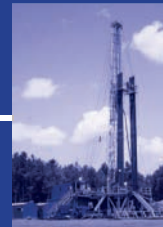
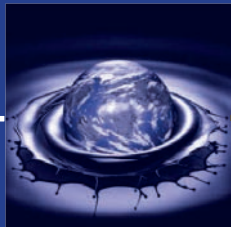


Center for Energy Studies

Annual Report • 2011



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Center for Energy Studies

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center for energy studies

ALLAN G. PULSIPHER, EXECUTIVE DIRECTOR

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Research 2011

During the past year, Center for Energy Studies researchers addressed timely energy-related issues impacting Louisiana and the Gulf Coast region.

Mark Kaiser, professor and director of the Research & Development Division, and **Yunke Yu**, research associate, published a series of timely articles in the *Oil and Gas Journal* on the future production and profitability of the Louisiana Haynesville natural gas shale play. An update on their work appears on the following pages.

David Dismukes, professor and associate executive director, completed an "OCS-related Infrastructure Fact Book" on post-hurricane impact assessment for the Bureau of Ocean Energy Management (BOEM). The fact book examines 13 major types of energy infrastructure along the GOM, including platform fabrication yards, shipyards and shipbuilding yards, port facilities, support and transport facilities, waste management facilities, and pipelines. The detailed report explains how the region's energy infrastructure is an important component of the overall value chain of North American energy production, refining, transportation, and distribution, and shows that a disruption in the region's infrastructure can have dramatic implications for not only domestic but also world-wide energy markets. As are all reports for BOEM, this report is available on the BOEM website www.data.boem.gov/homepg/data_center/other/espis/espismaster.asp?appid=1

Dismukes and Christopher Peters, research associate, prepared the report "Diversifying Energy Industry Risk in the GOM," focusing on post-2004 changes in offshore oil and gas insurance markets, also for the BOEM. The study finds that many post-storm insurance-related changes were not unexpected, including changes to total coverage limitations, coverage terms, risk-sharing terms, and premiums. The more significant unexpected changes were higher annual informational requirements for insuring offshore assets and the greater degree of asset risk assessment and modeling that has become commonplace in the industry.

Mark Kaiser, Allan Pulsipher, professor and executive director, and **Brian Snyder**, research associate, assessed the opportunities for alternative uses of hydrocarbon infrastructure in the Gulf of Mexico. Their research reveals that it is possible for mariculture and offshore wind projects to use oil and gas infrastructure in the future, but in the near term, converting platforms to artificial reefs is the only realistic use.

Omowumi O. Iledare, professor and director of the Energy Information Division, prepared "A Comparative Analysis of the Performance of Selected E&P Firms in the U.S. & Abroad." The research determined that positive changes in petroleum prices matter significantly more than taxes in petroleum producing regions worldwide. There is also statistical evidence to suggest that the impact of tax burdens on E&P outcomes in the U.S. are significantly less than the outcomes abroad, but the impact of a higher tax burden on the aggregate performance of E&P investments by Financial Reporting System energy companies in the U.S. and abroad is significant.

For a full listing of publications and projects,
visit www.enrg.lsu.edu

Haynesville Update

Mark J. Kaiser

Shale gas plays are an important part of the U.S. and Louisiana energy landscape and a powerful engine for economic growth and tax revenue, but often, reserves are overstated and costs understated, and many unconventional wells require peak market conditions to be commercial. In this note, we assess operator reserves disclosures in the Haynesville and provide a forecast of future production scenarios. Unless market conditions improve, well profitability will suffer and production at current levels will not be maintained in the future.

“For gas prices below \$4/Mcf, only the best producing wells, which occur about once every four or five wells drilled, are profitable.”

Haynesville Production

Louisiana’s Haynesville shale started producing in 2008, and within the last three years, gas production in the state has doubled (Figure 1). In 2011, 62 percent of state gas production was sourced from the Haynesville (Figure 2).

Haynesville wells decline rapidly, and production depends strongly on the number of wells that are brought on-line. Once investment and drilling slows down, as was evident during the first half of 2012, production will fall quickly. In July 2012, gas prices are the lowest in a decade, and additional contraction is expected as operators reduce capital expenditures and rigs in the area idle or reposition to other oil and liquids-rich gas basins.

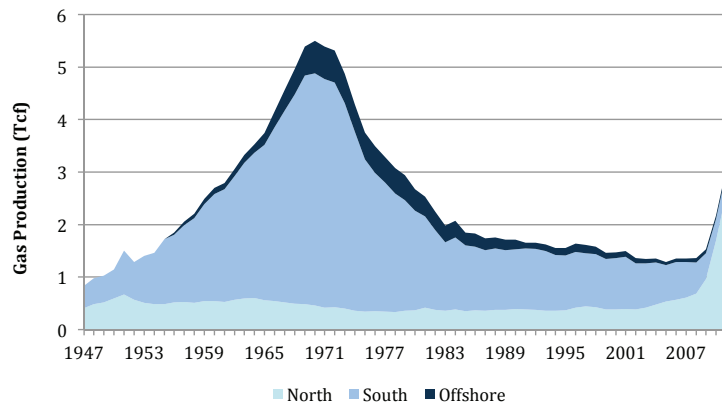


Figure 1. Louisiana historical gas production by region (1947-2011).

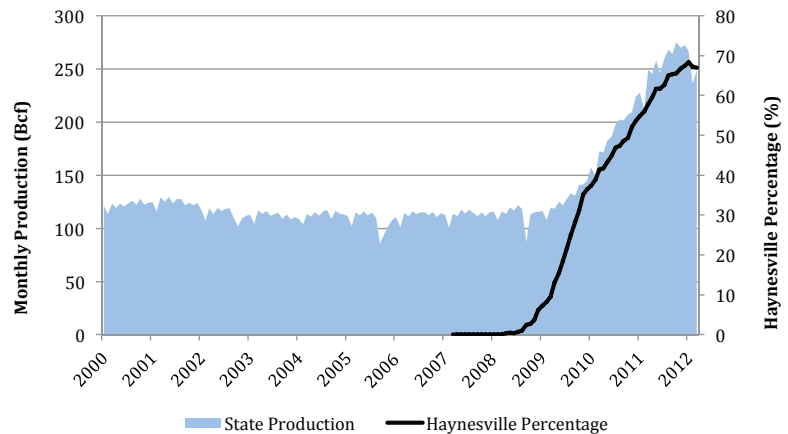


Figure 2. Haynesville contribution to state gas production (2000- March 2012).

Drilling Activity and Rig Count

From 2008 through March 2012, 2,265 wells were spud in the Haynesville, and 2,027 wells were completed (Table 1). The number of rigs working the Haynesville is shown in Figure 3. There was a steady increase in rigs through 2Q2010, and then just as steady a decline thereafter. High rig counts correspond to greater numbers of wells spud, and at current counts, we would expect between 30-60 wells/quarter to be drilled in the region through the end of the year.

Challenging Economics

High completion rates are a general characteristic of resource plays because the continuous nature of the formation leads to low discovery risk. High completion rates do not correspond to profitability, however, and to assess economics, cost and revenues must be considered.

To produce, shale gas wells are drilled horizontally and require hydraulic fracturing to establish a flow path from the reservoir to the wellbore. To date, 75 percent of Haynesville wells have been drilled between 11,000 and 12,500 ft. vertical depth with a horizontal distance of 4,000 to 5,500 ft. The depth of the Haynesville shale and horizontal trajectory of the wellbore, and the large number of stages involved in fracturing, mean that drilling and completion costs are higher than shale wells drilled elsewhere in the U.S. Early wells in the Haynesville cost between \$11 and \$13 million to drill and complete, while today, costs often range from \$9 to \$10 million.

The high cost of well construction coupled with fast decline rates means that the ability to squeeze out a profit from production is challenging (impossible) in low price environments. Various analysts have estimated the breakeven price for the average Haynesville well between \$3 and \$6/Mcf. Previously, we showed that the average Haynesville well is not expected to be commercial except under peak market conditions. For gas prices below \$4/Mcf, only the best producing wells, which occur about once every four or five wells drilled, are profitable.

Table 1. Haynesville shale drilling, completion, and production activity

Year	Wells Spud	Wells Completed	Haynesville Production (Bcf)	State Production (Bcf)
2007	8	2	0	1,355
2008	163	58	20	1,360
2009	540	351	331	1,528
2010	890	700	1,040	2,261
2011	608	796	1,900	3,048
1Q2012	64	122	508	752
All	2,273	2,029	3,799	10,305

Source: Louisiana Department of Natural Resources.

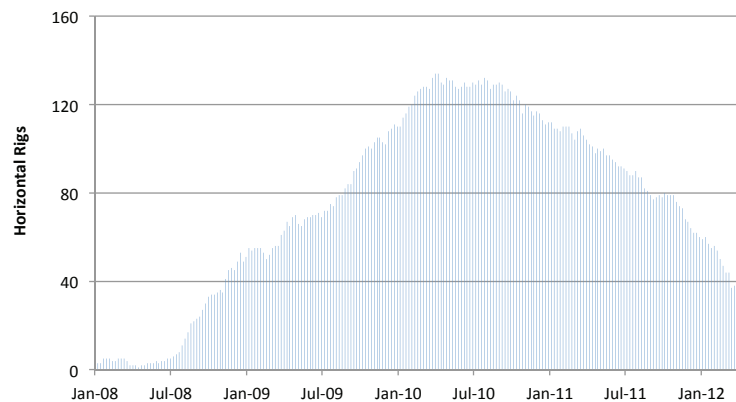


Figure 3. Number of Haynesville horizontal gas rigs (January 2008-March 2012).



Average Profiles

In Figure 4, the average production profiles from all Haynesville wells grouped by year of first production are depicted. Many factors contribute to well production, including the depth, thickness, and lateral extent of the shale; organic richness; thermal maturation; permeability and pore pressure; stimulation success; and completion strategy. All shale gas wells are dominated by early “flush” production, which is the rapid flow of gas from the fracture network created by the stimulation treatment. Initial production rates tend to reflect how much rock has been exposed by the completion, and as the length of the lateral and fracture network complexity increases, initial production generally increases. After the fractures produce, the surrounding rock matrix gives up its gas molecules much more slowly, and production rates drop off quickly.

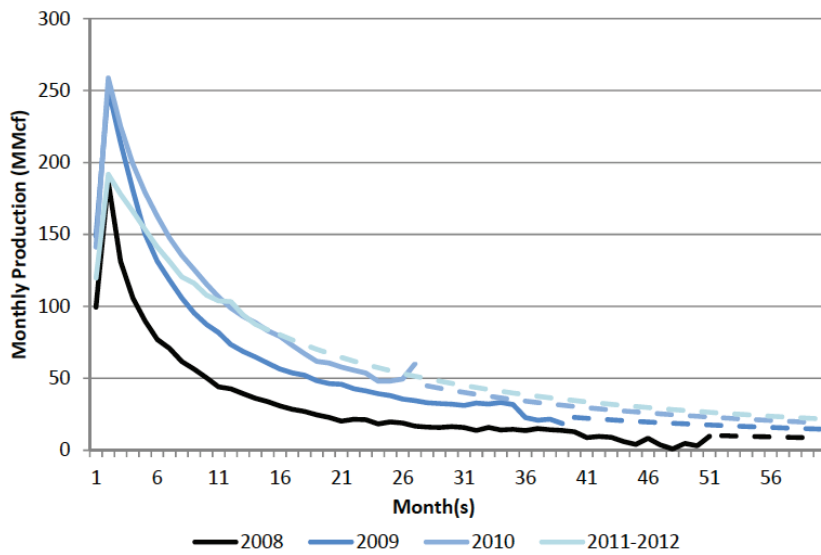


Figure 4. Average monthly production profiles by well vintage.

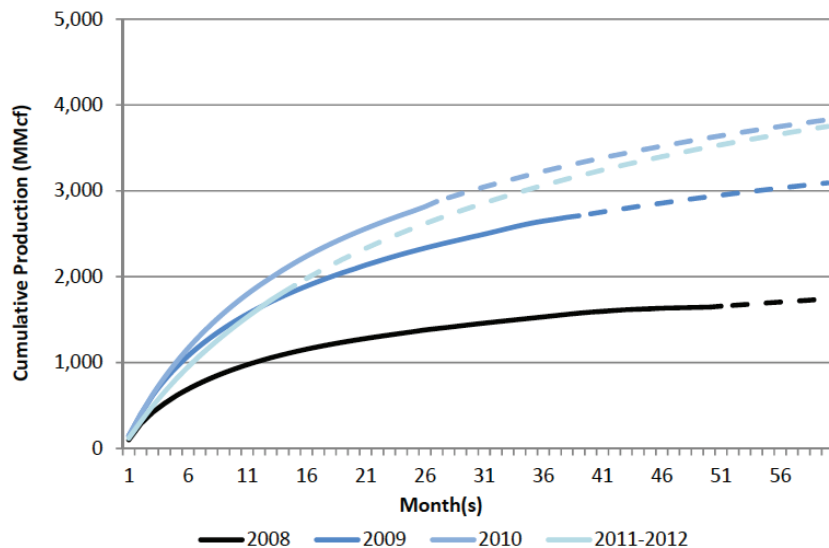


Figure 5. Average cumulative production profiles by well vintage.

Hedging Price Risk, Valueless Volumes, and Severance Tax Suspensions

Average recovery volumes are depicted by vintage in Figure 5. Most wells recover half of their expected ultimate recovery (EUR) during the first year of production, and between 60 and 70 percent during the first two years. This leads to three important consequences.

Gas prices during early production are a major risk factor for companies that are not hedged. Many companies use derivatives and other financial instruments to protect against weak gas prices and volatility, but in depressed price environments, it is difficult to find attractive hedge prices for significant volumes, and operators become exposed to price risk.

Steep decline curves leave little room for value later in life. EURs are important to book reserves, but after a few years, economics become irrelevant because of the rapid production decline and marginal tail volumes.

Under Louisiana Revised Statute 47:633(7) (c), all severance tax collected from production of a horizontal well is suspended for a period of 24 months or until payout of well cost is achieved, whichever comes first. Since the majority of production from Haynesville wells occurs during the first two years and well costs are high, the state foregoes a significant amount of tax revenues in support of the Haynesville development.

Expected Ultimate Recovery

The ultimate recovery of a well is a function of its decline rate, formation characteristics, reservoir drive, completion design, operational practices, and investment strategy. For shale gas wells, the effectiveness of the fracture system is a primary factor in well success and long-term production.

We computed the EUR for all 1,920 producing Haynesville wells circa March 2012 on both single-well and multiple-well LUWs. Single-well LUWs completed in 2008 are expected to yield an average EUR of 4.2 Bcf per well, and for those completed in 2009-11, between 5.6 and 5.9 Bcf/well. On multiple-well LUWs completed in 2009-11, EURs range between 5.3 and 6.0 Bcf/well. For the 1Q2012 inventory of single and multiple well leases, Haynesville EUR is estimated at 6.5 Tcf and 2.9 Tcf, respectively.

Haynesville Proved Reserves

There are 30 operators working the Haynesville in 2012. The top five producers – Chesapeake, EXCO, Petrohawk, Encana, and El Paso – produced 80 percent of Haynesville production in 2011 and held half of proved reserves (Table 2). The top 10 operators had an inventory of 2,129 active wells,

produced 1.8 Tcf in 2011, and reported 14.7 Tcf proved reserves and 7.0 Tcf proved undeveloped reserves on December 31, 2011. Reserves for the private companies Swepi and Beusa were inferred. In total, reserves disclosures for both public and private firms operating in the Haynesville are estimated at 20.7 Tcf proved and 10.6 Tcf proved undeveloped. Our EUR calculations based on the 1Q2012 well inventory (9.4 Tcf) is broadly consistent with operators proved developed producing reserves (10.1 Tcf).

Operator Reserves Disclosures

It is instructive to compare operators' average well recoveries based on their reported proved reserves and active well inventories to our average well EUR calculations. Chesapeake, for example, reported 4,134 Bcf proved reserves from 692 active wells, or about 6 Bcf/well, similar to our average EUR estimates for 2009-11 completions. QEP Energy and El Paso's reserves per active well are also similar to our EUR estimates, providing confidence in the manner in which these companies book reserves. EXCO is conservative (3.5 Bcf/well), while Petrohawk, Encana, and Comstock fall on the high end (7.4 to 10.3 Bcf/well), and EOG Resources is highly optimistic (22.4 Bcf/well).

Table 2. Haynesville's top 10 operators performance statistics (2011).

Operator	Ownership	Active Wells ^a	P1 ^b (Bcfe)	PUD ^b (Bcfe)	Production (Bcfe)	P1/Active Well (Bcfe/well)
Chesapeake	Public	692	4,134	1,848	579	6.0
EXCO	Public	323	1,128	305	315	3.5
PetroHawk	Subsidiary	303	2,252	1,261	299	7.4
Encana	Public	233	2,400	1,152	240	10.3
Swepi	Private	132	827	415	57	6.3
QEP Energy	Public	128	783	345	108	6.1
El Paso	Subsidiary	122	750	375	111	6.1
Comstock Resources	Public	106	918	551	77	8.7
EOG Resources	Public	49	1,100	511	2	22.4
Beusa Energy	Private	41	445	240	14	10.8
Top 10		2,129	14,736	7,003	1,804	6.9
Total		2,298	20,719	10,572	1,891	9.0

Source: SEC filings, company websites, Louisiana Department of Natural Resources.

- a. Active wells include producing, idle and drilling in-progress wells on March 31, 2012.
 b. P1 = proved reserves; PUD = proved undeveloped reserves as of December 31, 2011.

Production Outlook

How will Haynesville gas production develop? Will drilling activity bounce back with increasing commodity prices? Will LNG export markets allow drilling activity in the Haynesville to achieve a degree of independence from gas price volatility? No one can foresee the future, but we can bound the expected profiles using a range of drilling scenarios.

We consider a 5-year forecast and depict monthly production totals assuming 200, 600, and 1,000 completions per year for the next 5 years (Figure 6). If 600 wells are completed annually, Haynesville production will remain essentially flat at current levels, while less than 600 completions per year will lead to a drop off in production, and more than 600 completions per year will grow production.

In Figure 7, cumulative build-out for each scenario is depicted. If drilling activity in the Haynesville stops today, the current inventory of Haynesville wells will produce about 9 Tcf through 2020 with no additional investment. If 200 wells are completed each year for the next 5 years, reserves will build-out to about 13 Tcf by 2020. For 600 completions per year, cumulative build-out will rise to about 21 Tcf.

Conclusions

Unconventional resources are more service intensive and costly to develop than conventional resources due to the complex nature of the plays, are more risky because of production and geologic uncertainties, and are more sensitive to low gas prices. Haynesville wells represent some of the most expensive onshore wells in the U.S., and although they are also among the most prolific producers, in depressed price environments it will be difficult for Haynesville production to compete against liquids-rich gas plays.

Fortunately, Louisiana is an established producer with extensive infrastructure and market demand, and because shale gas development is at the beginning of its learning curve, we expect technological progress to continue to improve the economics of unconventional development. Application of technologies to find “sweet” spots and implement the best completion strategies will separate successful players from those who are not, but in the short term, unless market conditions improve, Haynesville profitability will suffer and production at current levels will not be maintained.

Kaiser, M.J. and Y. Yu., “Louisiana Haynesville Shale - 1, 2, 3”, *Oil and Gas Journal*, 68-79, Dec 5, 2011; 70-74, Jan 9, 2012; 60-67, Feb 6, 2012.

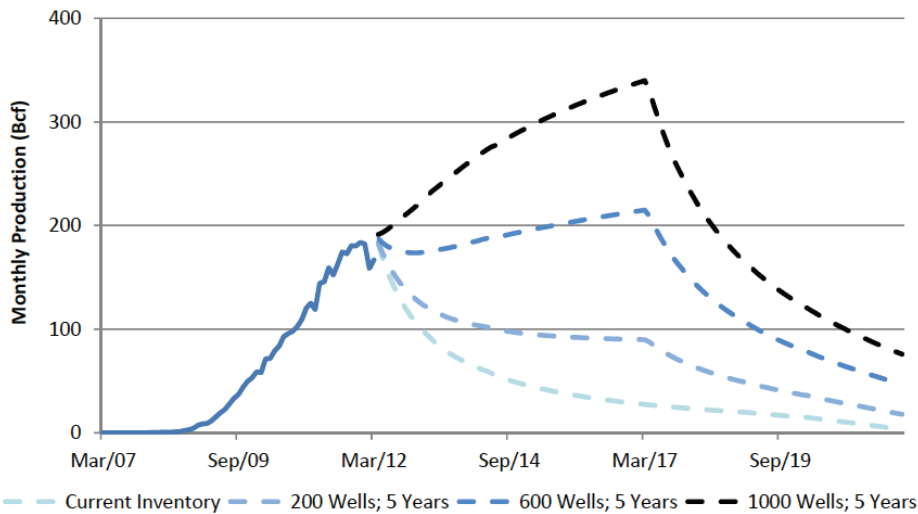


Figure 6. Haynesville shale production by completion scenario (2012-2021).

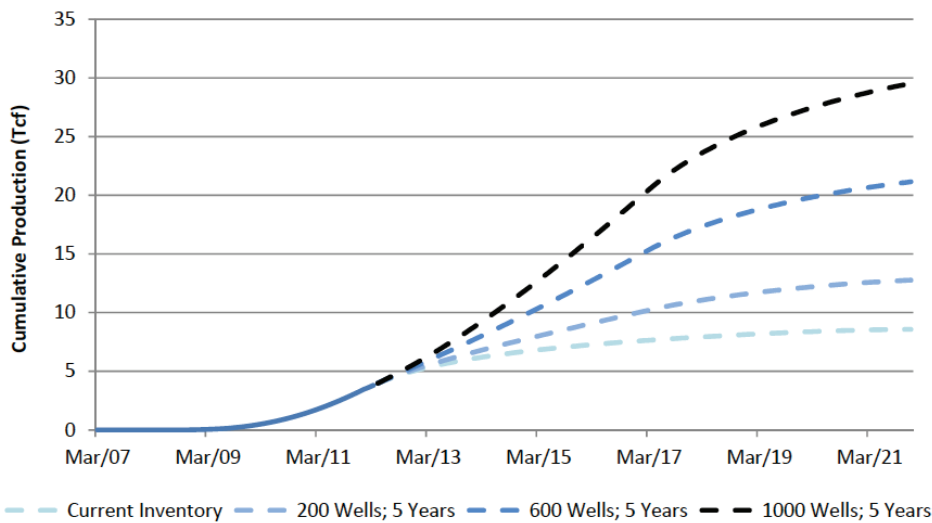


Figure 7. Haynesville shale cumulative gas production scenarios (2012- 2021).

Outreach & Education

2011 Conferences and Symposiums

The Center's 2011 event calendar included conferences, symposiums, meetings and a film screening. CES hosted the inaugural meeting of the state's Natural Gas Vehicle Leadership Committee and provided Louisiana energy briefings for executive staff of the Canadian Consul General, Paula Caldwell St-Onge, and the legislative staff of Congressman Bill Cassidy.

The 2011 Alternative Energy Conference featured the Second Louisiana Clean Energy Expo. Co-hosted by CES and the Greater Baton Rouge Clean Cities Coalition April 14, the event included forums on clean fuels and green jobs and exhibits by propane providers Ferrellgas, South Coast Solar, LLC, Team Honda of Baton Rouge, the Louisiana Business and Technology Center and more.

Tim Barckholtz of ExxonMobil's Corporate Strategic Research spoke October 17 on his company's efforts in biofuels development, particularly its alliance with Synthetic Genomics, Inc., for production of photosynthetic algae. The audience included University researchers, students, and industry representatives. Barckholtz espoused the benefits of producing transportation fuels from algae, including the fact that it can be grown using land and water unsuitable for food production and that it could potentially yield greater volumes of biofuels per acre than other biofuel sources. According to Barckholtz, algae-based biofuels could provide greenhouse gas mitigation benefits versus conventional fuels because growing algae consume CO₂.

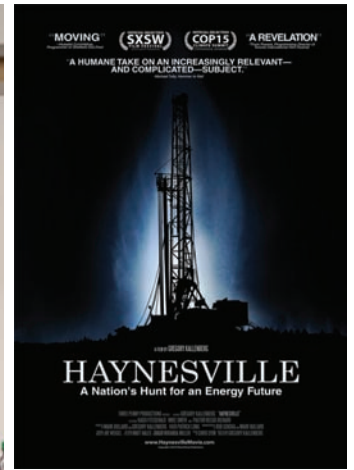
The Center for Energy Studies, with the Consumer Energy Alliance and America's Natural Gas Alliance, presented a screening of the documentary film **Haynesville: A Nation's Hunt for an Energy Future**, in the Dalton J. Woods Auditorium April 19. The film's writer and director, Gregory Kallenberg, introduced the film to a packed house. Afterward, the audience was treated to a panel discussion on the Haynesville Shale play and its potential economic and



Louisiana Public Service Commissioner Eric Skrmetta (left) introduced guest speaker Barckholtz (second from right). Also attending the biofuels presentation were Secretary of Economic Development Stephen Moret (second from left), David Dismukes, and Commissioner of Agriculture Dr. Mike Strain.



Harry Livingstone of Devon Energy discussed opportunities in the Tuscaloosa Marine Shale play. CES presented a screening of the documentary film *Haynesville: A Nation's Hunt for an Energy Future*, in the Dalton J. Woods Auditorium April 19.



environmental impacts on the state. Panelists were Stephen Moret, secretary, Louisiana Economic Development; Jimmy Field, chairman, Louisiana Public Service Commission; Tommy Foltz, director of government relations for Petrohawk Energy; Shane Schulz, manager of governmental affairs for QEP Energy; and Kallenberg. CES's David Dismukes moderated the panel.

The 2011 Energy Summit, "Unconventional Louisiana: Shale, Sands, and Other Opportunities," held October 18, addressed the timely topic of oil and gas shale plays in the state and their potential economic impact, with one speaker comparing the Tuscaloosa Marine Shale to that of the massive Eagle Ford natural gas play in Texas, which has generated 13,000 full-time jobs and more than \$500 million in salaries.

CES is grateful to the following for providing support for our 2011 educational events

- American Electric Power
- America's Natural Gas Alliance
- Chevron
- ConocoPhillips
- ExxonMobil
- Greater Baton Rouge Clean Cities Coalition
- Kean, Miller, Hawthorne, D'Armond, McCowan & Jarman, LLP
- Louisiana Department of Economic Development
- Louisiana Department of Natural Resources
- Louisiana Mid-Continent Oil & Gas Association
- Louisiana Public Service Commission
- Southern Strategy Group
- Suez Energy
- WSJ Group

Media interviews for 2011 included the following:

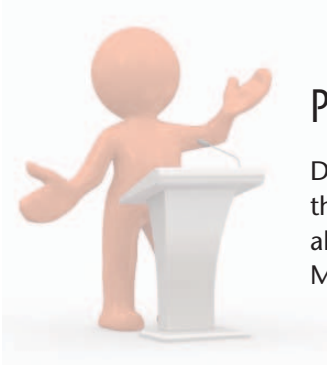
David Dismukes interviewed by Louisiana Public Broadcasting regarding renewable energy, BIC Alliance on the Tuscaloosa Marine Shale, and the *Baton Rouge Business Report* on the Tuscaloosa Marine Shale.

Allan Pulsipher on ExxonMobil discovery with LPB's *Louisiana: The State We're In*, on NBC 33 TV regarding petroleum reserves release, and WWL Radio with Garland Robinette on shale and green jobs.

Wumi Iledare *Times-Picayune* on efforts to repeal tax loopholes and potential impacts on the oil and gas industry.



Visit www.enrg.lsu.edu/conferences
for full agendas and details on all CES conferences



Presentations: 2011

During 2011, CES faculty traveled throughout the state and the nation to deliver energy industry expertise to professional associations, business, industry, and government agencies. Most CES presentations are available on the CES website.

February

“Regulatory Issues in Inflation Adjustment Mechanisms and Allowances” • **David E. Dismukes**, NASUCA Monthly Gas Committee Meeting

“Overview of Climate Change Science and Policies” • **Mike D. McDaniel**, Louisiana Public Service Commission

“Environmental Economics: Background and Basics,” “Environmental Regulations Impacting the Electric Power Industry,” “Carbon Regulation: Policies, Trends & Impacts” • **David E. Dismukes**, LPSC ARRA Seminar on Clean Air Markets

March

“Forecasting and Energy Demand Analysis: Issues and Trends in Energy Regulation” • **David E. Dismukes**, Michigan State University, Institute of Public Utilities, Forecasting Workshop for Regulators, Charleston, South Carolina

“Geographic Units Used for Socioeconomic Impact Analysis in the Gulf of Mexico Region” • **Allan G. Pulsipher and Kathy Perry**, 2011 BO-EMRE Information Transfer Meeting, New Orleans

April

“Impact of Fiscal System Terms and Instruments on Petroleum Project Economics: A Case Study of Nigeria” • **Wumi Iledare**, 4th NAAE/IAEE International Conference, Abuja, Nigeria

May

“Louisiana’s Natural Gas Advantage: Can We Hold It? Grow It? Or Do We Need to be Worrying About Other Problems?” • **David E. Dismukes**, LCA/LCIA Annual Legislative Conference

“Learning Together: Building Utility and Clean Energy Industry Partnerships in the Southeast” • **David E. Dismukes**, American Solar Energy Society, National Solar Conference

June

“America’s Natural Gas Advantage: Securing Benefits for Ratepayers through Paradigm Shifts in Policy” • **David E. Dismukes**, SEARUC 2011 Annual Conference

“Energy Market Trends and Policies: Implications for Louisiana” • **David E. Dismukes**, Executive Briefing, Lakeshore Lion’s Club Monthly Meeting

“Modeling Framework for Low Carbon Emission Analysis of the Oil and Gas Sector” • **Wumi Iledare**, Workshop on Low Carbon Development in the Oil and Gas Sector, Abuja Nigeria

July

“Creating Ratepayer Benefits by Reconciling Recent Natural Gas Supply Opportunities with Past Policy Initiatives” • **David E. Dismukes**, NASUCA Gas Committee Meeting

August

“Strengthening Transparency and Accountability in the Oil and Gas Sector in Nigeria: Are the Provisions in the Petroleum Industry Bill Pragmatic?” • **Wumi Iledare**, Institute of Petroleum Studies

“Changing Energy Markets and Policy” • **David E. Dismukes**, Louisiana Department of Natural Resources Annual Conference

September

“Energy Market Changes and Policy Challenges” • **David E. Dismukes**, Southeast Manpower Tripartite Alliance (SEMTA) Summer Conference

“Natural Gas Trends and Impact on Industrial Development” • **David E. Dismukes**, Central Gulf Coast Industry Alliance Conference

October

“A Comparative Analysis of the Performance of Selected E&P Firms in the U.S. & Abroad” • **Wumi Iledare**, 30th USAEE/IAEE North American Conference

“Comparative Economics of Petroleum Fiscal Systems and Contractual Terms Underlying Petroleum Resource Development in West Africa” • **Wumi Iledare**, West Africa Fiscal Systems Colloquium, Accra, Ghana

“CSAPR and EPA Regulations Impacting Louisiana Power Generation” • **David E. Dismukes**, Air and Waste Management Association (Louisiana Section) Fall Conference

November-December

“Development Risks and Petroleum Fiscal Systems: A Comparative Study of the Gulf of Guinea” • **Wumi Iledare**, 29th NAPE Annual International Conference, Lagos, Nigeria

View or download CES presentations at
www.enrg.lsu.edu/presentations



The Energy, Coast & Environment Building rotunda conference center hosts educational events for the LSU community and the public throughout the year.

Under the Rotunda

The Dalton J. Woods Auditorium, rotunda conference room, and lobby were venues for 193 events in 2011, including 32 public outreach events hosted by the Center for Energy Studies, Louisiana Geological Survey, the School of the Coast and Environment and other units. Gatherings included University organization meetings, seminars, dissertation defenses, and film screenings. The conference facilities and calendar are managed by CES librarian Versa Stickle.

Legislative Update

Part of the Center’s mission is to keep abreast of policies impacting the state’s energy industry. During the regular session of the Louisiana Legislature, the Center provides an up-to-date accounting of bills under review, their status, authors, and detailed summaries. Research associate Elizabeth Dieterich prepares the documents and makes them available twice per week throughout the session.

Greater Baton Rouge Clean Cities Coalition

In 2011, the Center for Energy Studies continued its partnership with the Louisiana Department of Natural Resources and the U. S. Department of Energy to support the efforts of the Greater Baton Rouge Clean Cities Coalition. A 501 (c) (3) non-profit, Clean Cities is one of around 90 similar organizations located throughout the U.S. that focus primarily on promotion of alternative fuels and alternate fuel vehicles. Clean Cities serves the Greater Baton Rouge five-parish air quality non-attainment area (Ascension, East Baton Rouge, Livingston, West Baton Rouge, and Iberville). The coalition, led in 2011 by co-coordinators Lauren Stuart and Kathy Perry, works to engage local stakeholders in government and industry in public policy issues, develop joint projects, and promote use of alternative fuels in their communities.

Clean Cities events in 2011 included:

- Clean Fuel Symposium & Louisiana Alternative Energy Expo, which showcased alternative fuel vehicles and renewable energy products and featured presentations on fuels and fueling infrastructure and transportation energy policy;
- Propane Lunch and Learn event for area stakeholders;
- Alternative Fuel Vehicles Workshop for the Louisiana Public Service Commission;
- Quarterly stakeholder meetings featuring presentations on new technologies;
- The unveiling of the LSU electric vehicle charging station, the installation of which GBRCCC helped to facilitate.



Visit www.gbrccc.org for more information on Clean Cities projects and educational programs

Personnel

Faculty

Allan G. Pulsipher, Ph.D., executive director and Marathon Oil Company Professor of Energy Policy in the Center for Energy Studies

David E. Dismukes, Ph.D., associate executive director, director of the Policy Analysis Division, and professor

Omowumi (Wumi) Iledare, Ph.D., director of the Energy Information and Data Division, professor of petroleum economics and policy research, adjunct professor of petroleum economics at the Craft & Hawkins Department of Petroleum Engineering at LSU and the University of Ibadan

Mark J. Kaiser, Ph.D., director of the Research & Development Division and professor

Mike McDaniel, Ph.D., professional-in-residence (retired) and an adjunct professor of environmental sciences in the School of the Coast and Environment

Ralph W. Pike, Ph.D., director of the Minerals Processing Research Division and Paul M. Horton Professor of Chemical Engineering

Research Associates

Elizabeth Dieterich

Jordan Lane

Siddhartha Narra, Ph.D.

Kathryn Perry

Christopher Peters

Ric Pincomb

Brian Snyder, Ph.D.

Lauren Lee Stuart

Yunke Yu

Staff

Ann Lewis, word processor operator specialist

Marybeth Pinsonneault, communications manager

Stacy Retherford, computer analyst

Diana Reynolds, assistant to the executive director

Versa Stickle, librarian

Michael Surman, computer analyst

MPRD Staff

The Minerals Processing Research Division consists of a director, associate director, four adjunct professors, a process engineer, two Ph.D. and three undergraduate students as listed below.

Director: **Ralph W. Pike**, Horton Professor of Chemical Engineering

Associate Director: **F. Carl Knopf**, Anding Professor of Chemical Engineering

Adjunct Professor: **Richard C. Farmer**, SECA Incorporated, Carson City, Nevada

Adjunct Professor: **Michael J. Richard**, Richard Consulting, Raleigh, North Carolina

Adjunct Professor: **William L. Waldrop**, Quantum Engineering Corp., Knoxville, Tennessee

Adjunct Professor: **Bert Wilkins**, Computer Ventures, Incorporated, Baton Rouge, Louisiana

Process Engineer: **Thomas A. Hertwig**, Mosaic Corporation (retired)

Ph. D. Student: **Debalina Sengupta**

Ph.D. Student: **Mohammed Shafi Syed**

Undergraduate Student: **Elizabeth Lester**, major English

Undergraduate Student: **Tate Stumper**, major chemical engineering

Undergraduate Student: **Arpan Seth**, major chemical engineering

minerals processing research division

RALPH PIKE, DIRECTOR
www.mpri.lsu.edu

The Minerals Processing Research Division (MPRD) was established in 1979 by Federal legislation as one of 31 State Mineral Institutes associated with the U.S. Department of Interior. The mission includes facilitating research and public service programs in process research and technology transfer, sustainable development, energy management, energy sustainability, and inherently safer design. This minerals processing research and public service compliments and benefits from the energy research and geological research performed by other groups in the Center for Energy Studies and the Louisiana Geological Survey.

MPRD's current research focus is development of new processes based on biomass resources that supply the same products as current plants and of bioprocesses that consume carbon dioxide. Cooperative research agreements are in place with Monsanto, Motiva Enterprises (formerly Texaco) and Mosaic (formerly IMC Agrico). This research and technology transfer involves collaboration with process and plant engineers at these and other companies. A parallel effort focuses on efficient use of available energy resources in an industrial setting. Also, research has been initiated to update previous results on estimating impacts on the Barataria Bay region of coastal Louisiana from the BP Deepwater Horizon Macondo oil well blowout and spill.

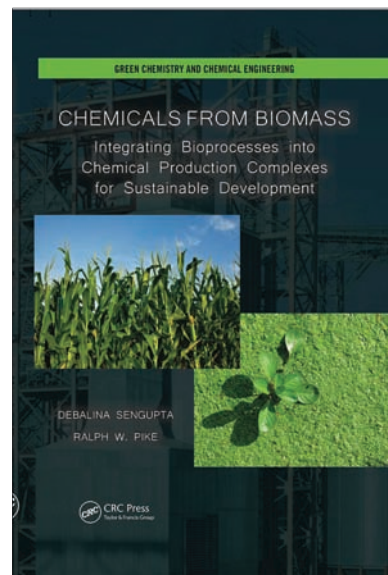
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Chemicals from Biomass

MPRD's "Chemicals from Biomass" research aims to aid in the transition of industries based on non-renewable resources to ones based on renewable resources. In the chemical production complex in the lower Mississippi River corridor, there are about 150 chemical plants producing a wide range of petrochemicals that are used in housing, automobiles, fertilizer and numerous other consumer products. Researchers have created a conceptual design of a biomass feedstock-based chemical production complex showing conversion routes for biomass feedstock--including oils, sugars, starches and cellulose--to chemicals and products such as ethylene and its derivatives such as polyethylene and polyvinyl chloride (PVC). The methodology used could be applied to other chemical complexes in the world for reduced emissions and energy savings such as the complex in Camaçari-Bahia, Brazil. Collaborative research has begun with the Federal University of Rio de Janeiro (UFRJ), and support has been requested from USAID to expand this effort for sustainable development in Brazil.

New Books Published on Energy Optimization and Chemicals from Biomass

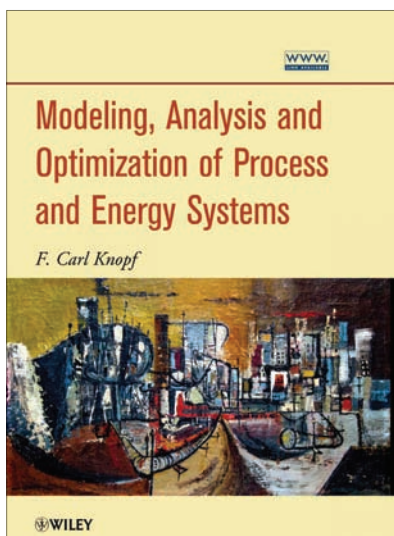
Two new books have been published based on MPRD research.



Chemicals from Biomass: Integrating Bioprocesses into Chemical Production Complexes for Sustainable Development (CRC Press)

Debalina Sengupta and Ralph Pike, describes a new methodology for developing and designing bioprocesses and demonstrating integration of these bioprocesses into an existing industrial complex.

For a complete description of the
"Chemicals from Biomass" project,
visit www.mpri.lsu.edu/thesisindex.html



Modeling Analysis, and Optimization of Process and Energy Systems (Wiley)

F. Carl Knopf, describes how energy costs impact the profitability of virtually all industrial processes. Stressing how plants use power, and how that power is actually generated, this book provides a clear and simple way to understand the energy usage in various processes, as well as methods for optimizing these processes.

Publications on Energy Optimization and Chemicals from Biomass

Knopf, F. Carl, Modeling Analysis, and Optimization of Process and Energy Systems, Wiley, New York, 2012.

Sengupta, Debalina and Ralph W. Pike, Chemicals from Biomass: Integrating Bioprocesses into Chemical Production Complexes for Sustainable Development, CRC Press, Boca Raton, FL, 2012.

----, "Chemicals from Biomass," Handbook of Climate Change Mitigation, Chapter 12, Springer, Heidelberg, Germany, 2011.

----, "Biomass as Feedstock," Handbook of Climate Change Mitigation, Chapter 65, Springer, Heidelberg, Germany, 2011.

Integrating a Cogeneration Facility into Engineering Education

A parallel effort to chemicals from biomass focuses on the efficient use of available energy resources in an industrial setting. Cogeneration is a topic of increasing importance to the economic viability of many industries. The government appreciates this need, and it has issued a "CHP Challenge" which has the goal of doubling the amount of cogenerated power in the U.S. by 2020. This goal necessitates capital investments exceeding \$10 billion/yr. There is also the potential for substantial dollar savings in existing CHP systems through optimal energy management schemes.

As part of an NSF-funded project, "Integrating a Cogeneration Facility into Engineering Education," we are integrating into chemical and mechanical engineering curricula the study of energy production and management with the analysis of real-time data from the 20 MW cogeneration system at LSU. Making such data web-available will allow sophomore-year students to perform industrial material and energy balance calculations on major unit operations including gas and steam turbines, air conditioning systems, cooling towers, and boilers. Junior-year students can explore advanced process modeling, including energy recovery in a heat recovery steam generator. Vertical integration of such individual operations allows senior students to explore global issues in energy production and management, including the optimization of utility costs and the analysis of process dynamics associated with process upsets and highly variable loads, and the resulting optimal control strategies.

The project involves LSU faculty members F. Carl Knopf, CES Minerals Processing Research Division and LSU Cain Department of Chemical Engineering, and Kerry M. Dooley, LSU Cain Department of Chemical Engineering; Peter Davidson and Tony Cupit, LSU Facility Services; and Michael Erbes, consultant. Partner universities including Tulane University, Florida State University, and University of Alabama are utilizing LSU-provided data and materials.



Updating the Estimation of Impacts on the Barataria Bay Region of Coastal Louisiana

The BP Deepwater Horizon Macondo well oil blowout and spill starting April 10, 2010, affected Barataria Bay and adjacent coastal marsh. This coastal area was studied intensively several years ago. New research has been initiated to update previous findings. Transport equations have been developed to predict velocity profiles, tidal fluctuations, and temperature and salinity profiles in the Barataria Bay region. The solutions of the transport equations were coupled to the species continuity equation for predicting the distribution of different species of nitrogen, detritus, phytoplankton, and other organisms contributing to primary production. Solutions as a function of time were determined for a coastal bay-salt marsh system when environmental conditions, tidal variations at the passes and fresh water flows into the system were specified.

Results were reported for the dynamics of tidal fluctuations, velocity profiles, and salinity and temperature distributions for conditions encountered in May of a typical year. Analysis of the effect of high fresh-water runoff was studied to simulate conditions encountered in a “wet-year” that show the shift in salinity profiles due to increased fresh-water flow into the bay system.

Analysis of planting marsh grass showed an economically feasible increase in total productivity including fisheries catch. A decrease in annual revenue occurred with a decrease in marsh grass area. Adding nitrogen as a nutrient increased total productivity.

These highly productive estuarine regions like Barataria Bay act as nursery grounds for shrimp during their period of greatest growth. The adult shrimp then migrate to the deeper offshore water to live and spawn. The optimum time to open the inland shrimping season in the estuary depends on the size distribution of shrimp in the estuary. This distribution change depends on the condition of the water (primarily salinity and



temperature), the availability of food, the migration of shrimp, and predation by other marine organisms. Population-balance conservation equations have been successfully used for predicting size distribution of shrimp in the Barataria Bay estuary for predicting the optimal catch. By comparing expected shrimp numbers and size distribution with measured shrimp numbers and size distribution, the impact of the BP Deepwater Horizon Macondo well blowout can be partially quantified.

Continuing Education for Professional Engineers

The Division maintains an extensive website, www.mpri.lsu.edu, that provides continuing professional development self-study courses for professional engineers' PDH requirements. Also available on the website are research results including journal articles, conference proceedings, technical reports, theses, dissertations, and computer programs. The programs have installation files that can be downloaded and used on an individual's computer. Included with the programs are users' manuals and tutorials. These programs have been developed using actual plants, and the process models can be applied to comparable plants.

Technology Transfer

Two technologies that have immediate and substantial energy savings on chemical plants and refineries are "pinch technology" and "on-line optimization." Large companies have corporate level groups that routinely apply pinch technology and on-line optimization. Small- to medium- sized chemical companies in Louisiana do not have the trained personnel needed to apply this technology. Two short courses on these topics are available on request by contacting the Division at www.mpri.lsu.edu.



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www.lgs.lsu.edu

Geological surveys in all the states and around the world conduct geological research on natural resources, hazards, and the environment and provide critical data and technical support to other state and federal agencies, municipalities, industry, academia and the general public. In Louisiana, the Louisiana Geological Survey (LGS) performs these functions. The LGS was first organized in 1869 and was permanently established in 1934 by Act 131 of the Louisiana State Legislature and has, since inception, been located on the campus of Louisiana State University (LSU). LGS was transferred to LSU in July 1997 by an Act of the Louisiana Legislature during its regular 1997 session (HB 2353). LGS reports to the LSU Vice Chancellor for Research and Economic Development through the Executive Director of the Center for Energy Studies. The LGS currently functions as a research unit on geoscience projects to accomplish its mission of providing unbiased geological and environmental information to promote environmentally sound economic development of the energy, mineral and water resources of the state of Louisiana.

THE BASIN RESEARCH ENERGY SECTION

The current Basin Research section projects are designed to address industry interest for geological information on oil and gas fields in the state and the potential development of the unconventional energy resources.

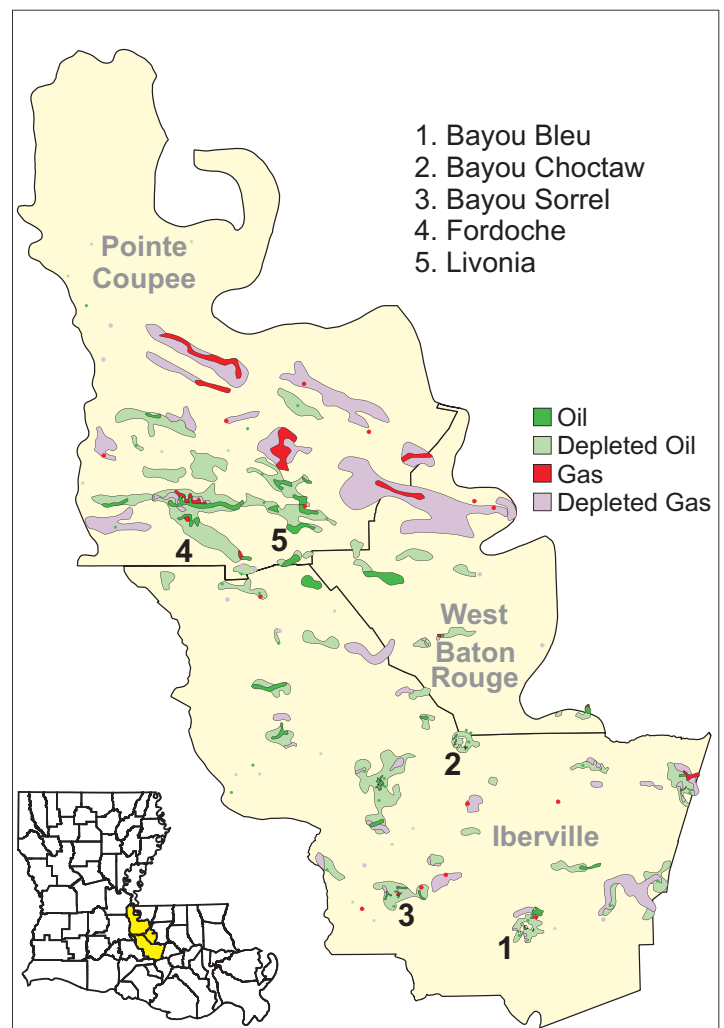
Louisiana Geological Survey Contributes to the National Geothermal Data System

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

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

The main objective of this one-year project funded by the USGS was to identify and describe suitable sites for carbon dioxide (CO₂) sequestration in a three parish area and to present relevant information on these sites in the format desired by the USGS. Because of time and funding limitations, the LGS focused attention on a three-parish area in southeastern Louisiana consisting of Iberville, Pointe Coupee and West Baton Rouge Parishes and covering

the Bayou Bleu, Bayou Choctaw, Bayou Sorrel, For-doche, and Livonia fields. These fields are typical of the geologic settings of oil and gas accumulation in Louisiana and are representative of settings where CO₂ sequestration might be accomplished in Louisiana. The fields selected for study were active and depleted oil and gas fields and saline aquifers which met the USGS assessment criteria (depth 3,000ft – 13,000ft; 500,000 BOE) to determine their suitability as CO₂ sinks. LGS compiled a database of relevant information for those fields which included publically available cross sections, maps, formation tops, lithographic data, permeability, porosity and calculated appropriate estimates of potential CO₂ storage volume in the reservoirs. All information generated was provided to the USGS in the final project report.



Louisiana Tank Geothermal Demonstration Project

LGS partnered with Louisiana Tank Inc. in a joint proposal to the U.S. Department of Energy which was funded by DOE to Louisiana Tank for \$5 million for 3 years from 1/29/10 to 3/31/13 to field demonstrate energy production from a well in Cameron Parish. LGS completed the first year deliverables which included the appropriate maps, cross sections, and the first year final reports of the geopressed and geothermal reservoir to be tapped and provided them to Louisiana Tank Inc. However, unfortunately, Louisiana Tank Inc. could not find financial investors for drilling of the well and they terminated the contract with the Department of Energy and the sub-award with LGS in July 2011.

National Coal Resources Data System (NCRDS)

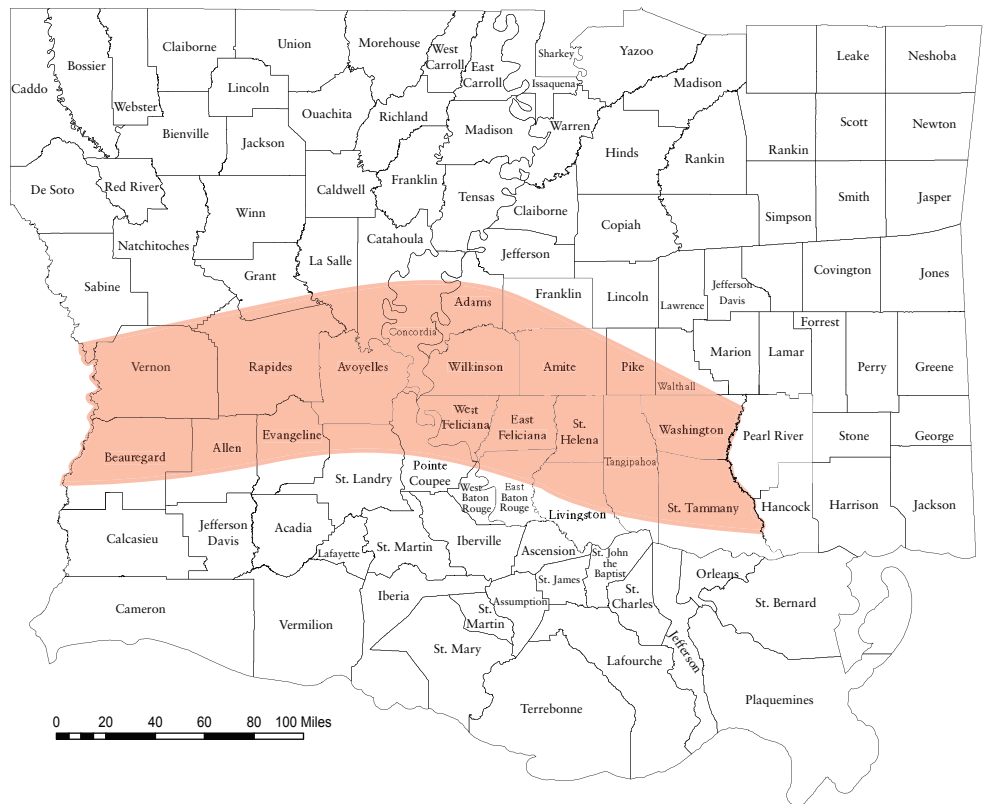
The NCRDS project is a cooperative program between LGS and the U.S. Geological Survey and is currently funded for a five-year period starting July 1, 2010. The project involves compilation of stratigraphic data, coal occurrence data, and mining data that can be used to assist in locating new resources of coal or of coal bed methane as well as to support state and national energy resource assessments.

Coalbed Methane Well Database

The presence of lignite seams in the Paleocene-Eocene Wilcox Formation in North Louisiana is well documented. LGS has a sub-award from the University of Louisiana at Lafayette (ULL) funded by the U.S. Geological Survey to maintain and update drilling activity for coal bed methane in North Louisiana. However, due to the current low gas prices, drilling activity to tap coal bed methane resources has been very drastically reduced and there is hardly any activity on this front. Information for this database is primarily compiled from the Louisiana Department of Natural Resources SONRIS online database system.

Tuscaloosa Marine Shale Play

A research article published in 1997 in the Basin Research Institute Bulletin titled "An Unproven Unconventional Seven Billion Barrel Oil Resource – The Tuscaloosa Marine Shale" co-authored by Chacko J. John, Bobby L. Jones, James E. Moncrief, Reed Bourgeois, and Brian J. Harder has become a much sought after publication due to the current high industry interest and drilling activity taking place in this trend. Technological advances in horizontal drilling since the publication of the paper and the prevailing high cost of oil and lower costs of gas together with the potential for oil production from the Tuscaloosa Marine Shale, as pointed out in this research paper, have caused the current high interest and drilling activity in the Tuscaloosa Marine Shale bringing with it considerable economic benefits to the state, local parishes, and citizens residing in the area. LGS continues to monitor industry activity in the Tuscaloosa Marine Shale and will update the paper depending upon availability of data and appropriate funding.



LSU Petroleum Engineering Geothermal Project

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

GEOLOGIC REVIEW

The Geological Review program is a project which was created by the Louisiana Geological Survey in 1982 to provide regulatory technical assistance to the Coastal Management Division (CMD) of the Louisiana Department of Natural Resources and to three districts of the U.S. Army Corps of Engineers (USACE) and is renewed every year. The purpose of Geologic Review of drilling permit applications is to ensure that the least damaging feasible alternative is permitted for oil and gas drilling in the environmentally sensitive coastal zone of Louisiana while still allowing the operation to proceed. Alternatives involved such concepts as reducing the size of ring levees and slips, reducing the length of board roads and canals, the use of directional drilling, and the use of alternate and less damaging access routes, but still allowed the well to be drilled while avoiding or minimizing any environmental damage involved. The long-term effect of Geological Review has been a significant reduction (up to 75%) in the average length of canals and board roads built in the Louisiana Coastal Zone.

GEOLOGIC MAPPING AND MINERAL RESOURCES SECTION

The Geologic Mapping and Mineral Resources Section conducts investigations of surface geology primarily involved with the creation of geologic maps, which depict the distribution of rock types, strata and geologic features, such as faults, according to their particular characteristics and geologic ages. While geologic maps have value in themselves for understanding the geology of the area, they also are major sources of derivative applications, such as the delineation of areas with engineering properties of interest (e.g. location of landfills, siting of industry, etc.).

Interpreting the geology in coastal-plain settings like in Louisiana presents problems that are subtler and less dramatic than those in other settings (e.g. in areas of active or geologically recent mountain building or volcanism and areas of high relief and topography). Still, the mapping of coastal-plain geology presents its own unique problems.

Status of Geologic Mapping in Louisiana

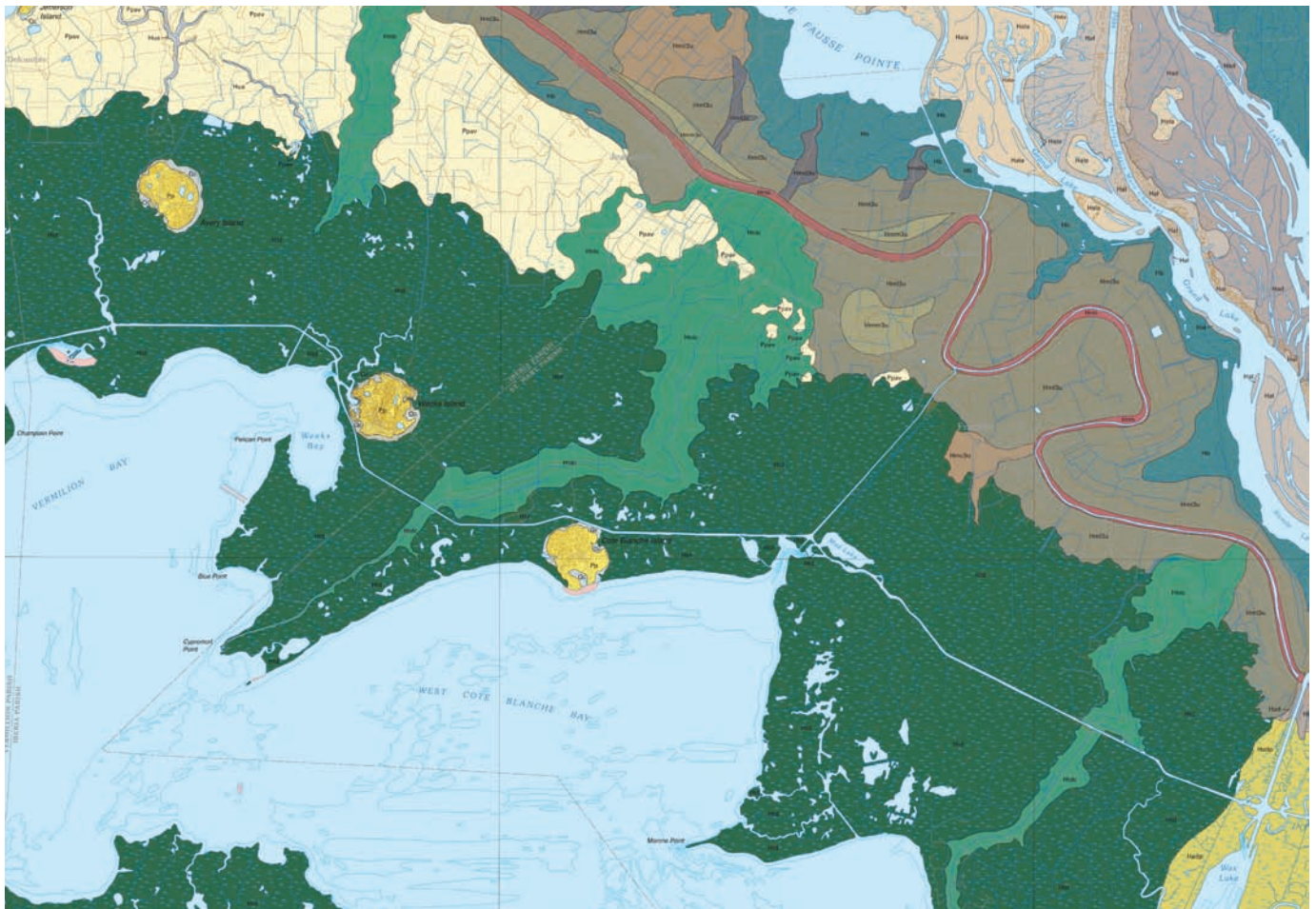
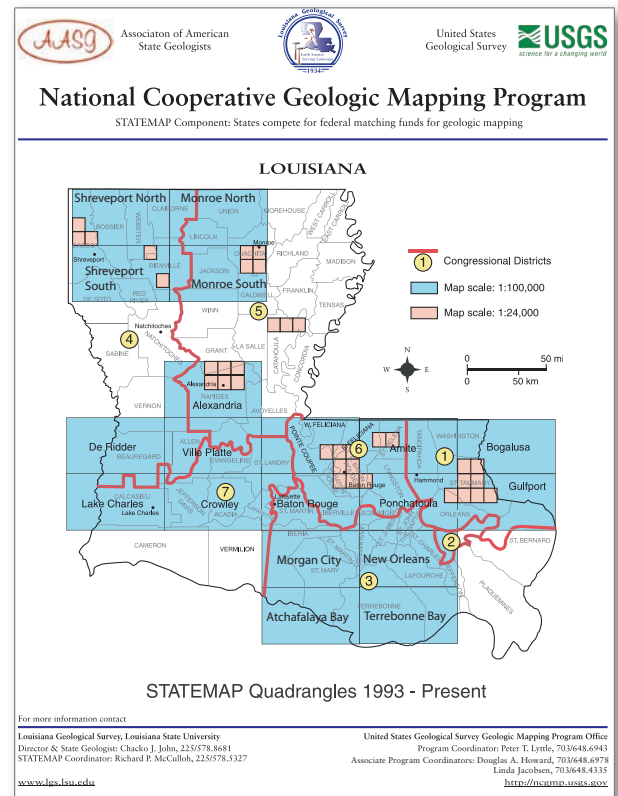
LGS is the only research organization doing geologic mapping in the state of Louisiana. LGS surface geologic mapping activity, supported by cooperative agreements with the U.S. Geological Survey under the National Cooperative Geologic Mapping Program, STATEMAP component, continued in fiscal year 2011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

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

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

Geomorphology/Geoarchaeology Project

LGS research associate Paul Heinrich prepared and submitted a report on the geomorphology and geoarchaeology of part of the New Orleans region for a project funded by Michael Baker Associates of Pennsylvania. This report summarized what is known about the geomorphology, geology, geoarchaeology, fauna, flora and natural history of the area that will be impacted by the New Orleans Rail Gateway Project. This report will be used along with an archaeological study of this area to manage and preserve cultural resources and sites which are found within the area.



Brushy Creek Impact Crater

The Brushy Creek Impact Crater identified in 1996 by LGS field mappers generates local and national interest. The Tourism Commission of St. Helena Parish is working on obtaining money to purchase the land containing the crater. They are looking into making it into a park. It also has inspired Marsha Allen Needham, a local artist, to paint a set of pictures, which she has exhibited locally. Also, T-shirts, which feature the crater, are on sale at the Curry Pharmacy in Greensburg, Louisiana.

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

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

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

References

- Heinrich, P. V., 2003a, *Origin of a circular depression and associated fractured and shocked quartz, St. Helena parish, Louisiana*. *Gulf Coast Association of Geological Societies Transactions*. vol. 53, pp. 313-322.
- Heinrich, P. V., 2003b, *Possible meteorite crater in St. Helena Parish, Louisiana*. *Louisiana Geological Survey News, Insights* vol. 13, no. 1, pp. 3-5.
- King, D. T., Jr. and L. W. Petruny, 2008, *Impact stratigraphy of the US Gulf Coastal states*. *Gulf Coast Association of Geological Societies Transactions*. vol. 58, pp. 503-516.
- McCulloh, R. P., P. V. Heinrich, and J. Snead, compilers, 1997, *Amite, Louisiana 30 x 60 minute geologic quadrangle (preliminary)*. Prepared in cooperation with US Geological Survey, STATEMAP program, under cooperative agreement no. 1434-HQ-96-AG-01490, 1:100,000-scale map plus explanation and notes.



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

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



WATER AND ENVIRONMENTAL SECTION

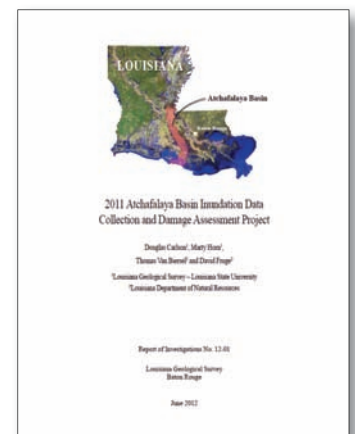
The water and environmental section of LGS performs research on the hydrologic systems of Louisiana, specifically on how the state's aquifers interact with each other and with the rivers, lakes, and wetlands. Hydrologic projects done by LGS provide technical assistance and support to state agencies and the various stakeholders interested in Louisiana's water resources, thus aiding in Louisiana's management of this critical and valuable resource.

Water Quality of the Carrizo-Wilcox, Red River Alluvial and Other Aquifers in Bossier, Caddo, and DeSoto Parishes

This project is aimed at determining the pre-existing water quality throughout the parishes mentioned and is funded separately by each of the parishes and Exco Resources. The high level of exploration and development of the Haynesville Formation Shale over a seven parish area (Bienville, Bossier, Caddo, Claiborne, DeSoto, Red River and Webster Parishes) resulting in the drilling of thousands of wells has resulted in public anxiety about groundwater levels and the potential freshwater contamination due to hydrofracking of the shale which requires 4 to 10 million gallons of water for each well. LGS hydro-geologists collected and analyzed samples from over 1,000 wells in the area establishing a base-line for pre-existing water quality throughout the study area. This data generated by LGS represents the largest, most comprehensive base-line study of groundwater in the state to date. Study results provided to parishes funding the project are critical in supporting them as principal stewards of local groundwater resources.

Atchafalaya Basin Flood of Summer 2011

LGS scientists played a key role in assessing the impacts of the summer 2011 flood of the Atchafalaya Basin caused by partial diversion of the Mississippi River from its main channel by opening of the spillways. The Louisiana Department of Natural Resources funded this project to collect samples and perform chemical analysis of floodwaters sampled on a period basis at selected locations. The analysis data made available to agricultural and environmental scientists provided information critical for post-flood remediation projects.



Evaluations of Water Permit Requests

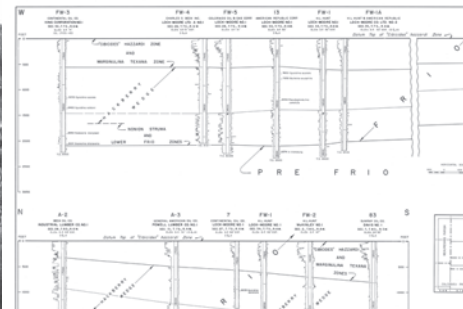
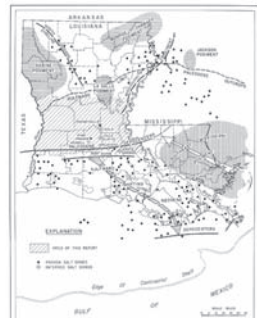
LGS was contracted by the Louisiana Department of Natural Resources (water section) to evaluate permit requests by natural gas companies for use of surface water for hydrofracturing operations in the Haynesville Shale gas play. LGS research associate Riley Milner has been working on this project and reviewing permits and making recommendations when requested by LA DNR.

LGS Contribution to the Groundwater Management Plan

The Louisiana Department of Natural Resources awarded a contract to Ecology and Environment Inc. (E & E Inc.) to produce a comprehensive ground water management plan for the state. LGS received a sub-award from E & E Inc. to compile a summary of surface and groundwater resources publications for Louisiana. The final report was delivered to E & E Inc. with a comprehensive listing of publications by regions and aquifer systems.

CARTOGRAPHIC SECTION

The Louisiana Geological Survey cartographic section specializes in the compilation, design, and production of maps, technical, and desktop publications and geographic information systems products. Most cartographic external projects are performed under contract to address the specific requirements of client agencies and also other LSU departments.



"Blowout of Louisiana Oil & Refining Co. Gleason No.1 well in Webster Parish" from Geological Bulletin No. 29 Figure 7
Some Major Features of Basin Configuration Related to Cycles of Deposition (Figure 2) from Geological Bulletin No. 42: Cenozoic Cyclic Deposition in the Subsurface of Central Louisiana
"Fault in South Wall of Abandoned Wolfe Gravel Pit (Indian Village) Showing Apparent Dip and Throw" from Geological Bulletin No. 36 Figure 6
Cross-Sections of Lower-Middle Frio in Bayou Serpent Area (Plate 5) from Geological Bulletin No. 36: Geology of Acadia and Jefferson Davis Parishes

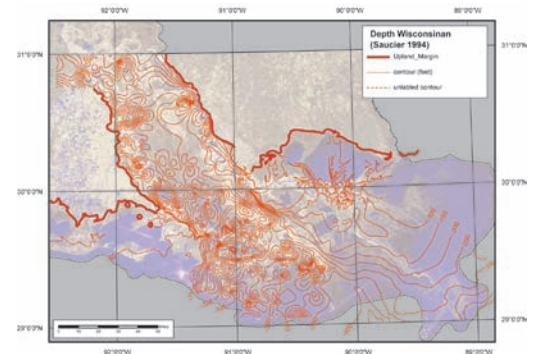
Inventory and Digital Infrastructure of Historic Louisiana Geologic Map Data

LGS was a participant in this USGS funded project under the National Geological and Geophysical Data Preservation Program (NGGDPP) passed by the U.S. Congress. During the FY 2011 phase of the National Geological and Geophysical Preservation Program (NGGDPP), the LGS addressed two of the program priorities: creating an inventory of the LGS historic geologic map collection and improving upon the state and national digital map infrastructure. Thousands of published and unpublished geologic maps, cross-sections, sample site maps, and other geo-data dating back over a century exist in LGS cartographic storage rooms. This un-indexed material consists of lithographic prints, working drafts, historic reference maps, and many original manuscripts on linen, vellum, positive and negative film, contact prints, and even some metal plates.

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

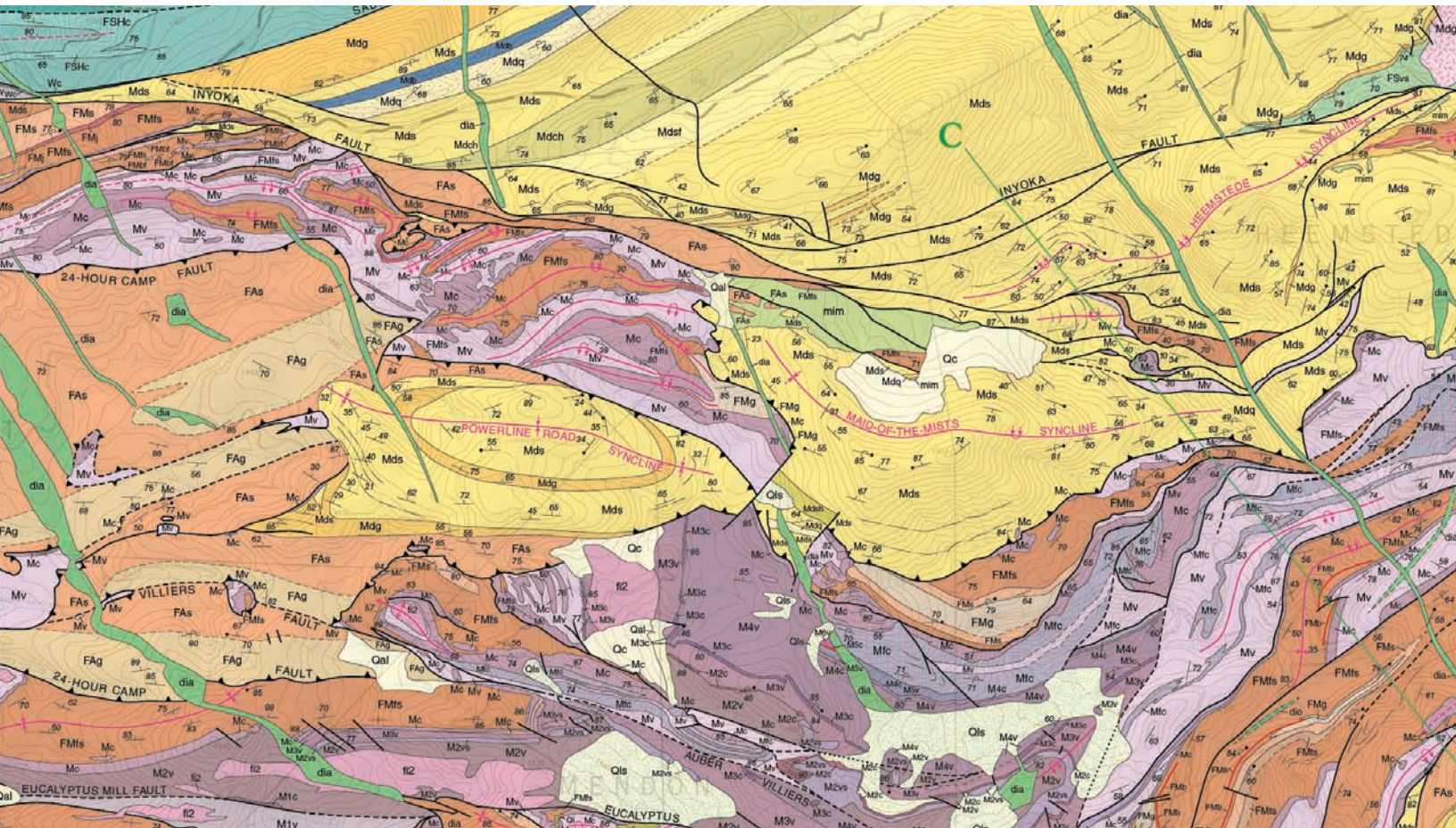
Quaternary Geology of the Louisiana Coastal Plain & Continental Shelf - a Small Scale GIS Compilation

This six-month contract was funded by the Office of Coastal Protection and Restoration (OCPR), the objective of which was to compile, design, and produce a GIS compilation of the quaternary geology of the Louisiana coastal plain and shelf in support of the state's efforts to further the state's efforts for planning and assessment of the coastal restoration and protection studies and projects. Data sources used for this project included LGS maps, atlases, reports and bulletins, and all other available published technical reports, other journal reports, and papers dealing with the coastal geology of Louisiana from various sources. The final technical report and all relevant GIS files were completed and delivered to OCPR in December of 2011.



Geologic Map of the Barberton Greenstone Belt, South Africa

The LGS Cartographic Section is providing technical and cartographic expertise in the production of an oversized (55x70 in) lithographic wall map of some of the oldest sedimentary rocks in the world (the Barberton Greenstone Belt, South Africa). This project is funded by the Stanford University Department of Geological and Environmental Sciences and the LSU Department of Geology and Geophysics. The map culminates a 30-year investigation by Gary Byerly and Don Lowe and will be published by the Geological Society of America in late 2012.



OUTREACH ACTIVITIES

Earth Science week 2011 was celebrated nationally from October 9-15, 2011. The theme for this week was "Our Ever Changing Earth". At the request of the Louisiana Geological Survey, the Governor of Louisiana, Bobby Jindal, issued a proclamation declaring October 9-15, 2011 as Earth Science week in the state of Louisiana. LGS received 50 educational kits for Earth Science teachers which included DVDs and teaching materials related to the theme. These kits were distributed to Earth Science teachers through program coordinator Jean M. Brett of the East Baton Rouge Parish Schools Division of Standards, Assessment and Accountability.

LGS participated in the International Astronomy Day activities sponsored by the Baton Rouge Parks and Recreation (BREC) in April at the Highland Road Observatory. The LGS exhibit booth featured information related to the Brushy Creek Meteorite Crater in St. Helena Parish discovered by LGS researchers during geologic field mapping.

Another event in which LGS participated was organized by the Baton Rouge Parks & Recreation as a one day educational outreach program for schools titled "Rock'n in the Swamp". It was held at the Bluebonnet Swamp Park on March 12, 2011.

LGS educational material consisting of brochures, field trip guides, maps, postcards and fact sheets on various geological topics are provided regularly to those interested on request. Technical publications are available at minimal costs by contacting the LGS publications department.

LGS STAFF RECOGNITION

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

Dr. Douglas Carlson – 10 years

Richard McCulloh – 15 years

John Snead – 15 years

Paul Heinrich – 15 years

Hampton Peele – 20 years

Reed Bourgeois – 20 years

John Johnston – 25 years

Dr. Chacko John – 25 years



The LGS booth featured a poster display of the Brushy Creek impact crater and the Greenwell Springs meteorite discovery. Thin sections of a meteorite and other rocks and minerals found in Louisiana were made available using the LGS's "Scope-On-a-Rope". Fossil specimens and various rock types were also on display at the booth. The LGS booth proved to be one of the star attractions for the hundreds of school students and other adults attending the event.

Research Associate Riley Milner visited the 8th grade class of the Brighton School at their request to provide teacher assistance for their earth science curriculum requirements in mineral and rock properties and identification and what a geologist does as a career.



LGS RESOURCE CENTER

The LGS Resource Center consists of a core repository and log library. It is located behind the old Graphic Services building on River Road. The core and log collections are included as part of the LSU Museum of Natural History as defined by the Louisiana Legislature and is the only one of its kind in Louisiana. The core facility has more than 30,000 feet of core from wells mostly in Louisiana. The well log library contains over 50,000 well logs from various parishes in the state. The LGS Resource Center is available for use by industry, academia and government agencies, and others who may be interested. There is a nominal daily charge for use of this facility. For more information, contact Patrick O'Neill at 225-578-8590 or by email at poneil2@lsu.edu.



Radiation Safety Office Personnel

Wei-Hsung Wang, Ph.D., CHP, CLSO, director

Mary J. Haik, M.S., operations manager & laser safety officer

Daryn M. Bovard, radiation specialist

Richard E. Teague, RRPT, senior technologist

Lorraine Day, Ph.D., CAMD liaison

Lorrie Gaschen, D.V.M., Ph.D., SVM liaison

Leslie M. Smith, PBRC liaison

Student Workers

Dylan Albers

Hannah Burson

Nicholas Desselles

Jamie Dismukes

Rebecca Hill

Nicholas Kubiak

Nicole Lee

Charles Wilson IV

radiation safety office

WEI-HSUNG WANG, DIRECTOR
www.radsafety.lsu.edu

The LSU Radiation Safety Office (RSO), which reports through the Center for Energy Studies (CES) to the LSU Office of Research and Economic Development, is an essential, unique, and vital regulatory compliance unit to support research and teaching activities involving the use of sources of ionizing and non-ionizing radiation at LSU. The LSU System's broad-scope Radioactive Material License issued by the Louisiana Department of Environmental Quality (DEQ) allows the University maximum flexibility to accomplish legitimate and realistic research and teaching objectives through the effective and efficient operation of a regulatory mandated radiation protection program carried out by the RSO. Under the direction of the Radiation Safety Committee (RSC), the RSO implements the radiation control policies and procedures such that radiation exposure to faculty, staff, students, the general public, and the environment will be maintained as low as reasonably achievable and that no radiation exposure will be received without societal benefit. Administrative authorization for the radiation protection program from the University is contained in LSU System's Permanent Memorandum-30 (PM-30). Enforcement actions for radiation safety violations are authorized under LSU Policy Statement-99.



Dr. Allen Brodsky, CHP, CIH, DABR, gave a seminar on "Perspectives on Radiation Exposures from Nuclear Events" at LSU.

RSO technical assistant Charles Wilson (left) and radiation specialist Daryn Bovard presented a talk on "ICRP 103 Decision Points" at the 2011 Radiobioassay & Radiochemical Measurements Conference.





RSO technical assistants Nicholas Desselles (left) and Jamie Dismukes inspect solid radioactive waste for possible violations and subsequent packaging.

As of December 31, 2011, there were 710 approved radiation workers (including 110 radiation principal investigators) and 192 radiation laboratories in the Departments of Agricultural Chemistry, Biological Sciences, Chemical Engineering, Chemistry, Civil & Environmental Engineering, Electrical & Computer Engineering, Entomology, Environmental Sciences, Geography & Anthropology, Geology & Geophysics, Mechanical Engineering, Oceanography & Coastal Sciences, Physics & Astronomy, and Plant Pathology & Crop Physiology; in the Schools of Animal Sciences, Human Ecology, Kinesiology, Plant, Environmental & Soil Sciences, Renewable Natural Resources, and Veterinary Medicine; and for the Athletic Department, the Center for Advanced Microstructures and Devices (CAMD), the National Center for Biomedical Research and Training (NCBRT), the Pennington Biomedical Research Center (PBRC), and the Student Health Center. The RSO provides training and personnel monitoring for radiation workers as well as performs routine site surveys and audits, radiation survey meter calibrations, x-ray equipment inspections, radioactive waste management, and leak tests of sealed radioactive sources for approved radiation laboratories to fully comply with regulatory requirements and licensing conditions. Information about ionizing radiation safety and training is located on the RSO website.

During the 2011 calendar year, the RSO reviewed and approved 47 grant proposals involving the use of radiation sources. Funds requested by these proposals were \$62,099,852. Actual funds granted to LSU were \$24,381,880.

The RSO is also responsible for the non-ionizing radiation safety within the purview of the LSU System's Safety Procedures for Non-Ionizing Radiation. As of December 31, 2011, there were 91 active Class 3B and Class 4 laser systems, 104 approved laser users (including 16 laser principal investigators), and 37 laser laboratories in the Departments of Biological & Agricultural Engineering, Biological Sciences, Chemistry, Geology & Geophysics, Mechanical Engineering, Oceanography & Coastal Sciences, and Physics & Astronomy, as well as CAMD, NCBRT, and the School of Veterinary Medicine. The RSO evaluates and inspects the inventoried Class 3B and Class 4 laser systems for laser intra beam hazards as well as provides online training. Information on ultra-violet radiation safety in the workplace is also available on the RSO website.

Due to limited manpower and resources, the CES provides administrative support for accounting and purchasing activities, computer and network maintenance, and personnel management for the RSO.

Seminar on Radiation Emergency Response

The RSO hosted a seminar on “Perspectives on Radiation Exposures from Nuclear Events” in the Dalton J. Woods Auditorium of the Energy, Coast and Environment Building. This captivating seminar was presented by a distinguished speaker, Allen Brodsky, who is a professor of Georgetown University. Brodsky is a world-renown expert in radiation dosimetry, emergency response, and applied health physics. He has more than 200 publications in scientific and professional journals, government reports and regulatory guides, book chapters, and books. He is a diplomat of the American Board of Health Physics, the American Board of Industrial Hygiene, and the American Board of Radiology, as well as a Fellow of the Health Physics Society (HPS). His most recent book *Actions for Survival: Saving Lives in the Immediate Hours after Release of Radioactive or Other Toxic Agents* provides not only life-saving information for the general public, but also recommendations for leaders of government agencies and emergency response organizations to enhance their ability to protect the public and to reduce the effects of weapons of mass destruction.

Inspection by DEQ

Radioactive material license and Increased Controls inspections of the LSU’s radiation protection program were conducted by two inspectors from DEQ’s Radiation Surveillance Section. They examined the standard operating procedures for essential radiation safety operations and the policies and procedures for Increased Controls. They also reviewed the records of Radiation Safety Committee meetings, individual and area radiation exposure monitoring, radiation laboratory contamination surveys, survey meter calibration, inventory and leak tests of sealed radioactive sources, radiation laboratory inspections, and radioactive waste disposal as well as inquired about the functions and applications of the Health Physics Assistant software, the procedures for receiving and monitoring radioactive material packages, and the current status of the National Source Tracking System. The inspectors walked through the radioactive waste storage facilities, the Increased Controls areas with enhanced security measures, and fifteen randomly selected radiation laboratories to check the radiation levels, calibration of survey meters, posting requirements, and security in these places. After the walk-through, an exit interview was held and no areas of concern were listed on the DEQ’s Field Interview Form.

DEQ Grants Approval for Using a Fluoroscopy Unit in Medical Research

Dennis K. Landin, associate professor and William Prescott Foster Professor in the Department of Kinesiology, has been conducting medical research with human beings by using a fluoroscopy unit to study shoulder joint kinetics under the approval of the LSU Institutional Review Board (IRB) and the exemption from the Louisiana Administrative Code Title 33 Part XV.110.E.1 granted by Peggy M. Hatch, assistant secretary for Environmental Compliance of the DEQ, in 2008. Due to the addition of a principal investigator and an attending physician, changes of the subject pool, modifications of research protocols and examination procedures (both the estimated whole body dose equivalent received by the subject and the fluoroscope used for the external rotation intervention study remained the same), and a new approval by the LSU IRB, a petition for a variance to the exemption previously granted to conduct medical research on human beings using a fluoroscopy unit was submitted to DEQ for its approval. The exemption was granted in 2011, by Cheryl S. Nolan, assistant secretary for Environmental Compliance of the DEQ.

Appointment for a New Member of the Radiation Safety Committee

Robert A. Holmes, associate professor of Comparative Biomedical Sciences and former chair of the RSC, retired from LSU in 2010. The RSC recommended Charles W. Lindau as Holmes’ replacement on the committee with a unanimous vote at the RSC meeting on January 20, 2011. Lindau, professor of Wetland Biogeochemistry in the Department of Oceanography and Coastal Sciences, was a faculty member of the Nuclear Science Center for 15 years and had taught courses of “Introduction to Nuclear Science” and “Fundamentals of Nuclear Radiation Science.” Per LSU System’s PM-30, Sandra C. Roerig, chair of the LSU System Radiation Safety Committee, approved Lindau’s nomination and Michael V. Martin, chancellor of LSU, appointed Lindau as a member of the RSC.

Professional Contributions

Wei-Hsung Wang, director of the RSO and associate professor at the CES, served as an invited panelist on the U.S. Nuclear Regulatory Commission (NRC) Radiation Protection Standards Workshop to discuss the potential changes to the NRC's radiation protection regulations and guidance in light of recommendations in International Commission on Radiological Protection *Publication 103: The 2007 Recommendations of the International Commission on Radiological Protection*. He was interviewed by WAFB-TV (CBS affiliate in Baton Rouge, Louisiana) regarding the concern of adverse health effects in the U.S. from the Fukushima nuclear power plant incident in Japan. He then served as a radiological expert on the U.S. National Oceanic and Atmospheric Administration Radiological Ideas Workshop to explore ideas to assess impacts to the marine environment from the Fukushima nuclear incident. Wang was reappointed to the Panel of Examiners of the American Board of Health Physics (ABHP) for another four-year term. Health Physics is the application of scientific principles to the protection of humans and environment from the hazards of radiation. The ABHP has been the certification body for the practice of professional health physics and responsible for determining the qualifications of a Certified Health Physicist since 1958. He was also appointed to the HPS Academic Education Committee to a three-year term. In this capacity, he proposes actions to encourage students to embark on health physics careers as well as to ensure that the quality and numbers of individuals entering the health physics profession meet projected demand.

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