975 at which time he joined the Louisiana Geological Survey in Baton Rouge.

Any individual who has ever served in any official capacity for the Gulf Coast Association of Geological Societies (GCAGS), the Baton Rouge Geological Society (BRGS) or for that matter, any of the member societies of the GCAGS will doubtless be aware of the valuable contributions made by Dave to every organization he has been involved with in various capacities. Dave was born in Forrest City, Arkansas, and graduated from Forrest City High School in 1938. He then attended Louisiana State University on a football scholarship, but his university career was interrupted when he was commissioned as a Second Lieutenant in 1942 to serve in the U.S. Army during World War II. He returned to LSU in 1946 and received his B.S. degree in 1947 and an M.S. degree in 1948 with specialization in micropaleontology. He was a student of H.V. Howe, R.J. Russell, H.N. Fisk, and C.J. Roy.

During his career in the U.S. Army, Dave advanced to the rank of Captain and was awarded the Silver Star twice, Purple Heart, the Mediterranean Theater Medal with three battle stars, and the Combat Infantrymen's Badge. Dave graduated from the Infantry School (1943), the U.S. Army Counterintelligence School (1955), the 4th (now 5th) U.S. Army Military Intelligence School (1962), and the U.S. Army Command and General Staff College (1967). He separated from active duty in 1946 but continued his military career in the Army Reserves and retired as Lieutenant Colonel in 1968. He is a life member of the Reserve Officers Association and the Military Order of World Wars (MOWW) and has also served as the Vice Commander/Commander-elect of the Baton Rouge Chapter of MOWW.

The only person to serve as President of both GCAGS (1985-86) and the Gulf Coast Section of the Society of Sedimentary Geology (GCSSEPM) from 1959-60 Dave was a very active member of these organizations as well as the American Association of Petroleum Geologists (AAPG), the local section of American Institute of Professional Geologists (AIPG), and other local societies. He co-founded the present BRGS in 1979 along with Harry Roland. He has served BRGS as President, Vice President, chairman of numerous committees, and was awarded Honorary Membership in 1991. He was the main motivating force behind BRGS. The highly successful 1995 and 2003 GCAGS Conventions in Baton Rouge were spearheaded by Dave Pope who was the General Chairman.

Dave attended the first GCAGS Convention while working in New Orleans in 1951, and has made most of them since then. He has served GCAGS in various capacities as Acting Secretary (1956-57), Vice President (1984-85), President (1985-86) and assisted in editing various GCAGS Transactions, served on various Committees, chaired technical sessions, judged papers, and has published papers in the Transactions, including the history of the GCAGS in 1991. Dave was the GCAGS Historian since 1983 and was awarded Honorary Membership in 1997. He is charter member of the Gulf Coast Section of SEPM (1953), and received Honorary Membership in 1987.

Both AAPG and AIPG have benefited from Dave's willingness and interest in involving himself in the various geological societies. He has been a member of the AAPG since 1949 and AIPG since 1985. He is an AAPG Certified Petroleum Geologist, and a contributor to the COSUNA Gulf Coast Correlation Chart (1988). Dave has served AAPG as a member on the Committee for the Preservation of Cores and Samples (1957-60), and has been on the membership Committee since 1988. He was Vice-President and President-elect of the Louisiana Section of AIPG (1997-98) and was the Vice-General Chairman for the 1998 AIPG Convention held in Baton Rouge. Dave has been a member of the New Orleans Geological Society since 1949, serving as Secretary (1956-57), Vice President and Program Chairman (1961-62) and has served on various committees.

Dave has been married to Alice Duke Akins of Baton Rouge since 1990. His two sons, David Brian "Rusty" and Mark Alan, live in Lafayette and they were born when he was married to Dorothy Salario, now deceased. Dave is also survived by his two sisters, Mary Jane Pope Wilson and Evelyn Pope Burrows Dunn, both of Forrest City and several nieces and nephews.

Dave's biography is essentially a history of selfless and dedicated service to the Louisiana Geological Survey, GCAGS, BRGS, and many other professional organizations.

He will be missed by all who knew him.

Chacko J. John

Conferences & Awards

LGS/LSU Cartographers Win National Map Design Award

Louisiana Geological Survey cartographers John Snead, Lisa Pond, and Robert Paulsell have been honored by the American Congress on Surveying and Mapping–Cartography and Geographic Information Society for the map "*The Atchafalaya Basin*", that won in the professional category for "Best Reference Map".

The 32nd annual ACSM Map Design Competition results were announced at the 2005 ACSM Conference in Las Vegas in late March. The purpose of these awards is to promote interest in map design and to recognize significant design advances in cartography. The competition is open to all professional and student map-makers in the United States and Canada. Noted cartographers and designers judge the entries based on the following criteria: overall design and impression, craftsmanship, color, and typography. Entries will be displayed at a number of other national and international professional functions and will then become part of the permanent collection of the U.S. Library of Congress.

The prizes for professional maps included:

- Best of Show – *Salton Sea Digital Atlas,* Lisa Benvenuti, Nate Strout and Ben Yetman, The Redlands Institute, University of Redlands
- Reference – *The Atchafalaya Basin,* John Snead, Lisa Pond and Robert Paulsell, Louisiana Geological Survey, Louisiana State University
- Thematic – *Battle of Hampton Roads,* Robert E. Pratt, National Geographic Society
- Book/Atlas – *National Geographic Atlas of the World,* National Geographic Maps
- Recreation/Travel – *Dynamap: Manhattan,* Ian White, Urban Mapping LLC
- Interactive Digital – *Salton Sea Digital Atlas,* Lisa Benvenuti, Nate Strout and Ben Yetman, The Redlands Institute, University of Redlands

www.acsm.net/cagis/04mapwinners.html

Robert Paulsell, Lisa Pond and John Snead.

Personnel News

Ann Tircuit, LGS Office Coordinator, has been working with team registration and supplies at the 102nd Annual Championship of Bowlers, sponsored by the American Bowling Congress. The event, being held in Baton Rouge at the River Center, began on February 12 and will run through July 4, 2005.

School Outreach

LGS Research Associate Riley Milner presented a general talk on the geology of Louisiana to the Galvez Primary school. The combined class of seven teachers and 130 second graders were shown rock and mineral samples. The students showed a keen interest in observing and holding rock and mineral specimens and had many questions. LGS was invited to make this presentation by Ms. Anne Brooks who is a teacher at the school.

Geological Society of America, Biloxi, Mississippi, March 17-18, 2005

Five LGS geoscientists presented four posters at the 54th annual meeting of the southeastern section of the Geological Society of America held March 17-18, 2005 at the Grand Casino Biloxi, Mississippi. The titles of the posters and associated abstracts which were published in Geological Society of America's Abstracts with Programs, v. 37, no. 2, are:

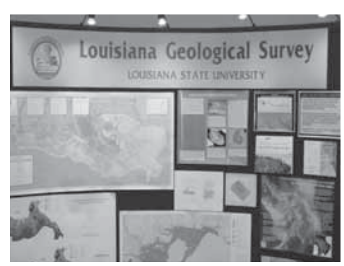
Carlson, Douglas, and Riley Milner, *"Multiple sedimentary axes impact on the Chicot Aquifer"*

Heinrich, Paul V., *"Contrasting Pleistocene and Holocene fluvial systems of the lower Pearl River, Louisiana and Mississippi, USA"*

McCulloh, Richard P., *"Basement tectonic signature in the orientation frequencies of streams in the western two-thirds of Louisiana"*

Miller, Byron, *"The Baton Rouge fault: conduit or impediment to groundwater flow?"*

LGS also had an exhibit booth at this meeting where LGS publications and ongoing research information were displayed. The booth attracted a large nymber of meeting attendees.



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LGS Hosts National Meeting of Geologic Mapping Specialists

The Louisiana Geological Survey hosted the 2005 Digital Mapping Techniques workshop (DMT '05) at LSU on April 24-27. DMT '05 is the ninth such national meeting and is an invitation-only event sponsored by the U.S. Geological Survey and the American Association of State Geologists. It is designed to bring together government mapping scientists, cartographers, and geologists who are using digital techniques to create and manage geologic maps and geographic information systems (GIS).

Chip Groat, director of the U.S. Geological Survey, delivered the keynote address. Most of the state and federal geologic mapping agencies were represented along with key GIS and digital graphics industry representatives. 104 participants represented 30 states and 3 countries at DMT '05. Robert Paulsell was the LGS coordinator for this conference and was assisted by Lisa Pond, Riley Milner, Reed Bourgeois, John Snead, Rick McCulloh and Jeanne Johnson. David Soller (USGS) arranged the technical program.

Topics included design and implementation of geodatabases, cartographic techniques for creating paper and digital maps, spatial data management, and progress toward building the National Geologic Map Database.

Sponsors for the meeting were the Baton Rouge Geological Society, Louisiana Oil Spill coordinators office (Roland Guidry, Director), Louisiana Section of the American Institute of Professional Geologists, and Navigation Electronics (Trimble). LGS thanks all these sponsors for their support.

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