HGS Bulletin
Houston Geological Society
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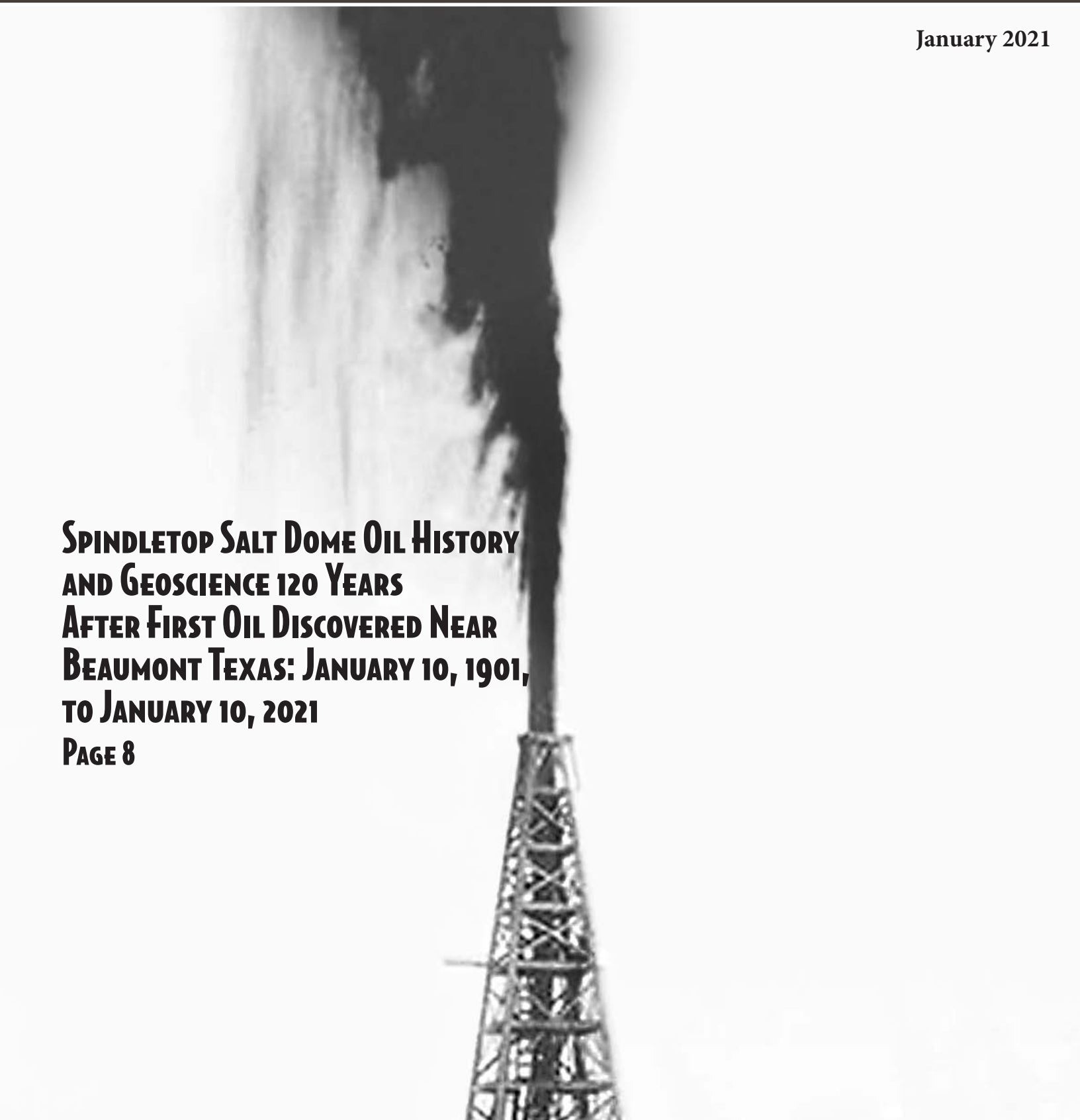
January 2021



Spindletop Salt Dome Oil History and Geoscience 120 Years After First Oil Discovered Near Beaumont Texas: January 10, 1901, to January 10, 2021

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The Bulletin
Houston Geological Society

Volume 63, Number 5 January 2021

In Every Issue

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Technical Meetings

Other Features

About the Cover: The infamous Spindletop Well that started the Texas Oil Boom.

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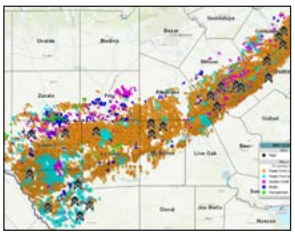

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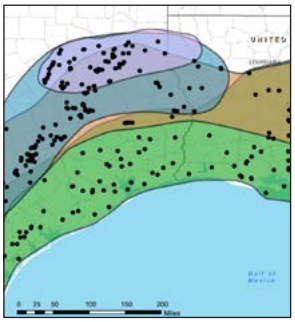

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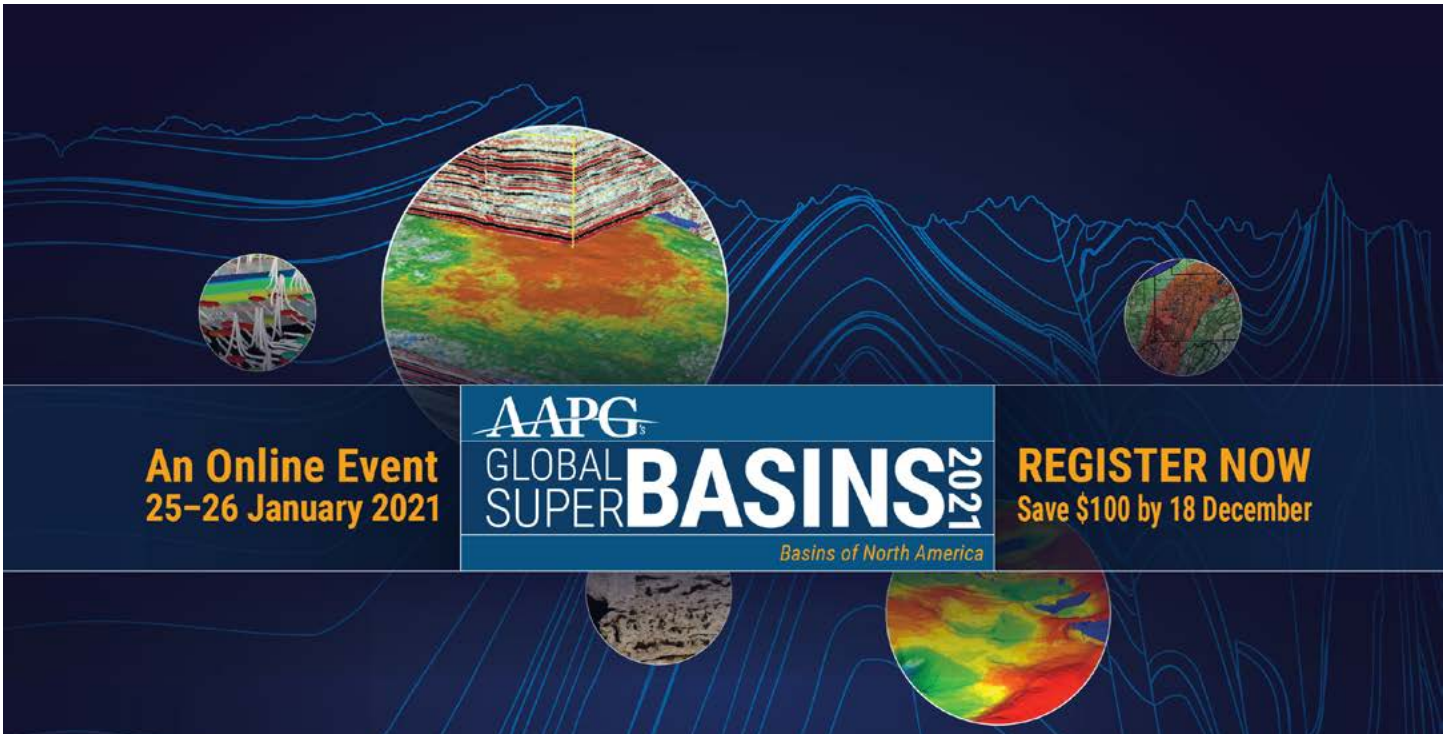


AAPG

GLOBAL SUPER BASINS 2021

Basins of North America

An Online Event
25–26 January 2021

REGISTER NOW
Save $100 by 18 December

Actionable Insights from North America's Greatest Basins

Super Basin applications continue to help drive the future of exploration and development. AAPG will be continuing its initiative to showcase some of the world's greatest super basins during the fourth Global Super Basins Leadership Conference, 25–26 January 2021. This online conference will feature a full two-day program of experts and commercial masters on North American onshore and offshore Super Basins. The geology, exploration, and development of these basins provide great analogs that can re-think other global basins' potential.

Industry leaders operating within the basins will share geologic, technical, and business insights while looking at lessons learned, challenges overcome, and future views from these basins. The program will be valuable to those working in the featured basins and global explorers looking for actionable insights from North American analogs.

Basins covered will include:

Permian Basin: Midland & Delaware
Analogs for Global Exploration
Anadarko Basin
Appalachian Super Basin
Gulfcoast Super Basin
Cretaceous Western Interior Seaway Basin
Western Canadian Super Basin

"Excellent diversity of talks. I really appreciated the consistent approach to communicating the geology – past, present, and future of each basin. Each presenter had a different approach that brought something unique about each basin forward."

– Super Basins 2020 Attendee Survey

To learn more visit:
SuperBasins.AAPG.org

Jim Tucker
president@hgs.org

Lots of Opportunities

One great thing about this new year is that it is likely to be an improvement on 2020. Regular readers know I usually mention volunteering, particularly in your professional societies. Right now is the time that both HGS and AAPG gather recommendations for recognizing active volunteers for their service. Past awardees for the HGS awards listed at: https://www.hgs.org/awards-list , and nominations may be sent to the HGS office or any Board member. Nominations for AAPG volunteer awards have information at: https://www.aapg.org/about/aapg/overview/honors-and-awards/association, nomination recommendations may be submitted there, and are reviewed by the AAPG Advisory Council. HGS awards are reviewed by the HGS Board.

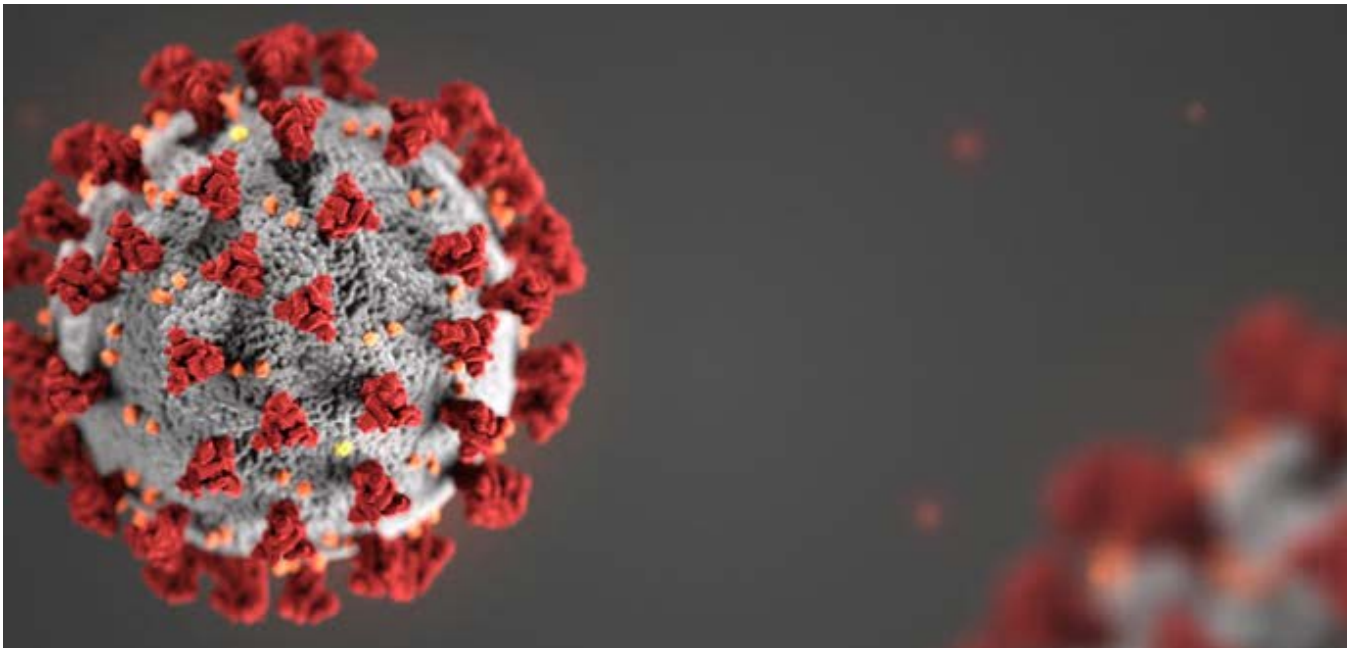
One fun annual activity is judging the Science and Engineering Fair projects submitted by area students. This event will be virtual this year, so there should be fewer scheduling conflicts, and will occur during the first quarter of 2021.

One fun annual activity is judging the Science and Engineering Fair projects submitted by area students. This event will be virtual this year, so there should be fewer scheduling conflicts, and will occur during the first quarter of 2021. Applications for becoming a judge are at: https://sefhouston.org/for-judges/. There are usually only a few student projects that fit in the Earth Sciences category to judge, and the HGS sponsors summer student internships at the Houston Museum of Natural Sciences.

Also, we have vacancies in the Ballot and Awards Committees. Please contact me if you are interested in finding out what is involved in either of these responsibilities.

Now some other things I'm thinking about while waiting for the geograph chart to come off. I recently saw a newspaper article on all the changes in the entertainment industry in Los Angeles, falling under the general category of Hollywood. For several decades, exploration has been compared to pharmaceutical research, capital intensive and dependent on intellect and scientific creativity. The number of $600 million is used so often as the cost to develop a new drug to suspect that someone made that calculation years ago, and it has not been reexamined. I moved from Houston, working on offshore Gulf of Mexico, to Los Angeles in 1984 to work in the international division of my company. What a shock to see the difference in the business section of the *Houston Post*, which was dominated by petroleum news, and the *LA Times*, where entertainment filled the business pages. Thinking on it though, the similarities between movies and prospects and wildcats became clearer. Both businesses are capital intensive, depending on a relative few creative and experienced people. And when a movie comes out or a well TDs, we generally know right away whether it is a company-maker, a bread-and-butter success with steady income, or a dry hole or a stinker going directly to the hotel closed-circuit TV channels in Asia. From the article, it sounds like we have a lot fewer lunches, and have a lot clearer view when our ideas are tested, and the outcomes are successful. ■

Have a safe month, and volunteer for something.
Jim Tucker



Coronavirus (COVID-19) Policy Statement: Updated Thursday, December 31, 2020

Because of the ongoing coronavirus (COVID-19) situation, all in-person HGS events through the end of 2020 are cancelled/postponed or will be substituted by online events. Please check the HGS website on a regular basis for all HGS online event opportunities.

The HGS Board will continue to monitor the situation and determine whether to extend the cancellation or postponement of HGS in-person events as we enter the New Year.

Please monitor hgs.org and your email for further communication concerning HGS events.

For more information about how you can help to prevent the illness, visit the CDC website: https://www.cdc.gov/.

2020-2021 HGS Board

Ceri Davies
editor@hgs.org

Here We Go Again!

Hello friends, A very warm welcome and Happy New Year to you all. I've never been one to dwell on the past but 2020 will take some beating. 2020. It was hard. It was scary. It sucked. It will change the way we conduct ourselves for the rest of our lives. But now we have the hope and optimism a New Year can bring.

Over the Holidays, with any international travel plans curtailed indefinitely, I've taken advantage of visiting some of the excellent parks we have in and around Houston. For those looking for something local, Kleb Woods Nature Preserve affords a simple 3-mile hike on the north side of the city off 2920, void of any bustling traffic noise, the ~130 acre park is a nice get away within easy reach. Cagle Recreation Area is located on the undeveloped northern edge of Lake Conroe in the Sam Houston National Forest. I am a big fan of the Sam Houston National Forest. Cagle is a relatively small campground with all the amenities to make for an enjoyable weekend, short hikes in the woods, pine trees that touch the sky and far enough away from the city lights to see the stars, with the added incentive of unreliable phone reception. Our final stop on the tour was Martin Dies Jr State Park, ~100 miles northeast of Houston, Martin Dies is a wonderful ~700 acre park with hiking, biking and canoeing set in the backdrop of a forest and swamp where the Neches and Angelina rivers meet. I agree, in terms of natural beauty Houston doesn't always have the appeal of some of the more charismatic oil towns in the world, but it is full of hidden gems to keep the outdoor enthusiast entertained.

Over the Holidays, with any international travel plans curtailed indefinitely, I've taken advantage of visiting some of the excellent parks we have in and around Houston.

As we enter 2021, the Houston Geological Society is making plans in accordance with the guidelines. Unfortunately, in person meetings and social events are still on hold. This month we have three talks delivered remotely, with talks on the Spindletop Oil field (January 11th), the State of Private Equity in Oil and Gas (January 25th) and the Marcellus Shale (January 27th) scheduled. In saying this however, one of our main events of 2021 will be the third annual EAGE-HGS Latin America Conference in October. In our planning, we are working on the assumption we will be holding this event in person. Additionally, our Golf Tournament and Shrimp Peel are still a big part of our plans, and something even the most creative of zoom user will struggle to deliver remotely. ■

Have a great start to 2021, talk soon.
Ceri

The Houston Geological Society Continuing Education Committee Presents

Applied Understanding for Geoscientists of How Engineers Calculate Reservoir Oil and Gas Volumes Using PVT, Plus How Those are Used in Reservoir Simulations

A 4 Hour Virtual Event

By Ronald (Ron) L. Lang, P.E.

Thursday Morning, January 21, 2021 8 AM – 1 PM CST

Please make your reservations on-line through the Houston Geological Society website www.hgs.org
Registration will close Wednesday, January 20, 2021 at 4 pm.
Meeting links will be sent at this time to the "Primary" email listed on your HGS account.

For more information about this event, contact HGS Office 713-463-9476 • office@hgs.org
Event Contact: Cheryl Desforges cheryldesforges@hotmail.com

Course Description

Learn to apply the fundamental principles of PVT beginning at the well site and progressing through the lab to the PVT report and its application in estimating oil and gas volumes:

Summary

This practical course will provide students with a working knowledge of Pressure Volume Temperature (PVT) and an understanding of Equation of State (EOS) and its application, following a path from field sampling to the lab and on to the examination of common practices and analyses used in classical and simulated reservoir engineering

Pricing

Attendees will receive a Certificate of Continuing Education for 4 PDH
This short course is being offered to HGS for a special discount from its $100 standard rate.
HGS members $60
Non-members $80*
HGS Student Members $20
**Non-Members can submit an application and pay their dues before registering to get the member price. Please call the HGS office at 713-463-9476 to be registered only AFTER your application and dues are submitted.*

Learning Objectives

- Understand the field separation processes and sampling procedures
- Learn how to select the method of sampling at the well site
- Learn how the PVT lab validates samples and conducts experiments
- Determine which PVT experiments to perform on your samples
- Identify the six reservoir fluid types and their phase behavior
- Learn to read PVT lab reports for DLE, CCE, CVD, and Separator Tests
- Construct black oil PVT tables for volumetrics and simulation models
- Understand why and how Equation of State (EOS) was developed

Introduction

As a Geoscientist it is useful to understand how your team Reservoir Engineer calculates reserves. You might ask what is Applied Understanding of PVT and Equation of State (EOS)? It means that you don't need to be an expert in PVT and EOS to immediately and effectively apply its fundamental principals in estimating oil and gas volumes at various temperatures and pressures. By the end of this course, you will understand phase behavior in the context of reservoir fluid types and the effect of PVT (pressure-volume-temperature) changes for a characterized fluid (a defined multi-component oil and gas system). You will be equipped to apply your knowledge in the field during sampling and in discussions with the lab, and confidently use the reported results to construct PVT tables with an EOS. You will also learn how to construct PVT tables using correlations built into Excel. The applied understanding of the fundamental principals is a must for petroleum engineers, especially for reservoir engineers who need to effectively estimate reservoir oil and gas volumes at reservoir temperature and pressure during depletion and enhanced oil recovery (EOR). It is valuable for Reservoir Geoscientists to have an understanding of these principals.

Course Outline

Volumetrics and Correlations

- Oil and Gas Volumetric Equations
- Oil Correlations for Rs Pb Bo
- Gas Correlations for Z and Bg
- Oil and Gas Behavior Animations
- Oil and Gas Correlation Spreadsheets

Field Separation and Sampling

- Surface Separation of Oil and Gas
- Sampling Separator Oil and Gas

Material Balance of Fluids

- A Day in the Life of a Mole

PVT Lab and Surface Samples

- PVT Lab Surface Sample Workflow
- PVT Lab Sample Validation
- PVT Lab Compositions
- PVT Lab Gas Plant Liquids

PVT Lab Experiments

- Methods and Analyses
- Physical Recombination
- CCE Experiment
- CVD Experiment
- DLE Experiment with Correction to Surface Conditions
- Example PVT Tables

Brief Overview of PVT Equation of State (EOS)

- Introduction to Equation of State (EOS)
- Fundamental Principles of EOS
- Hydrocarbon Component Systems
- Six Reservoir Fluid Types
- What can be achieved with EOS

Closing Comments

Biographical Sketch

Ronald (Ron) L. Lang, P.E. has over 40 years of experience in reservoir engineering, including classical and simulation applications. He is actively involved as a consultant in domestic and international studies requiring application of PVT equation of state (EOS) principles. He participates in association with geoscience teams in field development strategies including primary, secondary, and enhanced oil recovery (EOR) projects. Mr. Lang is a regular guest speaker for the SPE International Continued Education Accelerated Learning Tutorials relating to PVT and EOS.

Mr. Lang received a BSc degree in Petroleum Engineering in 1974 from Texas Tech University. His career began with Amoco Production Company in Houston and transitioned to consulting firms engaged in exploration and development; acquisition and divestment transaction advisory; and petroleum engineering technical evaluations. He is a licensed professional engineer in the state of Texas.

As an experienced simulation engineer, Mr. Lang learned the importance of correctly applying PVT (EOS) to properly characterize reservoir fluids and accurately predict fluid behavior and its impact on reservoir oil and gas volumes and performance. He has studied under the guidance of leading experts in this field in the oil and gas industry. Mr. Lang had a supporting technical role during the litigation of the Deepwater Horizon Macondo oil spill. In the development of conventional and unconventional oil and gas resources, it is crucial for engineers to understand the differences among the various classes of reservoir fluids. In particular, reserves and their value can be lost rapidly if engineers do not properly identify near-critical fluids, and their behavior, such as in the volatile oils and retrograde gases.

Instructor Contact Information:
Ronald (Ron) L. Lang, P.E.
LangPE@att.net
(832) 217-8133 (mobile)

Monday, January 11, 2021

Virtual Meeting via Zoom
6:30 –7:45 p.m.

HGS Members $10 Non-Members $30 Students $5
https://www.hgs.org/civicrm/event/info?id=2256
Registered Attendees: A confirmation email will be sent upon registration with meeting links.
Event contact: Bryan Guzman – bryanguzman85@gmail.com

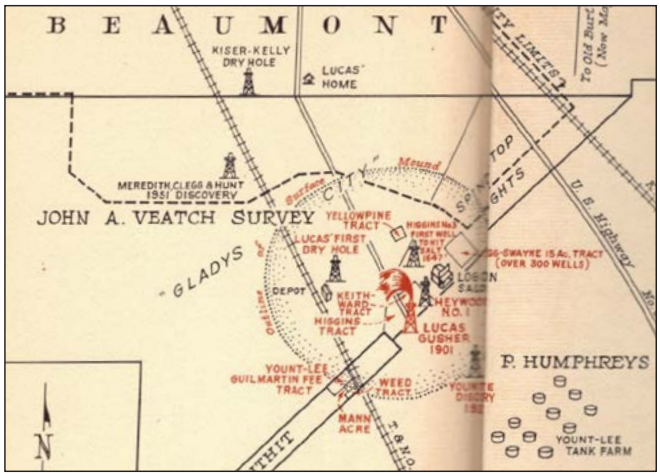
Jeff Spencer, *Sentinel Petroleum*
Robert Pledger, *Ashford Oil and Gas*
Linda Sternbach, *Star Creek Energy*
Charles Sternbach, *Star Creek Energy*
Rosemary Laidacker, *Independent*

Spindletop Salt Dome Oil History and Geoscience 120 Years After First Oil Discovered Near Beaumont Texas January 10, 1901, to January 10, 2021

On January 10, 1901, an unlikely crew of wildcatters, drillers, and oil promoters discovered Spindletop Oil field, in East Texas, by drilling in a marsh near today's Lamar University campus Beaumont. The Spindletop oil discovery made history: the first U.S. well to produce 100,000 barrels of oil per day. The frenzy of oil exploration and the economic development it generated became known as the *Texas Oil Boom*. The United States soon became the world's leading oil producer, surpassing Russia. The discovery ushered in new wealth, new technology, and rocketed Texas's state to national prominence. The Spindletop oil field has produced 150 million barrels of oil in a land area of little more than 500 acres.

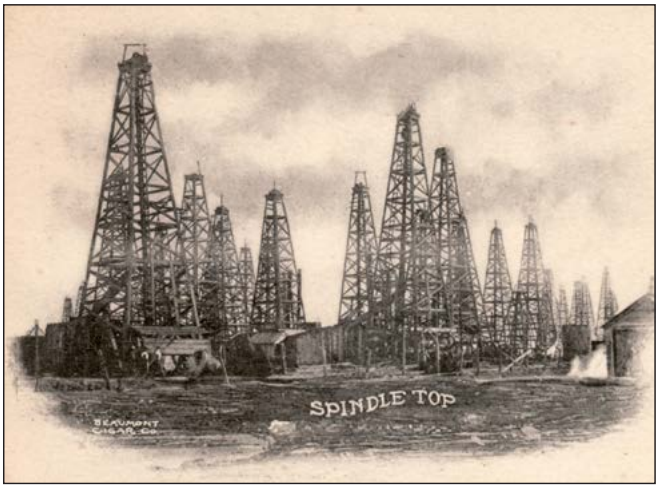
This virtual HGS program will intrigue the audience with both history and modern exploration methods over the Spindletop salt dome. Jeff Spencer (Sentinel Petroleum, and Vice President of the Petroleum History Institute) will start the program and show historical photos of the 1900s during boom times. Robert Pledger (Ashford Oil and Gas) currently operates producing wells on Spindletop and will talk about how the oil is trapped and show geological information on how his company continues to find oil reserves. Charles and Linda Sternbach will discuss Michel T. Halbouty's landmark books on Spindletop field and his influence on salt dome exploration and salt tectonics. Rosemary Laidacker, who grew up near Spindletop, will talk about her family's history in the oil business and show field trip photos to Spindletop's historic site from numerous HGS and AAPG field trips (1998-2017) to Gladys City Oil Museum.

Before the Spindletop blowout, few scientists and drilling investors believed that they would find prolific amounts of oil in Texas. Spindletop's petroleum riches occur encased in traps adjacent to the salt dome not far from the surface. In the late 1890s, a genius appeared on the horizon. A self-taught prospector and businessman, Patillo Higgins, who grew up in Beaumont, sought a source of natural gas for his brickyard and envisioned producing oil and gas. Higgins wanted to drill on Spindletop Hill, one mile to the east and four miles south of Beaumont. The hill had the



appearance of a spindle due to trees on its hilltop called in Spanish "cimas de boneteros," "tops of spindle-trees." Higgins was very observant, looking for evidence of oil and gas on Spindletop Hill. He observed natural gas seeping from the top of the hill, which he could light with a torch. Higgins met with many geologists, mostly from the northeastern U.S., who felt no significant oil occurred in Texas. It's fair to say Higgins had no supporters from the academic geological community.

Undaunted, Higgins leased land over Spindletop. In August 1892, George W. O'Brien, George W. Carroll, Pattillo Higgins, and J.F. Lanier formed the Gladys City Oil, Gas, and Manufacturing Company to do exploratory drilling. The company tried drilling two test wells but ran into trouble trying to penetrate below 300 feet, encountering a quicksand-like formation. Abandoning those wells, Pattillo Higgins then teamed with Captain Anthony F. Lucas, the leading expert in the U.S. on salt-dome formations. Lucas made a lease agreement in 1899 with the Gladys City Company and a subsequent agreement with Higgins. Lucas drilled to 575 feet before running out of money. He secured additional funding from John H. Galey, James M. Guffey, and Andrew Mellon of Pittsburgh to create the Guffey Petroleum Company.



Discovery

The Spindletop discovery well was spudded on October 27, 1900. They drilled through December of 1900, trying to make a hole below 800 ft. At 800 feet, they reached limestone, and on December 9, oil started showing up in the slush pit. The oil was coming from a 35 feet thick oil sand at a depth of 870 feet. Yet, that oil sand was too soft and fine to develop at that time, and Captain Lucas's wife, Caroline Lucas, convinced them to continue drilling to 1,200 feet to fulfill the contract.

On January 10, 1901, the drillers replaced a worn bit at 1139 ft, when a low rumble sent mud and then drill stem tools blowing out of the hole. Silence followed, then an explosion of more mud and gas, more silence, a flow of oil, and then a roar. On January 10, 1901, at a depth of 1,139 ft (347 m), the Lucas Gusher or the Lucas Geyser blew oil over 150 feet (50 m) in the air at a rate of 100,000 barrels per day (16,000 m3/d)(4,200,000 gallons). Nine days passed before the well was under control.

Spindletop Oil Field was the largest gusher the world had seen. The discovery catapulted Beaumont into an oil-fueled boomtown. Beaumont's population of 10,000 tripled in three months and eventually rose to 50,000. By the end of 1902, more than 500 companies and 285 wells were in operation. Spindletop produced 17,420,949 barrels of oil in 1902, but only half that much in 1903 as production declined. Yet Spindletop inspired wildcatting along the Gulf Coastal Plain. Significant salt dome oil fields included Sour Lake and Saratoga in 1902, Batson Prairie in 1903, the Humble oil field in 1905, and the Goose Creek Oil Field in 1908.

Second Life

Production at Spindletop began to decline rapidly after 1902, and the wells produced only 10,000 barrels per day (1,600 m3/d) by 1904. Unfortunately, the developers had signed a 20-year contract to sell 25,000 barrels per day at $0.25 per barrel to Shell Oil. Operations were stressed when the price climbed above $0.35 per barrel. Mellon, who had lent money for Spindletop's development, took control of the company and created Gulf Oil.

On November 14, 1925, the Yount-Lee Oil Company brought in its McFaddin No. 2 at a depth around 2,500 feet, sparking a second boom, culminating in its peak production year 1927, during which the industry produced 21 million barrels of oil. A young geologist named Michel T. Halbouty had joined the Yount-Lee Oil company and became fascinated with salt domes, including Spindletop and High Island in Texas. Halbouty wrote several books on salt domes and furthered the science of salt tectonics. He correctly envisioned the presence of "salt overhangs" that could trap oil on the salt dome's sides. Michel T. Halbouty anticipated salt overhangs despite difficult log correlations and poor quality seismic and gravity measurements. The Spindletop oilfield again boomed in the 1950s, with the production of sulfur by Texas Gulf Sulfur Company until about 1975. Salt-brine extraction became a lucrative operation in the 1950s. In 1963–66 even deeper oil production was achieved with an average depth of 9,000 feet.

HGS field trip to Gladys City Spindletop Museum 1998 (L to R) Steve Hill, Dan Smith, Charles Sternbach, Michel T Halbouty, Rick Fritz, Craig Moore, Jeff Lund.

HGS celebrated Spindletop's 100th anniversary in 1998 and 2001 with field trips led by Michel T. Halbouty. Trips arrived by bus to the Spindletop Gladys City Boomtown Museum on the campus of Lamar University. See their webpage at https://www.lamar.edu/spindletop-gladys-city/index.html.

The 2001 HGS Field trip celebrated the 100th anniversary and included over 300 geoscientists and guests. Organizing the trip were HGS Presidents: Charles Sternbach, Jeff Lund, Craig Moore, Jim Tucker, and attendees included Andrea Reynolds, Rick Fritz of AAPG, and many others. Michel T. Halbouty autographed books during the field trip. Past U.S. President George H. W. Bush also attended the ceremony in Beaumont. HGS returned to Spindletop Hill in 2014 on an AAPG convention field trip organized by Robert Pledger and Rosemary Laidacker.

HGS Virtual Dinner Meeting *continued on page10*

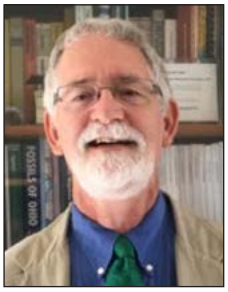
HGS General Virtual Dinner Meeting continued from page 9

Our virtual 2020 program will discuss the amazing history of Spindletop Field: colorful characters, booms and busts, and formation of the East Texas oil industry. We will also show maps and cross-sections across the field, point out the discovery and show photos from the Gladys City Boomtown Museum, dedicated to Spindletop Field, on the campus of Lamar University. The museum entrance features a huge black and white vintage seismic line mural. ■

Biographical Sketches

Jeff Spencer, *Sentinel Petroleum*

Topic: *History of Spindletop and Beaumont Using Historical Photos*



Jeff Spencer is a charter member, past President, and current vice-president of the Petroleum History Institute (PHI). Jeff is a geoscientist and principal with Sentinel Petroleum, Houston, Texas. He received a BS in Geology from the University of Cincinnati and an MS in Earth Sciences from the University of New Orleans. Jeff formerly employed by Amromco Energy (2013-2017), Midstates Petroleum Company (2010-2013), Black Pool Energy (2005-2010), Samson (2005), Osprey Petroleum (2000-2005), Unocal (1998-2000), and Amoco Production Company (1981-1998). Jeff has authored or co-authored more than 50 oil field history papers. He is co-author of *Ohio Oil and Gas* (2008) and authored *Texas Oil and Gas* (2013). Jeff also serves as the Historian for the Gulf Coast Association of Geological Societies (GCAGS).

Robert Pledger, *Ashford Oil and Gas*

Topic: *Modern Look at the Geology and Geophysics of Spindletop*

Robert Pledger has mapped and drilled wells on Spindletop Field since he was a teenager. His company still owns oil and gas leases on Spindletop. He uses well control and 3D seismic to develop oil and gas economically on the salt dome. Robert has co-founded and held leadership positions at companies including Benchmark Oil & Gas Company, Energy Securities Corporation, St. Croix Resources, Inc., and Ashford Oil & Gas Company LLC, where he currently serves as President. Pledger holds a B.S. in Geology from Lamar University and an MBA from the University of Dallas. He is an AAPG Certified Geologist and a member of the American Institute of Professional Geologists (AIPG) and the Society of Independent Professional Earth Scientists (SIPES). He served as Vice President of HGS and in the AAPG House of Delegates.

Linda Sternbach, *Star Creek Energy*

Topic: *Spindletop as Halbouty Interpreted the Salt Dome*

Linda Sternbach serves as Vice President of Star Creek Energy in Katy, Texas. She is an expert in subsurface mapping using well logs, digital technology, and seismic data. Linda has mapped salt domes in the onshore Gulf Coast using 2D and 3D and worked for ARCO Oil and Gas, and Kerr McGee, in salt provinces in the offshore Gulf of Mexico, including mapping subsalt prospects and working offshore lease sales. She has an MS in geology from Rensselaer Polytechnic Institute, Troy, New York.

Charles Sternbach, *Star Creek Energy*

Charles Sternbach is President of Star Creek Energy. He is a past President of the AAPG (2017-2018) and HGS (1999-2000) and served as President of the AAPG Division of Professional Affairs (2013-2014). Charles has a PhD in geology from Rensselaer Polytechnic Institute, and he worked for Shell Western Exploration and Production, Jordan Oil and Gas, and chose to become an independent geologist in 2003. Charles and Halbouty became friends and worked on projects together for a decade. Halbouty told Charles the three secrets to Spindletop, which he will share in the presentation.

Rosemary Laidacker, *Independent*

Topic: *HGS and AAPG Field Trips to Gladys City Spindletop Museum*

Rosemary Laidacker is a pioneer in the oil industry, being the first female geophysicist hired by Amoco, then Pan American Petroleum. She went to high school in Sour Lake, Texas (birthplace of Texaco), and the high school was in the middle of Sour Lake oil field, located about 18 miles west of Spindletop. She grew up hearing stories of Spindletop and was intrigued by oil exploration. She studied Mathematics and Physics at Lamar University and obtained a Master's from the University of Houston in Geology/Geophysics. She has specialized in oil and gas prospect generation and development in the Gulf Coast, both onshore and offshore, and has worked on many discoveries in Texas and Louisiana. After starting her career with Pan American, she went on to work for Cities Service Oil and spent time at Total Petroleum, where she was District Geophysicist. She most recently worked for Chevron as a consultant but now spends more time managing her family's Trust Fund minerals and royalty

in Southeast Texas. Rosemary is a long time member of the AAPG and has been an active volunteer for the HGS in several capacities. She is also a member of the SEG and local GSH and an AAPG Certified Petroleum Geophysicist.

More Reading

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Spellman, Paul N. (2001), *Spindletop Boom Days*, Texas A&M University, College Station, Texas, 266 pages.

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Featured Sponsor

Monday, January 25, 2021

Virtual Meeting via Zoom
7:00 –9:00 p.m.

HGS Members $10 Non-Members $25 Students $5
https://www.hgs.org/civicrm/event/info?id=2232
Registered Attendees: A confirmation email will be sent upon registration with meeting links.
Event contact: Bryan Guzman – bryanguzman85@gmail.com

HGS North American Virtual Dinner Meeting

Brian Matlock CPA, MBA
BKD CPAs & Advisors
Bernard "Buddy" F. Clark, Jr. Partner
Haynes & Boone
Chris Micsak
Pickering Energy Partners

The State of Private Equity in Oil and Gas

With sluggish market prices, the dynamics between sources & uses of Private Equity Funds have become vital & relevant in benchmarking returns and value add in portfolio assets.

The value chain that drives the production of hydrocarbons from pore to pump allows integration of new techniques & technologies in helping de-risk the opportunities.

Private Equity & other capital resources are challenged to deploy creative solutions for debt and equity strategies. The covenants & thesis for allocating the investment capital plays a role in shaping the performance of these portfolio assets.

The event will bring together stakeholders in the sources and uses of the Oil & Gas Private Equity ecosystem as the state of the dynamics is explored with a view to driving sustainable value in the industry. ■

Biographical Sketches

Brian Matlock is a partner in with BKD LLP and serves as the firm's National Energy and Natural Resource Leader, specializing in oil and gas private equity. Prior to joining BKD, Brian was a partner with KPMG serving as one of the firm's energy private equity fund leaders.

Through his experience with energy private equity funds, Brian has experience with auditing and accounting matters related to mineral extraction, power generation and energy companies, such as: upstream oil and gas, midstream oil and gas, downstream oil and gas, oil and gas participation funds, oil and gas royalty funds, master limited partnerships, oil and gas industrial manufacturing, workover and wireline servicing companies, solar power, wind power, biomass and other traditional power generation plants.

In addition to his responsibilities at BKD, Brian is very active in the energy industry, serving as the former chairman of the North American Petroleum Accounting Conference and a current board member, a member of the following organizations: Dallas and Fort Worth Council of Petroleum Accounting Societies, Dallas ADAMs Energy Forum, Dallas Petroleum Engineering Club, and the Dallas Petroleum Club. Brian was also selected as one of the "Who's Who is Energy" in 2013 by the Dallas Business Journal and was selected for the AICPA Oil and Gas Revenue Task Force in 2013.

Brian is a graduate of Texas Wesleyan University, where he received his Bachelor of Business Administration in accounting as well as his Master of Business Administration in accounting and management information systems. He is a member of the American Institute of Certified Public Accountants (AICPA) the Texas Society of Certified Public Accountants (TSCPA) and the Financial Executives Networking Group.

Buddy Clark is the co-chair for the firm's Energy Practice Group representing clients in the oil and gas industry, including banks, private capital providers and producers in secured and unsecured credit transactions and equity investments; producers, joint venturers and midstream companies in oil and gas exploration, production and development agreements, and producing property and midstream acquisitions, joint developments and partnerships; and energy related litigation and bankruptcies. In June 2016, Buddy published *Oil Capital: The History of American Oil, Wildcatters, Independents and Their Bankers*, which traces the relationship between independent producers and their capital providers in America's oil and gas industry. Buddy is a frequent speaker at oil and gas conferences and is often cited as an authority on current issues facing the oil and gas industry in trade publications and financial journals.

Selected Client Representations

- Energy lenders in senior and mezzanine syndicated, club and sole bank facilities ($10 million to $3 billion) in connection with secured reserve based oil and gas production loans, including preparation and negotiation of credit facilities, mortgages and related loan documents.
- Representation of capital providers and management teams for exploration and production companies.
- General legal advice to oil and gas companies on various transactional matters including multi-state producing property acquisitions, reserved based and production payment financings, dispute resolution and operating matters.
- Acquisitions of producing properties in Texas, Louisiana, Michigan, Mississippi, Montana, North Dakota, New Mexico, Oklahoma, Ohio, Alabama, Arkansas, Kansas, Pennsylvania, W. Virginia and Gulf of Mexico.
- Workouts and debt restructurings on behalf of energy lenders and borrowers in multi-state secured oil and gas production loans and bankruptcy related oil and gas producing property acquisitions.

Chris Micsak is a Director at Pickering Energy Partners. Prior to joining PEP, he was a director at Tudor, Pickering, Holt & Co. Asset Management. Micsak was a Vice President at Haddington Ventures, a midstream infrastructure focused private equity fund prior to TPH Asset Management. Before that, Micsak was a senior analyst at Bentek Energy, a boutique energy consulting and analytics firm where he covered North American and global energy markets. Micsak has also held trading and analytical positions at investment banks and hedge funds in New York, Connecticut and Hong Kong. He received a BA in Economics and Asian Studies and graduated magna cum laude with Honors from Colgate University.

Positioning HGS Educational Outreach for the Future

The HGS Educational Outreach program is transforming! Please join us to reach the next generation of geoscientists.

The Covid-19 crisis has highlighted that our outreach programs could be expanded with internet options. For example, we sometimes get requests for commendable websites to provide geoscience-themed videos and classroom activities. There are thousands of websites with geoscience content, ranging from quality science demonstrations to flat-earth conspiracies. And gaps exist in what is now available on the internet. A presentation on "What is a geologist?" suitable for 7th-graders might be out there on YouTube somewhere, but can you find a similar presentation suitable for a 2nd-grader? Educators teaching in this crisis have little time for scouring the web to find the useful gems.

The Covid-19 crisis has highlighted that our outreach programs could be expanded with internet options. For example, we sometimes get requests for commendable websites to provide geoscience-themed videos and classroom activities.

We started a private Facebook group of HGS members to share our favorite web finds and to identify non-starters. Our immediate goal is to develop a list of web-based resources which could be published on the existing HGS internet site. If there are gaps in the available resources, we might develop products to fill the gaps, using HGS-volunteer expertise.

Interested? To join the HGS Educational Outreach Sandbox (a private Facebook group), you need a Facebook account. Log into your Facebook account, click on the 'Groups' icon (looks like a bear-paw), and search for "Houston Geological Society Educational Outreach". Submit a request to join the group. If you currently are a member of HGS, you will be granted access to the private group within a few hours or a day. If you get stuck or have questions, contact Steve Johansen (geosjjohansen@gmail.com). ■

MEMBERS IN TRANSITION WEBINAR

MIT: RETIREMENT PLAN OPTIONS WHEN YOU LEAVE YOUR EMPLOYER

Keri Vaught
Financial Advisor

January 18, 2021
11:30 AM - 1:00 PM
Online Via GoToWebinar
Cost: $5

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Unemployed members and students who want a discount can reach out to fakintunji@unitexoil.com

Wednesday, January 27, 2021

Virtual Meeting via Zoom
12:00 –1:00 p.m.

HGS Members $10 Non-Members $25 Students $5
https://www.hgs.org/civicrm/event/info?id=2261
Registered Attendees: A confirmation email will be sent upon registration with meeting links.
Event contact: Bryan Guzman – bryanguzman85@gmail.com

Randy Blood
DRB Geological Consulting

Giving 110%: Field and Laboratory Observations of the Marcellus Shale and Associated Strata Which May Explain Well Production in Excess of Gas-In-Place

The highly productive nature of the Marcellus Shale has led to an interesting observation where individual well EUR often exceeds the calculated Gas-In-Place (GIP). An explanation for this paradox may be found in one, or both, of two broad categories: 1) Our understanding of gas storage in the Marcellus Shale is lacking and this results in volumetric petrophysical models underpredicting GIP, or 2) our assumptions about drainage volume of a well are incorrect and they are drawing hydrocarbon from a larger source area than we expect.

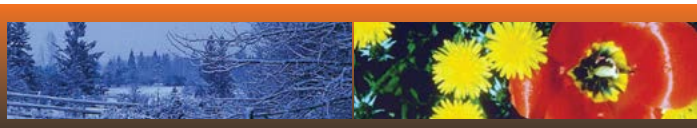
To address GIP, the talk focuses on three aspects of the volumetric model: 1) implementing the Ambrose-Hartman correction to the free gas calculation, 2) modifying the water saturation to reflect anthropogenic sources of water in core, and 3) implementing a dynamic pore pressure gradient. Pressurized rotary sidewall cores were collected from the Marcellus Shale in a well drilled under slightly overbalanced conditions to minimize gas escape. After measuring total gas evacuated from the cores, total uptake experiments were conducted to determine the storage capacity of the samples at varying pressures. Isotopic analysis of core, drilling, and produced water was used to determine the source of these waters. Finally, field analysis of the occurrence of natural hydraulic fractures compared to total organic carbon (TOC) was used to estimate the variation of overpressure development at the bed scale. Total uptake experiments confirm the necessity of the Ambrose-Hartman correction to the free GIP component to accurately quantify GIP. Isotopic analysis of core, drilling, and produced water indicate that the majority of water encountered in the Marcellus Shale results from the drilling and completion process with minimal evidence of mobile in situ water. The increased density of natural hydraulic fractures (NHFs) associated with increasing TOC reveals a strong relationship between overpressure development in beds and TOC content, suggesting the need to treat pore pressure as a dynamic value. When these three aspects are considered, GIP values can increase by 25%.

To address drainage volume, it is worth noting that there are multiple organic-rich units overlying the Marcellus Shale that may contribute to production. Field studies indicate the presence of discrete channel-fill black shales that occur within the overlying grey-shale dominated successions of the Hamilton Group. These features are characterized by black shale facies which are feet to tens of feet in thickness and miles to tens of miles in width. Channel bases are erosional discontinuities marked by pyrite-bearing phosphatic lags. Detailed analyses of well logs indicate such features of the same scale are found in the subsurface. Moreover, common to these deposits is the presence of what we interpret to be gas chimneys: narrow zones of heavily fractured rock 10s to 100s of feet wide, and 100s of feet tall. These fractures consist of closely spaced Mode 1 natural hydraulic fractures that are 10s to 100s of feet tall. The gas chimneys occur at or near the top of black shale dominated strata and continue upward into overlying organic-lean grey to silty shale-dominated strata. Such gas chimneys may connect Marcellus Shale strata to overlying black shale reservoirs in the Hamilton Group or Geneseo Shale. ■

Biographical Sketch

Randy (David) Blood is a geologist and petrophysicist based in the greater Pittsburgh area working on various aspects of Paleozoic strata in the Appalachian Basin. His current interests include evaluating sedimentary features within mudstones and how they affect hydrocarbon transport, drilling and completions, and the distribution and accumulation of critical minerals and rare earth elements. Before starting DRB Geological Consulting, he worked for EQT Production and Chesapeake Energy evaluating their unconventional assets, defining horizontal landing zones, and using inorganic geochemistry data to model facies, estimate rock mechanics, and help solve wellbore stability issues. He also has experience evaluating unconventional assets and sedimentary successions in basins across the United States and abroad.

January 2021



Sunday	Monday	Tuesday	Wednesday
	Virtual Pre-registered Prices: Virtual Meetings members ..... $10/15 Emeritus/Honorary members..... $10/15 Student members ..... $5 Nonmembers $30/35	**Reservations:** The HGS prefers that you make your reservations on-line through the HGS website at www.hgs.org. If you have no Internet access, you can e-mail office@hgs.org, or call the office at 713-463-9476. **Reservations for HGS meetings must be made or cancelled by the date shown on the HGS Website calendar, normally that is 24 hours before hand or on the last business day before the event**. If you make your reservation on the Website or by email, an email confirmation will be sent to you. If you do not receive a confirmation, check with the Webmaster@hgs.org. Once the meals are ordered and name tags and lists are prepared, no more reservations can be added even if they are sent. **No-shows will be billed.**	
3	4	5 **HGS Board Meeting** *6 p.m.*	6
10	11 **HGS General Dinner Virtual Zoom Meeting** *"Spindletop Salt Dome Oil History and Geoscience 120 Years After First Oil Discovered Near Beaumont, Texas – January 10, 1901, to January 10, 2021," Jeff Spencer, Robert Pledger, Linda Sternbach, Charles Sternbach,Rosemary Laidacker, Page 8*	12	13 **HGS Environmental and Engineering Dinner Virtual Zoom Meeting** *TBA*
17	18 **AAPG Members in Transition Webinar** *Page 14*	19	20
24 31	25 **AAPG Global Super Basins Virtual Event** **HGS North American Dinner Virtual Zoom Meeting** *"The State of Private Equity in Oil and Gas," Brian Matlock CPA, MBA; Bernard "Buddy" F. Clark, Jr; Chris Micsak. Page 12*	26	27 **HGS General Lunch Virtual Zoom Meeting** *"Giving 110%: Field and Laboratory Observations of the Marcellus Shale and Associated Strata Which May Explain Well Production in Excess of Gas-In-Place" Randy Blood, Page 15*

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- **$4,700,000** Jury verdict, oil company violates geologist non-compete contract. Settled later on confidential terms.
- **$2,000,000** Settlement for downhole failure of casing results in loss of well bore, net to client $1,372,411.79.
- **$1,175,000** Settlement for geologist and family where oil company drilled too close to geologist property. Case filed 18 years after well drilled. Net to client $664,822.51.
- **$986,000** Cash settlement, net to clients $657,207.60, plus future mineral interest valued at $500,000.00. Dispute over mineral interest ownership from thirty year old contract.

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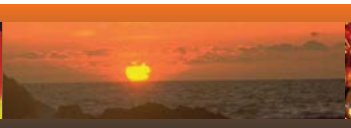

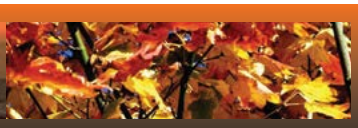

GeoEvents

Thursday Friday Saturday

	1 Don't wait, make your reservations online at hgs.org	2
7	8	9
14	15	16
21 HGS Continuing Education *"Applied Understanding for Geoscientists of How Engineers Calculate Reservoir Oil and Gas Volumes Using PVT"* *Page 6-7*	22	23
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AAPG Members in Transition Webinar
Page 14

January 21, 2021
HGS Continuing Education
Applied Understanding for Geoscientists of How Engineers Calculate Reservoir Oil and Gas Volumes Using PVT
Page 6

January 25-26, 2021
AAPG Global Super Basins 2021
An online event
Actionable Insights from North America's Greatest Basins
Page 2

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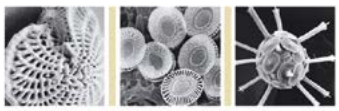

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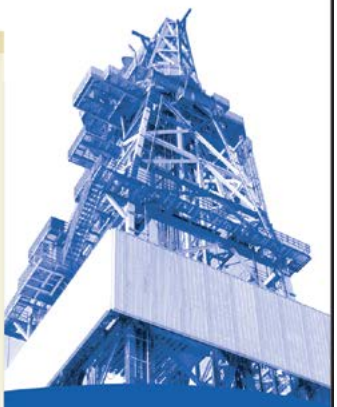

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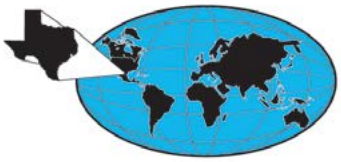

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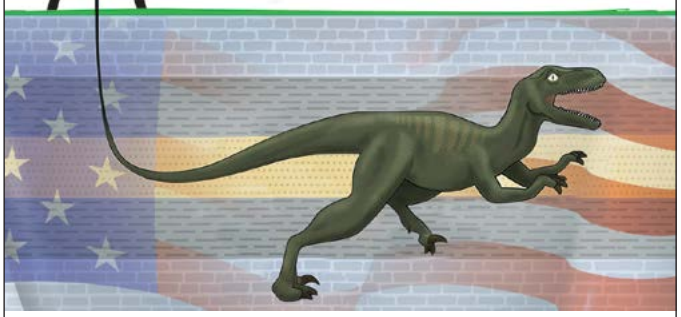

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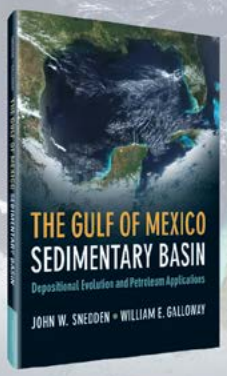

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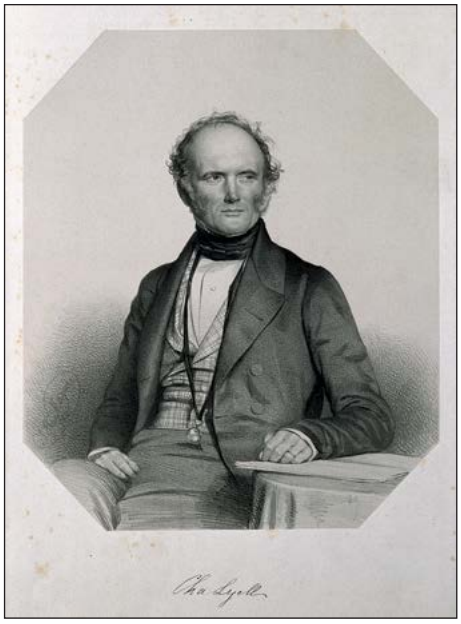
Creating Charles Lyell's World Online

By David McClay, Philanthropy Manager, Library & University Collections, University of Edinburgh

The University of Edinburgh has recently brought together an extensive collection of geologist Sir Charles Lyell's (1797-1878) papers and archives. Exciting plans are now in place to make this fascinating and unique collection freely available online for the benefit of all who have an interest in the history of the earth sciences through one of its greatest practitioners and promotors.



Lyell portrait, 1849

Sir Charles Lyell

Charles Lyell was fundamental in establishing the popularity and credibility of geology as a science in the nineteenth century, especially in disseminating fellow Scot James Hutton's theory of uniformitarianism, the theory that changes in the earth's crust during geological history have resulted from the action of continuous and uniform processes, still observable today. Another Scot, Sir Archibald Geikie, afterwards popularised the theory by coined the phrase "The present is the key to the past"

Through extensive field work, travel, popular lectures and bestselling books, Lyell became internationally famous and respected by many scientific communities. His *Principles of Geology*: being an attempt to explain the former changes of the Earth's surface, by reference to causes now in operation (1830-33) was in print throughout his life and was regularly revised to incorporate new evidence and arguments.

Lyell's understanding of geology and broader natural history influenced many, notably his friend and admirer Charles Darwin. Taking Lyell's Principles with him on his famous voyage of the Beagle, changed his geological understanding and challenged him to elevate the potential of rigorous scientific investigation and ambitious theorising. Darwin wrote to his father in law, Leonard Horner in 1844; "I always feel as if my books came half out of Lyell's brains and that I never acknowledge this sufficiently, nor do I know how I can, without saying so in so many words – for I have always thought that the great merit of the Principles, was that it altered the whole tone of one's mind and therefore that when seeing a thing never seen by Lyell, one yet saw it partially through his eyes."

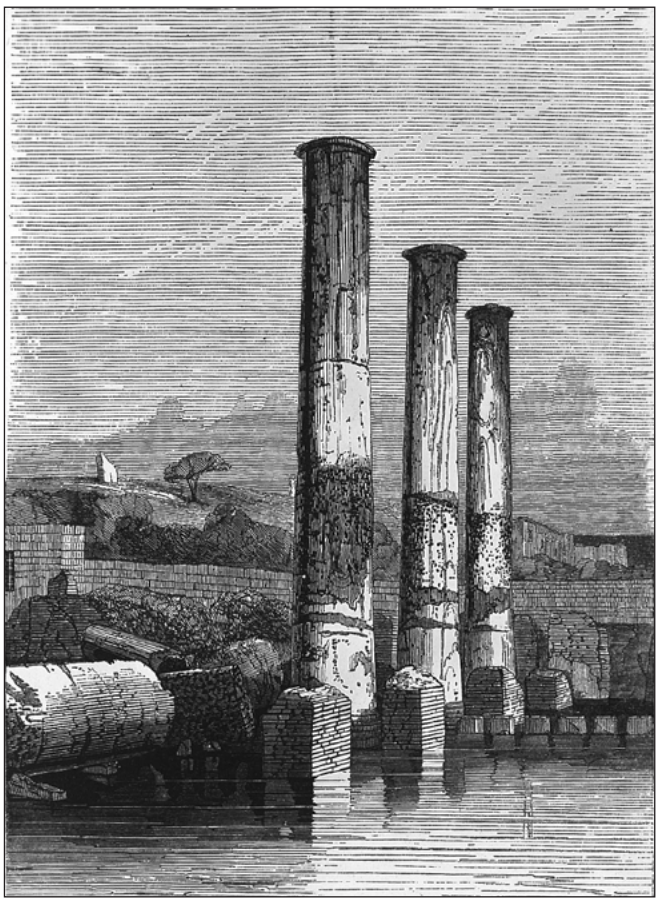
Lyell in America

Lyell was also influential in America, making four visits in the 1840s and 50s. The first visit in 1841-42, with his wife Mary, was to deliver the Lowell lectures to vast audiences in Boston. These were extensively covered in the newspapers, with a large clippings collection in his archive alongside his hand written speaking notes.

Interest in his visit led to the publication of two volumes of *Travels in North America* (1845). This recorded his geological observations, but also social and political opinions, including the sensitive matter of slavery. Whilst a useful record of observations and opinions, some at the time, including Darwin were disappointed by Lyell's apparent ambivalence towards slavery.

The Lyells revisited America in 1845–6 to deliver the Lowell lectures again and two further volumes of their travels appeared in 1849. Two further visits to America in 1852 and 1853, included representing London's Great Exhibition Commission of 1851 to Industrial Exhibition in New York. These North American

Creating Charles Lyell's World Online *continued on page 20*



Principles frontispiece Temple of Serapis, 1830

Creating Charles Lyell's World online

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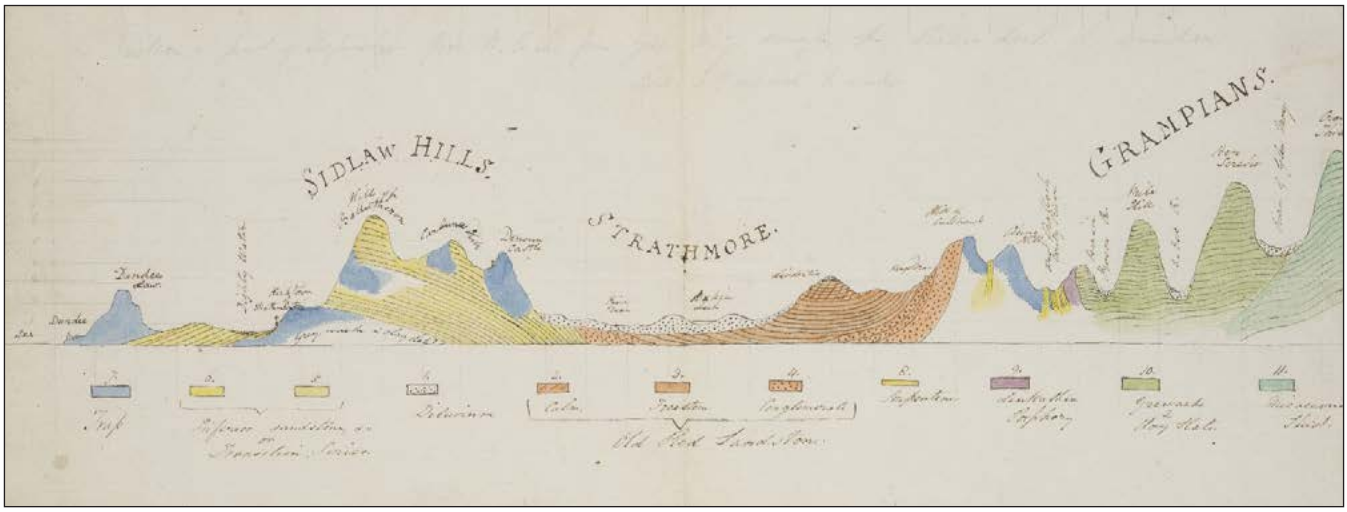


Geological cross section of Forfarshire, Scotland

travels, along with his extensive British and European journeys, are extensively recorded in his rich archive of letters and notebooks, now held by the University of Edinburgh.

Founding the Lyell Archives

The foundation Lyell collection was generously donated to the University in 1927 by Lady Lyell of Kinnordy. These archives include field and lecture notes, correspondence and press cuttings. Areas of geological focus includes Forfarshire, the Madeira and Canary Islands, Mount Etna and New Zealand. The correspondence, from 1831-1873, extends over more than 6,500 folios and offers fascinating detail, not only on Lyell, but a lively selection of influential and curious members of nineteenth century society. A small but important Lyell specimen collection came with the papers and consists of around one hundred stone artefacts (axes, spears and arrow heads), three meteorites, 25 fossils and 25 rocks. Some of the specimens are significant because they were used to illustrate his books, including flint tools which relate to his research for his *Geological Evidences of the Antiquity of Man* (1863).

The 1927 donation was not motivated by a particularly significant Lyell and Edinburgh connection. However, by the early twentieth century the University's geological credentials has been well established. Sir Roderick Murchison had founded Edinburgh's chair of geology in 1870, the first appointment being Sir Archibald Geikie.

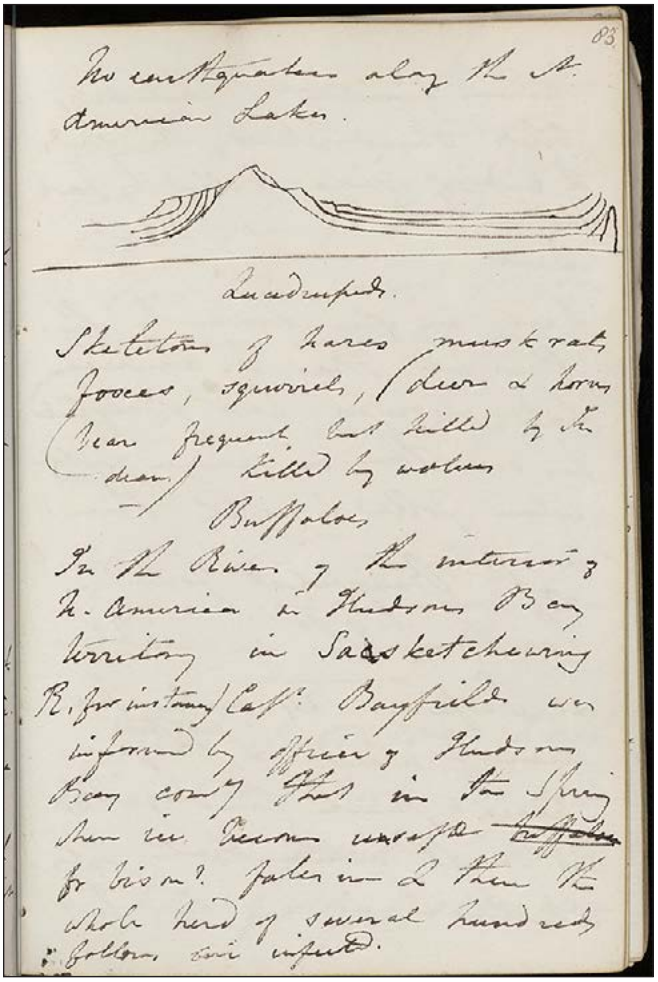
Lyell's Notebooks

Having a longstanding Lyell archive, the University of Edinburgh was particularly keen to acquire his notebooks when they became available in 2019. These 294 pocket notebooks, which, except a few missing ones, form a long and uninterrupted series of continual thought and study from 1818 to 1875. They vary from approximately 70 to 270 pages, and are crammed with extensive notes and memoranda on geology, natural history, social and political subjects, with many hundred accompanying sketches and diagrams. They are fascinating and invaluable.

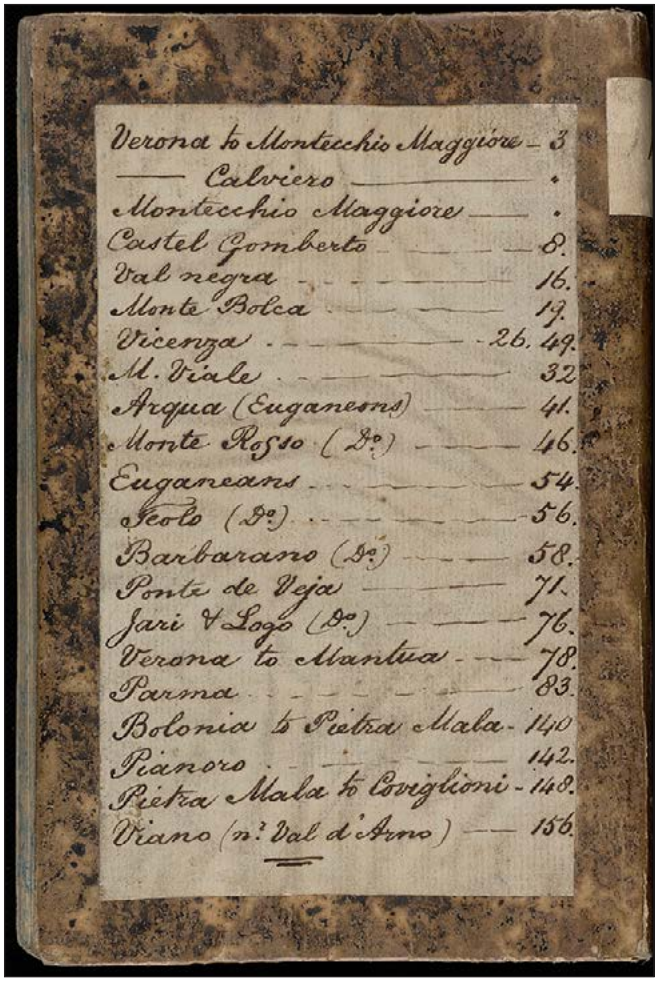
Lyell's habitual use of notebooks was a key part of his working method and integral to his geological research and publishing. In addition to gathering the raw materials for much of his printed work, they offer the most immediate insights into his life, reading, draft and copy correspondence and, most critically, his immediate and developing thoughts.

The notebooks had remained in Lyell family possession until the death of Charles, 3rd Baron Lyell (1939-2017) when they were valued at £1,444,000 and provisionally sold to an overseas

Lyell notebooks shelf selection



Lyell notebook, regarding North American buffaloes



Lyell notebook, Italy, cover and index, 1828

buyer. An Export Bar was applied, having been designated as of national significance and if at all possible they should be kept in the UK. Thanks to a negotiation, based on the tax advantage of a Private Treaty Sale, a revised purchase price of £966,000 was set. Between June and October 2019 over 1,100 donations reached the funding target. Whilst the University of Edinburgh, the National Heritage Memorial Fund and the John R. Murray Charitable Trust made vital major donations, it was also the coming together of many individuals, societies and grant giving bodies, including the Geologists' Association, who helped achieve the goal of saving the notebooks. A notable feature of the fundraising campaign was the wide international response and generosity, with many generous donations coming from North America, with Texas and Houston being particularly well represented.

Completing Lyell's Archives

The University of Edinburgh, with the addition of the notebooks had now established itself as the archival centre for Charles Lyell. When government ministers, specialist advisors and the Treasury decided to accept the bulk of Lyell's remaining archives under the British government's Acceptance in Lieu of Inheritance scheme, they decided to allocate, for free, to Edinburgh.

This varied collection arrived in August 2020 and perfectly complements the rest of the archives. Highlights include a further 1,200 letters, to and from Lyell and between his family members. Special correspondents include Charles Darwin, Joseph Dalton Hooker, Leonard Horner, Thomas Huxley, Sir Roderick Murchison, John Murray III, Herbert Spencer and George Ticknor.

The collection's scientific, personal and publishing papers include much material on Lyell and his wife's experiences in America, journal articles and offprints of scientific papers, reviews, speeches and lectures notes. The varied publishing items include drafts of his literary works, including an early autobiographical manuscript, partial book manuscripts including the *Principles of Geology*, annotated revision copies of his works and illustrations, lithographs and maps.

Creating Charles Lyell's World Online *continued on page 22*

Creating Charles Lyell's World online continued from page 21

Further recent opportunities to add to the collection have included a Lyell family album of letters and photographic portraits and foreign language editions of his books. Again the support of organisations such as the Friends of the National Libraries and the Friends of Edinburgh University Library have made these acquisitions possible.

Charles Lyell's World Online

With this extensive Lyell archive now assembled at the University of Edinburgh, focus has turned on how to make the most of this collection and share it as widely as possible. Our Charles Lyell's World Online project is an extensive programme of conservation, preservation, digital photography, cataloguing, transcription and online access and engagement.

Conserving and preserving the physical collection is essential to allow traditional in-person consultation and research, as well as displays and exhibitions. However, the full potential of the collection will only be achieved through an additional online version of the Lyell's archives.

With high quality digital photography of the notebooks, along with the most significant parts of the remaining archive collection, we will create the basis of a fascinating online resource. These images will be made more accessible and understandable by transcribing the text and contextualising with information and interpretation around the biography, bibliography, chronology and science. Such an online resource, which is freely accessible, will be useable by a wide range of people, from specialist historians and scientists, to the casual and inexperienced browser or student.

In addition to describing and making accessible the collections held at the University of Edinburgh, the Charles Lyell's World Online will also seek to act as a hub for other relevant Lyell and contemporary resources, whether that is further archives, texts or specimens.

Grants, donations and the University of Edinburgh's own resources have already covered the costs of conservation, the first curatorial post and the design and build of the Charles Lyell's World Online website, the latter with the generous support of the International Association of Sedimentologists. By investing in the archive in this way the true value of the collection will be realised for current and future generations and made publicly available for all, creating a far greater knowledge and appreciation of Lyell's life and world, a time in which the earth sciences came of age. The next stage of the project and fundraising will be to digitally photograph the collection, so that it can be shared freely online.

Forthcoming Events

There is an ongoing programme of activities to promote this remarkable archive collection and encourage engagement and research. This includes a series of free online events in February 2021. To encourage our American supporters and friends to attend these we will be hosting these with respect to different time-zones. I hope you can join us to learn more. ■

Further Reading

To learn about these events and more about the archives and our developing plans and progress a website and blog:

Through Lyell's Eyes:
https://www.ed.ac.uk/information-services/library-museum-gallery/crc/the-sir-charles-lyell-collection

Library Lyell Website
http://libraryblogs.is.ed.ac.uk/lyell/

The Eagle Ford Shale Play of Texas Thirteen Years of Development December 2020

By Kurt Mire, P.E., Mire Petroleum Consultants

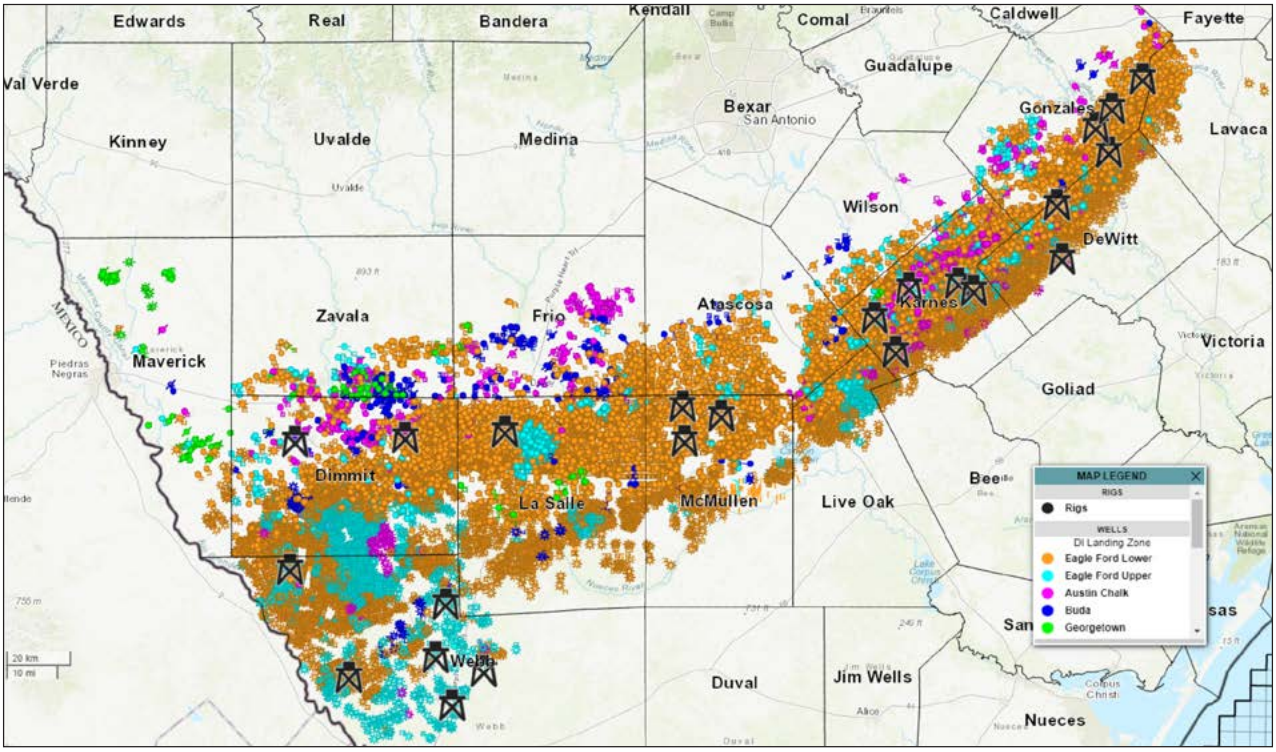


Figure 1. *Eagle Ford wells and current drilling rigs map from Enverus. Colors show the five target reservoirs*

The Eagle Ford Shale of Texas is one of the most prolific unconventional oil and gas plays in the world. The play covers about 7 million acres in 15 counties across South Texas. Since 2008 it has been developed with over 19,000 horizontal wells. See **Figure 1**.

Total production through September 2020 is 3.1 billion barrels of oil and 14.2 TCF of gas. Production rates from the play peaked in March 2015 at 1.35 million barrels per day and 5.3 billion cubic feet per day. See **Figure 2**.

Development History

Horizontal wells with multi-stage hydraulic fracture stimulations have been used to exploit the oil and gas reserves. The main reservoir target is the Lower Eagle Ford with additional development in the Upper Eagle Ford, Austin Chalk, Buda and Georgetown formations. Drilling activity peaked in 2014 with 3,658 well spudded. Activity has steadily dropped since then and for 2020 only about 300 wells will be drilled. See **Figure 3**.

Over the history of the play 154 operators have drilled wells. The most active operators have been EOG, Chesapeake and Marathon. The top operators accounting for 80% of the drilling are shown in **Table 1**.

The Eagle Ford Shale Play of Texas *continued on page 24*

Operator	Wells	Share	Cum Share
EOG Resources	2,732	14.2%	14.2%
Chesapeake	1,926	10.0%	24.3%
Marathon Oil	1,559	8.1%	32.4%
SN EF Marverick	1,419	7.4%	39.8%
Burlington Resources	1,267	6.6%	46.4%
Devon Energy	948	4.9%	51.3%
Murphy E&P	780	4.1%	55.4%
EP Energy	735	3.8%	59.2%
Callon (Eagle Ford)	589	3.1%	62.3%
Lewis Petro	547	2.8%	65.1%
SM Energy	546	2.8%	68.0%
Ensigh Operating	515	2.7%	70.7%
Ovintiv USA	491	2.6%	73.2%
BPX Operating	460	2.4%	75.6%
Repsol Oil & Gas	423	2.2%	77.8%
Penn Virginia	401	2.1%	79.9%
Rosetta Resources	343	1.8%	81.7%

Table 1. *Most active operators by number of wells spudded*

The Eagle Ford Shale Play of Texas

continued from page 23

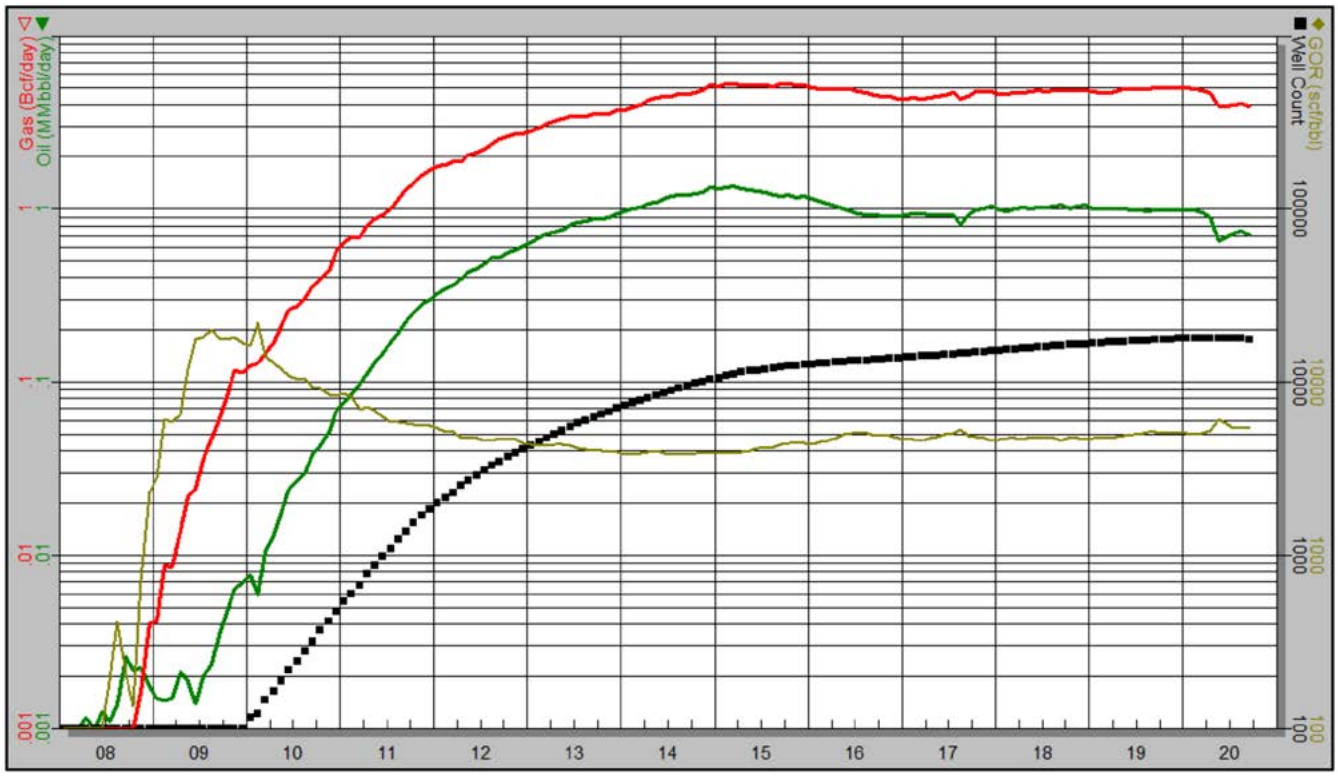


Figure 2. *Production rates 2008 – 2020, MMBOPD (green), BCFD (red), gas-oil ratio (gold) and active wells in black*

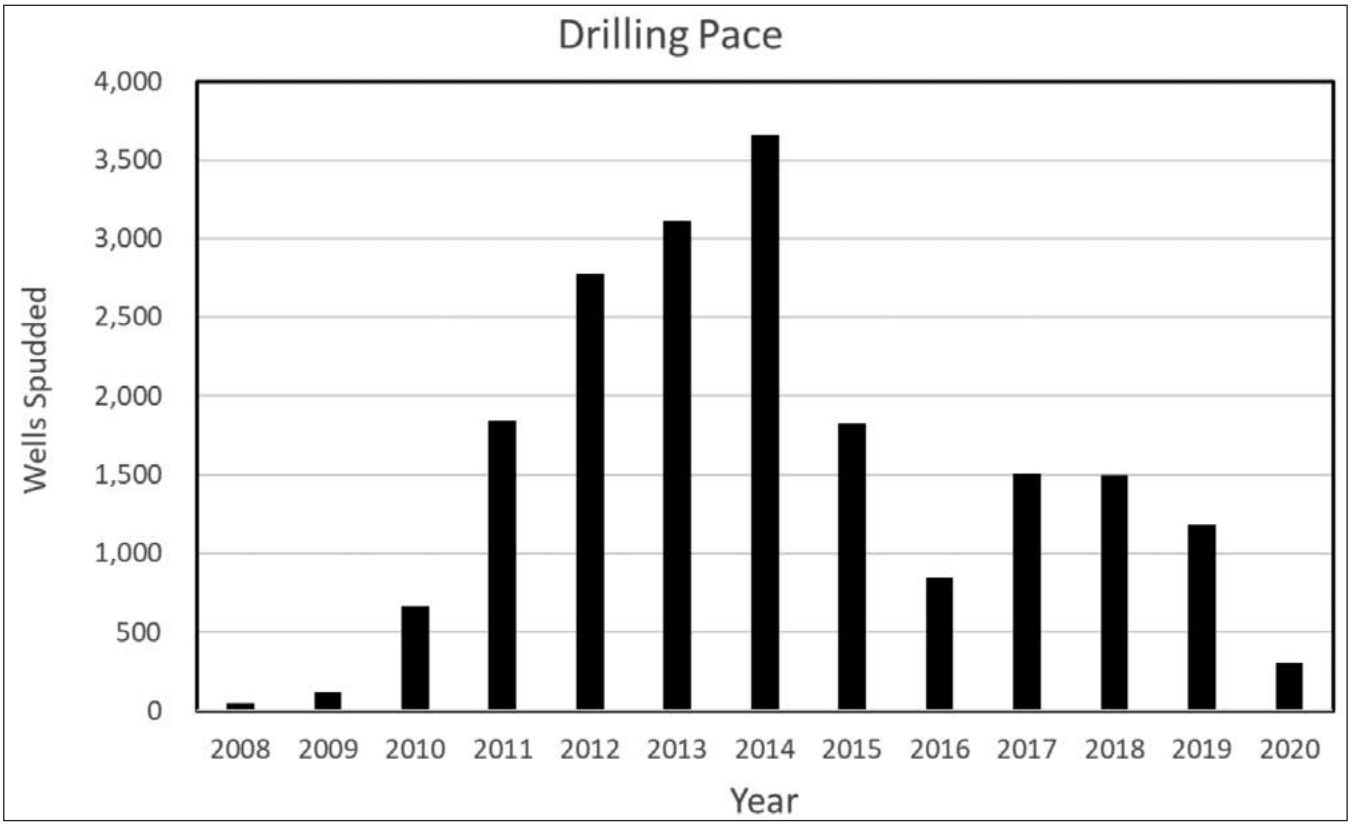


Figure 3. *Horizontal wells spudded each year (2008-2020). Year 2020 is estimated from available data*

The most active county for drilling has been Karnes followed by Dimmit and La Salle. The primary target of the horizontal wells is the Lower Eagle Ford Shale, followed by the Upper Eagle Ford. See drilling by county and target reservoir in **Tables 2 and 3**.

Current data shows that seventy-one (71) wells are drilled but not completed (DUCs).

Completion and Well Performance

Historic well completion data shows that lateral lengths and proppant concentrations have increased every year except 2020 (partial data). Well production performance (6 month cumulative production per lateral foot) generally increased through 2016 but has shown some degradation for the last three (3) years. See completion and production data in **Table 4**.

Currently activity

Current production from the play is about 735,000 BOPD and 4 BCFD from active 17,800 wells. Drilling activity includes twenty-four (24) rigs. EOG is the most active driller, and Webb County has the most rigs. Helmerich & Payne is the most active drilling contractor in the play. See current rig activity data in **Tables 5, 6, and 7**.

The Eagle Ford Shale Play of Texas *continued on page 26*

Operator	Wells	Share
Karnes	3,740	19.5%
Dimmit	3,130	16.3%
La Salle	2,966	15.5%
Dewitt	2,017	10.5%
Webb	1,955	10.2%
McMullen	1,447	7.5%
Gonzales	1,341	7.0%
Atascosa	945	4.9%
Live Oak	593	3.1%
Frio	348	1.8%
Lavaca	269	1.4%
Zavala	199	1.0%
Wilson	131	0.7%
Maverick	88	0.5%
Bee	25	0.1%

Table 2. *Wells by county*

Operator	Wells	Share
Lower Eagle Ford	15,445	80.5%
Upper Eagle Ford	2,755	14.4%
Austin Chalk	689	3.6%
Buda	210	1.1%
Georgetown	95	0.5%

Table 3. *Target reservoirs*

Year	Proppant lbs.	Lateral Length ft	Proppant Conc. lbs./ft	6 Month Production BOEPD/1000 ft
2008	2,699,992	2,816	959	77
2009	2,621,771	4,323	607	82
2010	3,836,547	5,330	720	83
2011	4,707,406	5,656	832	75
2012	5,327,533	5,827	914	80
2013	6,259,948	5,902	1,061	84
2014	7,921,561	6,090	1,301	90
2015	9,845,463	6,302	1,562	102
2016	12,303,679	6,566	1,874	121
2017	14,432,034	7,274	1,984	113
2018	15,617,422	7,617	2,050	107
2019	17,278,224	7,668	2,253	106
2020	16,095,404	7,750	2,077	

Table 4. *Yearly average well completion and performance data*

The Eagle Ford Shale Play of Texas

continued from page 25

Operator	Rigs
EOG Resources	6
Conocophillips	3
Marathon Oil	2
Penn Virginia	2
Ageron Energy	1
Callon Petroleum	1
CML Exploration	1
Crimson Energy	1
EP Energy	1
Escondido Resources	1
Gulftex Energy	1
Lewis Energy	1
Rosewood Resources	1
Silverbow Resources	1
SM Energy	1

Table 5. *Current rigs by operator*

Contractor	Rigs
Helmerich & Payne	11
Nabors Industries	5
Ensign Energy Services	3
Patterson-UTI Drilling	2
Hazelett Drilling	1
Lewis Petro Properties	1
Precision Drilling	1

Table 6. *Current drilling contractors*

County	Rigs
Webb	6
Karnes	5
Gonzales	4
La Salle	3
Dewitt	2
Dimmit	2
McMullen	2

Table 7. *Current rigs by county*

Well spacing and reserves

Over the life of the play the average lateral length for the horizontal wells is 6,068 feet. With well counts through 2020 the spacing so far is about 362 acres per well indicating about 2,500 feet between laterals.

Well production trends from the last three (3) years of drilling show that the wells on average should each produce about 260 MBO and 1,350 MMCF over their lives. However, there appears to be a slight reduction in well performance since 2016. With current product prices ($46 Oil & $2.60 Gas) the average well should be economic to drill.

Summary

The Eagle Ford Shale is a major US unconventional oil and gas play that has been under development for the last thirteen (13) years. It covers about 7 million acres and has produced 3.1 BBO and 14.2 TCF from more than 19,000 wells.

Good well performance and current well spacing should allow additional development over the next several years. However, the evidence of well performance decline over the last few years should cause future drilling to be concentrated in better parts of the play (sweet spots) where current well spacing is higher. (Well data, rig data, and target reservoirs from Enverus-Drillinginfo.) ■

Biographical Sketch

Kurt Mire, P.E. is a senior reservoir and production engineer with 35 years of experience in E&P. This experience has been gained at major and independent oil companies and by projects done for Tier 1 consulting firms Ryder Scott Company and Netherland, Sewell & Associates. Domestic experience includes Louisiana, Texas, Gulf of Mexico, Mid-Continent, and Rocky Mountains. International experience includes Mexico, South America, Iraq and Trinidad. He has proven skills in reservoir and production engineering, operations reserves estimation, Monte Carlo simulation, nodal analysis, field studies, project management and property evaluations. Kurt has a BS in Petroleum Engineering from the University of Louisiana at Lafayette, 1982. Texas Professional Engineer #115886.

35 Years Experience

Mire Petroleum Consultants, Houston	2020
Mire & Associates, Inc., Houston	2004-2020
BP America, Houston	2001-2003
Independent Consultant, Lafayette, LA	1999-2001
Subsurface Consultants, Lafayette, LA	1993-1998
Black Gold Production Co. Hammond, LA	1991-1993
Independent Consultant, Morgan City, LA	1988-1991
Texaco, Inc., Morgan City, LA	1983-1987

Oil Geochemistry of the Texas/Louisiana Gulf Coast: The Gift that Keeps on Giving

By Catherine M. Donohue (cdonohue@geomarkresearch.com), Craig D. Barrie, J. Alex Zumberge, John E. Zumberge and Matthew White
GeoMark Research, Houston, TX

This month, the HGS is celebrating the anniversary of the Spindletop well and the emergence of the oil industry in Texas and the greater Gulf Coast. Part of this celebration is to recognize that the exploration spirit guiding the early oil pioneers, such as Patillo Higgens and Anthony Lucas, is still alive today and can find fertile ground in the gulf coast region. For more than 100 years the onshore Texas/Louisiana coast has proven time and again that a good understanding of petroleum systems and geology will yield impressive, profitable results. The key to such a high performing region starts with the presence and quality of the source rocks. While the early days of exploration focused upon salt dome traps and hoped for the best, those working the area in the present day have the benefit of both more advanced science and geologic/contextual understanding to identify and predict key source rocks and tell the petroleum system story.

The impressive production history of the Gulf is not the work of one source unit. From the Jurassic to the Tertiary, the Gulf Coast has several world class source rocks that continue to fuel exploration and production activity. While there is a considerable body of literature to confirm the identity of the source rocks (**e.g. Sofer, 1988; Thompson, 1995; Wenger, et al., 1995**), the dynamics of petroleum generation, expulsion, migration and accumulation often result in mixed geochemistry/source signatures in the resulting oils. While unraveling this story over the past 30 years, GeoMark Research has analyzed more than 700 oil samples, looking to understand the age, type, and maturity of the source rocks that generated them (for methods see **Zumberge et al., 2005**). Fast forward to the present day, and the advent of unconventional exploitation has expanded this dataset to include more self-sourced plays that further define and delineate oil-source correlations. The current interpretation of this oil dataset includes source assignments that describe the age and depositional environment. The spatial distribution of these oil families (**Figure 1**) will be discussed and although the details of the interpretation are beyond the scope of this review, the illustrated trends are a valuable part of confirming regional source effectiveness and should be used to guide ongoing petroleum system evaluations. Today, as the oil industry focuses on maximizing profits in areas of low risk at lower investment, the Gulf Coast still stands as an area of opportunity if this knowledge is applied successfully.

Oil Geochemistry of the Texas/Louisiana Gulf Coast *continued on page 28*

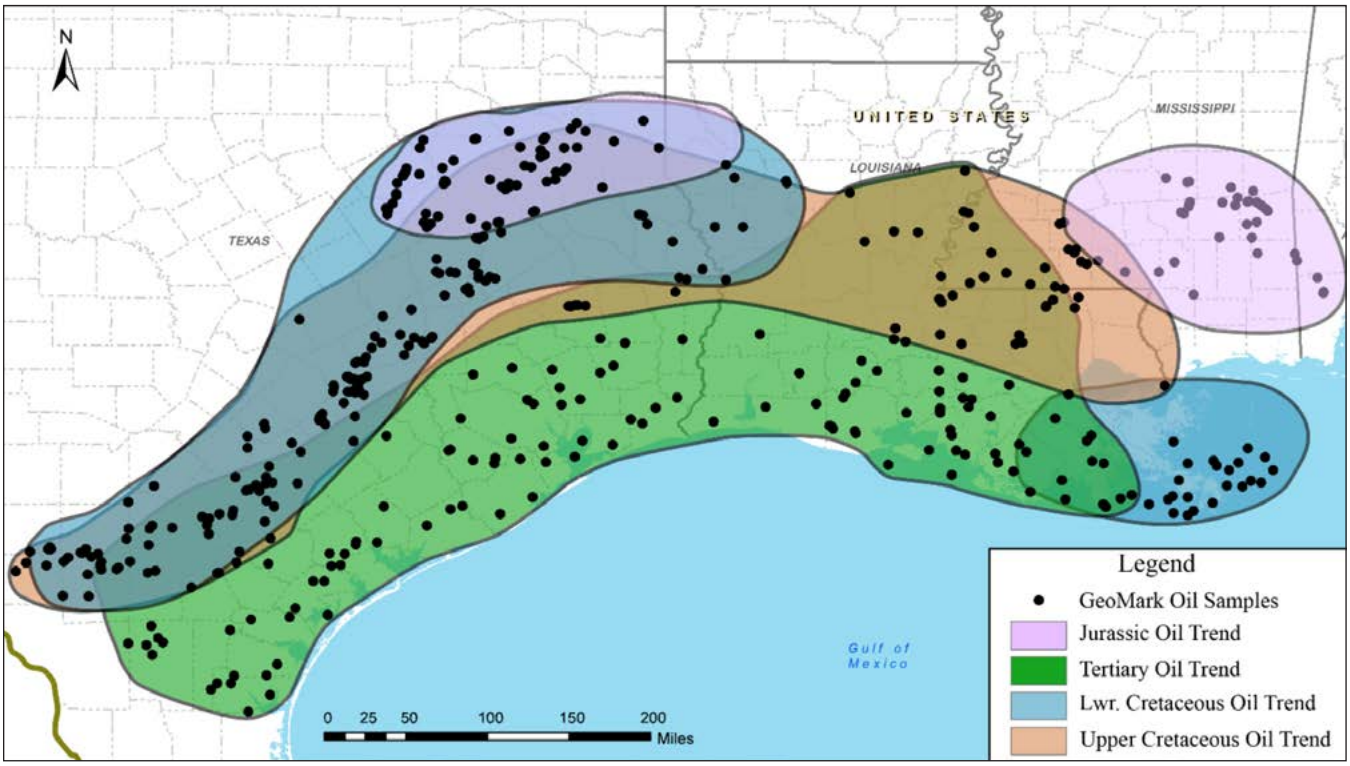


Figure 1. *Location Map of the oil samples and source trends onshore, along the coast of Texas, Louisiana and Mississippi in the USA.*

Oil Geochemistry of the Texas/Louisiana Gulf Coast

continued from page 27

Regional Background

Starting at the end of the Paleozoic, the North America craton acted as a passive margin to provide clastic sediments and deposition into the developing Gulf of Mexico basin. The similar climate and depositional history of the region allows for correlative stratigraphy across the area since the mid Jurassic. The main structural elements of the Texas/Louisiana coast can be divided into highs (Llano uplift, San Maros Arch, Angelina Faults trend, etc) and lows (East Texas Basin, N. Louisiana Salt Basin, etc). Generally, it is these lows which act as the kitchens for petroleum generation. Although facies changes and maturity differences drive variation in petroleum quality across the basin, we are fortunate to have a "playlist" of correlative source rocks to look to when prospecting in the region (**Figure 2**).

Oil Families

Jurassic

During the Jurassic, a marine transgression led to the deposition of carbonate and massive salt and other evaporites across much of the Gulf area. This unique environment is identified by carbonate derived biomarkers, elevated sulfur concentrations and other well established geochemical parameters (**e.g. Sassen, 2001**). This Jurassic-aged oil family is characterized by kerogen deposited in a shelfal-carbonate to marl environment and is reservoired in formations ranging from the Triassic to Late Cretaceous in age (**Figure 1**). There is an up-dip limit to the effectiveness of this Jurassic family, due to lack of burial. Down-dip the Jurassic is over mature around the coastline but is a major source of petroleum in the offshore, deep-water plays of the Gulf of Mexico.

Lower Cretaceous

The onshore lower Cretaceous shows a dramatic change from continental shelf to the north, with thick carbonate units, to open marine to the south, dominated by shale deposition. The lower Cretaceous oil family is historically present and active right across the trend, however, definitive identification of the source of this family was limited in the past due to lack of adequate source samples. The Pearsall source rock of central Texas has been clearly matched to lower Cretaceous reservoired oils, however, in east Texas and central Louisiana, many of these reservoirs contain mixed geochemical signatures (**Figure 1**). Recent work by **Zumberge, et al. (2019)** has definitively outlined the extent of the active lower Cretaceous source rocks in east Texas and provides the criteria with which to differentiate the oils. This determination ensures lower risk exploration in this area and builds the framework with which to expand it into Louisiana.

Upper Cretaceous

Over the past decade, most of the production from the central to southern coastal region has been dominated by the prolific Upper Cretaceous source rocks of the Eagle Ford/Tuscaloosa shales

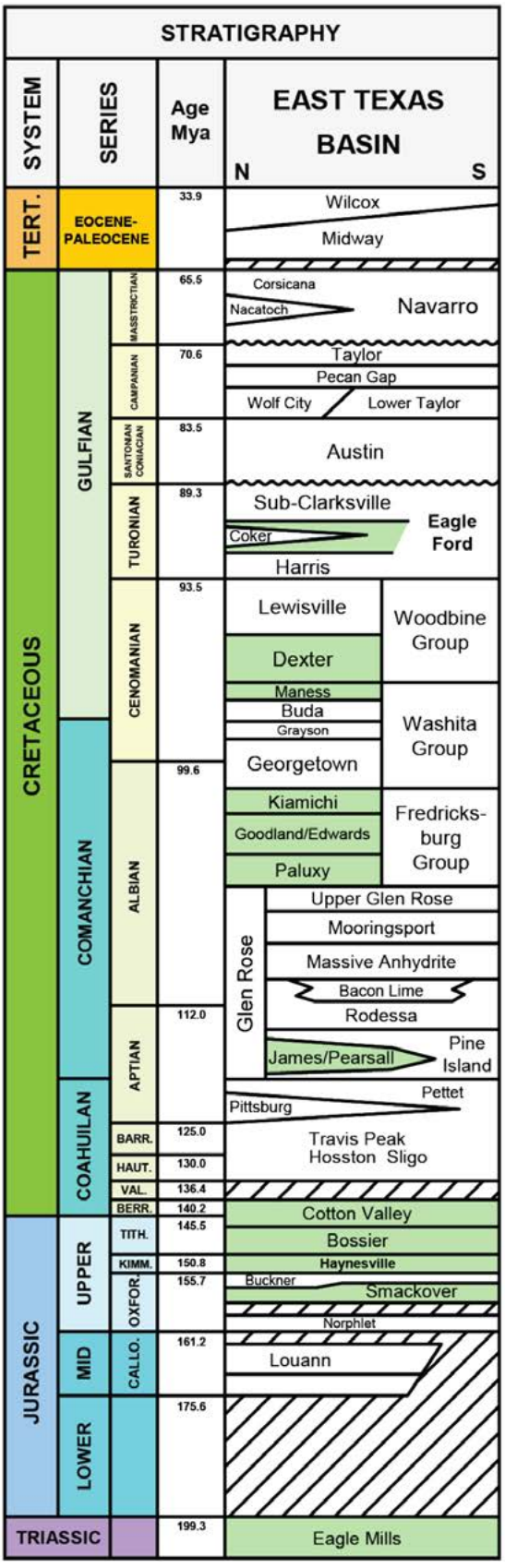


Figure 2. *Stratigraphy of the Texas/Louisiana Gulf Coast region from the late Triassic to Tertiary. Source rocks are indicated in green*

(**Zumberge et al., 2016**) (**Figure 1**). These source rocks remain in the oil window and are at an economic depth agreeable to resource play development. For petroleum geochemists, this activity has provided a unique opportunity for extensive source rock/oil correlation work, which importantly has distinguished differences in the Eagle Ford Vs Tuscaloosa depositional environment. Furthermore, this work has highlighted the central area of Louisiana Austin Chalk as an important exploration opportunity for future development. The chalk reservoir of this area contains a range of oil quality, from heavy, low maturity crude oil in eastern Louisiana to gas on the east Texas border. The strong east/west phase trend is not readily explained by maturity alone. Determining the extent to which the apparent source rocks are contributing to these different areas is a crucial question for exploration and development today.

Tertiary

The Tertiary marks a change in depositional environment from a dominantly marine system to a deltaic, coastal system – similar to what it is at the present day. Clastic sediments from the Great Plains and Colorado Plateau of North America were readily carried by the Mississippi and Red River/Houston/Brazos paleo drainage systems across the coastal area, depositing coals, sands, and terrigenous clays. The Midway/Wilcox formations mark the beginning of this depositional change in the Paleogene. These units contain TOC and source potential of a higher terrigenous component and while some areas are mature enough to generate hydrocarbon today, it is a gas prone kerogen, as opposed to the dominantly oil generating source rocks of the Jurassic and Cretaceous (**Pitman and Rowan, 2012**). The signature of the source rocks is apparent in resins and coals identified across the coastal region, but conversion to hydrocarbon is clearly limited by maturity (**Figure 1**). Younger Tertiary source rocks in the Oligocene and Eocene likely contain similar kerogen types but would likely be only locally mature, due to substantial and rapid burial of Tertiary sedimentation. Equivalent source rocks of this age are more active in offshore positions, where source rock thickness and maturity is greater.

Conclusions

More than a century of exploration and production has provided a wealth of information across the Gulf Coast, but while the framework may be firmly established, it is clear the region is still a land of exploration and production opportunities. New technologies combined with a much more expansive knowledgebase means a greater ability to predict reservoir quality, highlight deeper opportunities that exist closer to proven source rocks, and articulate the key parameters of specific plays that were once mistakenly lumped together, causing inappropriate development plans and missed pay. The conventional sandstone reservoir production from the Gulf's early years can be further developed with more advanced imaging while the migration story of deeper/older source rocks that contributed to younger reservoirs can provide a bread crumb trail to exploit. As discussed briefly in this article, a regional examination reveals there is still exploration to be conducted in east Texas and the Louisiana Chalk as we now understand the contributions and trends of the different contributing source rocks. Modern tools and a history of success leads to the conclusion that when armed with a pioneering spirit and the right data, explorers in the Texas/Louisiana Gulf Coast region will be rewarded. ■

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Remembrance

Roger W. Simmons
1926-2020

Roger Williams Simmons, age 94, was called to Heaven on Monday, the 14th of December, 2020. Roger was born on the 9th of December, 1926 in Baton Rouge, LA. When Roger was five, his family moved to Houston. As a member of the Greatest Generation, and upon graduation from Lamar High School in 1944, he immediately volunteered to serve in the United States Army, where he would be commissioned as a First Lieutenant at the age of 18. After the service, Roger later graduated with a Bachelor of Science in Geology from the University of Houston. For many years, Roger worked as a geologist and later as a realtor.

Roger was a man who never had a bad day in his life, who constantly smiled, told big stories, handed out compliments and generally carried on! Indeed, nothing captured Roger's zest for life more than his standard response whenever you asked how he was doing – "REMARKABLY WELL!". He was a long-time member of the Petroleum Club of Houston where he loved dancing with the love of his life, Nancy. Additionally, some of their favorite times were hosting dinner parties and cruising the world with longtime friends. Of course, his greatest joy of all was his beloved children and grandchildren, whom he proudly called his "tomorrow's"!

Roger is preceded in death by his father Benjamin Simmons and mother Robbie, and his granddaughter Payton. Roger is survived by his devoted wife of 51 years, Nancy, and their daughter Nancy Marie Sweeney (Jason) and his son Kirby (Jean Anne); grandchildren Kirby Nicole (Mike), Mason, Cade, Ben and Charlotte; great grandchildren Kyler, Grayson and Copper, along with so many loyal friends. The family wants to thank his caregivers Katina Bailey, Noreen Shaw, Ruth Smith, & Wanda White. ■

Summarized from the Sunday December 21, 2020 Life Tributes section of the *Houston Chronicle*.

HGS *Bulletin* Instructions to Authors

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