HGS Bulletin

Volume 67, Number 1

Houston Geological Society

SEPTEMBER 2024

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# In Every Issue





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**About the Cover:** Large-scale cross-bedding in aeolian beds of the Cedar Mesa Sandstone. This outcrop is on Highway 95 in Utah near Hite Crossing of the Colorado River. The Cedar Mesa is a Permian (Wolfcampian) in age. The exposure allows a 3-D view of the cross beds to understand fluid flow better.

# Technical Meetings



# Features



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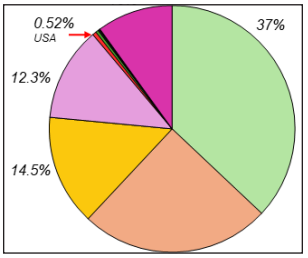

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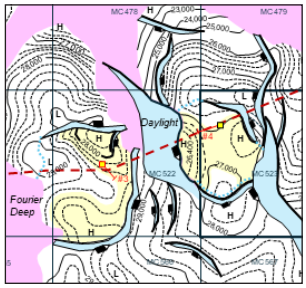

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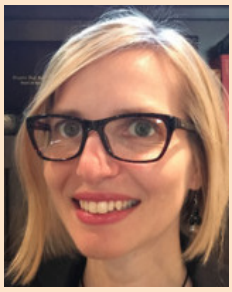

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*penny70@att.net*

# Welcome to the 101st Year of the Houston Geological Society

I am pleased to welcome you to the 101st year of the Houston Geological Society. HGS was founded on August 8, 1923, and over the past 100 years, it has been an integral organization for our geoscience community. I am truly honored to serve as President of HGS as we move forward together and look to the next century for HGS.

## VISION FOR HGS

As HGS President, it is my goal to continue to build HGS as a premier Houston-area geoscience organization. This vision can only be realized with your active participation and support. Let's work together to make HGS the "go-to" organization for our geoscience community, advancing geoscience by building strong community relationships and encouraging the dissemination of geological technology through education and other networking platforms. Your role is crucial in making HGS a leading resource that will guide us into future geoscience opportunities and adventures.

*HGS will be the "go-to" organization advancing geoscience with the dissemination of geological technology through education and networking platforms*

To accomplish this goal, I would like to focus on three objectives for this year.

- Grow HGS's membership
- Build HGS as a geoscience resource and networking organization
- Strengthen HGS's financial sustainability. I will have more information on these goals in next month's HGS letter.

## HGS'S BOARD MEMBERS

As we transition into HGS's 101st year, I would like to take a moment to acknowledge the tremendous efforts of the past HGS Board members, committee chairs, volunteers, staff, and family members. Your dedication and hard work have set a strong forward momentum for us to build upon. I would also like to highlight the 2024-2025 Board Members as they take on their new roles and responsibilities, knowing that they will continue the legacy of excellence.

HGS's Past President, Paul Britt, did a tremendous job on various matters that arose during his tenure. I would like to highlight two of his accomplishments.

- Negotiation of the HGS office lease, which locked in lower rent for a newer, more comfortable office space located in the same building
- Sound fiscal management of the 2023-2024 HGS budget.

Patty Walker, President-Elect, and I are focused on continuing HGS's momentum.

HGS's Past Vice President, Linda Sternbach, and her husband, Charles Sternbach, did an outstanding job organizing the HGS's 100th Anniversary Gala, which was indeed an exceptional event. In addition, Linda organized insightful and informative technical presentations for the HGS Luncheon and Dinner Meetings. Both the Sheriff's Lecture and the Wildcatters Dinners were sell-out capacity events and, in addition, were exceptional networking opportunities for attendees. Catie Donohue, 2024-2025 Vice President, is working diligently to organize our HGS speakers for this year. Catie stated: "For this year's HGS events, I would like to showcase the geological talent of Houston area professionals, technology development, and mentorship; HGS is here for you as a place for communication, networking, and community engagement."

HGS's Past Secretary, Kenneth Mohn, compiled detailed monthly reports of the HGS Board meetings and worked with Membership Chair Kurang Mehta to compile new membership applications. Sophie Broun, 2024-2025 HGS Secretary, worked closely with Kenneth and continues compiling thorough reports, and is working with the new Membership Chair, Oyie Ekeng, on new HGS membership applications.

HGS's Past Editor, Caroline Wachtman, brought the HGS *Bulletin* to a new level of excellence through the publication of in-depth, technical articles covering a variety of current topics, ranging from deepwater deposits in the Gulf of Mexico to Carbon Capture Utilization and Storage. The *Bulletin* remains a critical technology transfer platform for our geoscience community. Ted

**From the President** *continued on page 9*

*Ted Godo, HGS editor 2024-25*
*tjgodo@gmail.com*

# Welcome Letter

For the first issue of the 2024-25 HGS year and the start of the second millennium year of our society, I would first like to express my heartfelt gratitude for all of you and your support. It is a great honor to be your editor for this year. Let me start by thanking my mentor and previous HGS editor, Caroline Wachtman. Caroline set the bar extremely high for me to follow, and I look forward to it, but I also need the help and input of all our members. As your new editor for the year, I would like to take a moment and introduce you to myself and my history as a geologist.

After earning an MS in geology from Ohio State, I have worked for two oil companies, Shell (35 years) and Murphy (5 years), and have done consulting work for the past 5 years. Over these 45 years in the industry, I've experienced many technical advances and changes in social and office practices. In the late 1970s, our offices at Shell were adjacent rooms located down single hallways. There were no computers; instead, we had large drafting tables stacked with folded paper 2D seismic lines. On the table, work started with a blank base map while on an overhead shelf sat piles of 2D seismic lines ready to interpret with pencils. On the base map, we manually wrote down the time or depth values of events from the interpreted seismic lines. Then we hand contoured the values. With an endless supply of colored pencils to interpret the seismic, we also annotated every paper log with correlation tops, paleo tops, and mud log shows, filling several filing cabinets along the private office wall. Office attire in this predominantly male workforce was always wearing coats and ties. As the years passed, we added: "casual Fridays" (no ties). With more time, "jean-wear" became not so outrageous. Of course, technologies developed such that new larger 3D acquisitions were made to locate new wildcat wells in exploration. This was in the late 1980s and early 1990s, but only a few explorationists were lucky enough to have a 3D survey. Moving to 2000 is when I first used PowerPoint for a presentation, whereas in previous presentations, we made 8 by 10-inch cardboard viewgraphs to place on overhead projectors. Today, of course, all geologic/geophysical interpretations are made on the computer, and people now (post COVID) work remotely from home over a significant amount of the work week.

*characteristics for success are a "desire to ask questions" and the "ability to tell a story"*

What did I learn that was useful to my career? The two most important skills or characteristics to develop are the desire to ask questions and the ability to tell stories. It may seem a bit trite, but natural probing curiosity often brings on the "ah ha" moments where different observations are held together to make a story. A natural storytelling ability integrates otherwise disparate observations woven together to make a cohesive argument or pitch. Besides, it's the most effective form of understanding in communications.

If I were a bit more specific in what I learned, it would be:

1. Passion for your craft. Try to learn something new every day. You learn not only in your specialty craft but also by learning some of the fundamentals in other specialties, which help you better understand their "error bars" of your input assumptions. Communication and iteration of the model with your colleague make for a better integrated model. Some of the other related skills examples I am referring to are geochemistry, basin modeling, geophysics, rock properties, paleontology, mud logging descriptions and shows, carbonate and clastic facies, and stratigraphy.
2. While company policies and procedures may evolve, the bedrock of geologic fundamentals remains constant. Your ability to think critically and synergize your ideas with the diverse skills of your team members will not only secure your current employment but also lay the groundwork for a lasting career. Keep asking questions and encourage coworker challenges.
3. Lastly, put your heart into your craft and do what you think is right after integrating all other team members' skills. Refrain from "managing upward." Good managers depend on you for advice and technical analyses.

During this year, one of my primary goals is to gather technical articles each month to share with our members. I deeply believe that our Bulletin can greatly benefit from the diverse expertise of our members. Whether your background is in traditional oil and gas, environmental science, carbon capture, $CO_2$, mining, paleontology, or hard rock science, your unique contributions are not just valuable, but integral to the success of our *Bulletin*.

If you have suggestions for improving our *Bulletin* or wish to contribute, please let me know directly or through the HGS office. ■

# GEOGULF2025

NACOGDOCHES

6-8 APRIL 2025

# Open call for abstracts

# Open Sept 1 - Dec 1

*Sessions Include:*

- *Gulf Coast Geology*
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- *Lithium and Critical Minerals*
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- *Deepwater GOM*
- *CCUS*
- *Geothermal*
- *Special Session: East Texas Basin*
- *ML, AI & Data Analysis*
- *And more*

**For more information visit:**

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**Kurt.Ley@kingwoodexploration.com**

**Hosted by:**

## From the President continued from page 5

Godo, 2024-2025 Editor, with Lucia Torrado, 2024-2025 Editor Elect, continue on this excellence trend as you will see in this September *Bulletin*.

HGS's Past Treasurer, Fang Lin, diligently worked with HGS board members and staff to provide monthly financial reports to the Board. Genn Lowenstein, the 2024-2025 Treasurer, is working with Treasurer-Elect Angela Hammond to continue compiling HGS monthly financial reports.

HGS has four directors who work closely with many HGS Committees. Directors Sharma Dronamraju and Judy Schulenberg will continue their two-year Directors' term in 2024-2025. Sharma works with several HGS committees on social networking events, such as the Sporting Clays Tournament, the Golf Tournament, and the Shrimp Peel & Crawfish Boil. Judy is working with the Continuing Education Committee, which focuses on providing instructive short courses for our geoscience community. Judy is also a current member of the Calvert Scholarship Fund committee. Directors Bill DeMis and Troy Meinen have completed their two-year Directors term of 2022-2024. Bill oversaw educational programs, including Earth Science Week and Educational Outreach. As part of HGS educational programs, our organization supported three summer internships at the Houston Museum of Natural Science. These young adults did outstanding STEM intern projects, and seeing our next generation of scientists is inspiring. Catherine Cox is the incoming HGS Director taking over these programs. Troy worked with HGS's Social Media, NeoGeos, and Student Expo Committees. The NeoGeos and the Student Expo are exceptionally successful networking events for HGS. Lauren Robinson will be taking the lead in working with these committees.

*In conclusion, I sincerely thank all the 2023-2024 HGS Board members for their dedicated support of HGS. I also thank this year's 2024-2025 HGS Board Members, who have already taken up the challenge of growing our HGS organization and building our geoscience community.*

**EXCITING EVENTS SCHEDULED FOR THIS FALL:**

We have an exciting and busy Fall 2024 for HGS with several scheduled conferences, symposiums, and HGS General Dinners and Luncheons. Here is a list of some upcoming events:

- **The Student Expo** is a highly successful recruiting and networking event for our geoscience community. The Expo brings together over 200 graduate students from across the country, with geoscientists and recruiters from 20 companies. This year, the Student Expo will be held September 9 – 10, 2024, at the Norris Conference Center. Registrations are on track to exceed last year's attendance.
- **The HGS Environmental and Engineering Meeting** will take place on September 11, 2024,, at Los Tios restaurant, located at 9527 Westheimer Rd. Three speakers will give the presentation: Michael D. Campbell, Henry M. Wise, and Bruce Handley. The title of the presentation is "A Tale of the Re-Discovery of the Brookshire Uranium Deposit Whose Time has Come." Undoubtedly, this will be a very interesting and well-timed presentation on uranium deposits and their historical importance in energy.
- **The HGS Dinner Meeting** will be held on September 16, 2024, at the Norris Conference Center. The speaker will be Dr. John Anderson, Rice University, who will present "Holocene versus Historical Response of the Gulf Coast to Sea-Level Rise and Climate Change: From Coastal Stability to Rapid Demise." This is a timely and "must-attend" presentation with derecho and hurricane Beryl.
- **The HGS-GESGB Africa Conference, "Africa 2024: The Future in Energy, Skills, and Diversity,"** will be hosted by HGS in Houston, TX. The conference theme is energy transition and includes theme sessions on new Discoveries, New Techniques and Technologies, Growing Value, and Keeping the Focus on the Future. I highly recommend signing up soon because the conference will be held on September 24 – 25, 2024, at the Norris Conference Center.
- **The GHS-HGS Symposium: Learning from Integrated Case Studies of Success and Failure** is a "must-attend" event in which the Geophysical Society of Houston (GSH) and the Houston Geological Society (HGS) have an opportunity to join to share our learnings. Conference organizer Charles Sternbach states, "Integrated case studies of geology and geophysics expand personal experience. These experiences, a rare and valuable heritage, help us find hidden gems..." I encourage you to put this one-day event held on November 14, 2024, on your calendar.
- **The HGS Sporting Clays Tournament** will be held on Saturday, November 22, 2024, at West Side Sporting Grounds. The Clays Shoot was brought back last year and is an extremely popular event, so look to register for attendance and sponsorship early.

*Looking forward to seeing everyone at these exciting HGS events.* ■

# INTEGRATED CASE STUDIES

## LESSONS FROM MISSED OPPORTUNITIES AND SURPRISE SUCCESSES

Charles Sternbach

## HGS/GSH Exploration Seminar
## November 14, 2024 One-Day Immersion
## @Norris Conference Center, West Houston

HGS or GSH Members only $275

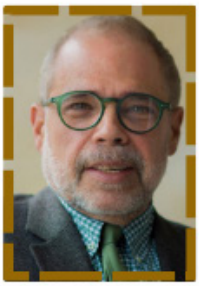

Katya Casey


Catie Donohue


Jeff Lund


Steve Cossey


Ted Godo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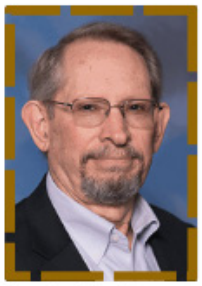
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# *Letter to the Editor*

# "Re-Discovery of Olmec Blue Jade", HGS Article, Published October 1, 2002

***By Robert E. Leslie, Jr., PE, CFM***

Dear Mr. Godo:

I was recently conducting some online research in preparation of a talk I plan to present to the Baton Rouge Geological Society, and I stumbled across the subject article posted on the Houston Geological Society website.

I could not help but chuckle when I read, "In the 1950s, a Guatemalan tomato farmer led William Foshag to a site in the Motagua river valley and showed him green jade similar to that commonly used in Aztec and Maya cultures."

Perhaps a more accurate statement should be,

"In the 1950s, Robert Leslie, an American operating an agricultural project in Guatemala, led William Foshag to a site in the Motagua River valley and showed him an abandoned Mayan quarry of green jade similar to that commonly used in Aztec and Maya cultures."

Yes, a tomato farmer did, indeed show Dr. Foshag jadeite from a long-abandoned Mayan quarry in Guatemala, but that farmer was born in Assumption, Illinois. He also co-authored a paper with Dr. Foshag (copy attached) on the discovery, published in American Antiquity, vol. XXI, no. 1 (1955).

Jadeite specimen 201238 has resided at the Smithsonian Institution since February 16, 1954, as documented by the attached correspondence. Incidentally, the jadeite boulder that my father pulled from his plow disks in 1952 is on display in my home library.

In my research, I have discovered an abundance of information incorrectly accrediting the re- discovery of jadeite in the Americas to others besides my father. To the credit of those other discoveries, many were made independently of my father's discovery, but they occurred in the 1970s and thereafter.

Some of those discoveries are associated with commercial enterprises that have a financial interest in self-promotion, which unfortunately has resulted in others mistakenly publishing that these discoveries, made well after my father's 1955 publication, are the first modern-day re- discovery of Central American jadeite. To avoid future misunderstanding, especially in the tenacious world of the internet, I have made this effort to reach out to your fine organization.

I hope this information and the attached documents help set the record straight. Thank you for your consideration and understanding.

Sincerely,

Robert E. Leslie, Jr., PE, CFM

# HGS NeoGeos Happy Hour


When:

**Thursday, 9.12.24**
**6:00 - 8:30 pm**

Where:

**Walkingstick Brewery**
956 Judi Way Street,
Houston, TX 77018

Cost:

$15 for HGS members
$20 for non-members
*includes 1 drink ticket

**Sponsored By:**

Southwestern Energy

# NeoGeos June Meeting

# We Are The HGS

**Chris Dauterive,** HGS member since March 2024

Chris Dauterive is a new member of HGS, but he has been employed as a geologist for 18 years. Born in New Iberia, Louisiana, in the heart of "Cajun Country", Chris's family moved east to the coastal town of Pass Christian, Mississippi, when he was only 5 years old but with many visits back to extended family members in New Iberia. His dad strengthened his Cajun roots by taking him duck hunting and eating traditional Cajun cuisine. Chris's father, grandfather, and great-grandfather were all in the medical field, so naturally, Chris gravitated to the sciences in school. But growing up in Pass Christian, close to the beach, Chris spent a lot of time on the water, observing coastal processes, and that's probably what began him thinking about geology. Chris explained, "Had I grown up in the city or inland, I am not sure I would have felt that connection" with geological processes. In Pass Christian, it was easy to "hang up the school bag and run across the street to the beach". Of course, after high school, Chris enrolled at LSU as a Biology major, following along in the footsteps of his father's father. As is often typical in school, it was a specific class that reignited his interest in geology and to veer off from the medical path. It was an oceanographic geology class taken as an elective that changed the professional path for Chris. "I was intrigued to learn the science behind many of the processes I had observed as a kid growing up on the coast," Chris responded. He then changed his major to geology.

*Chris joined HGS to hear challenges of colleagues and their approach to problem-solving*

**We Are The HGS** *continued on page 15*

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**Mark Shann,** HGS member since April 2024

Mark Shann grew up in East Sussex of the United Kingdom on Neocomian sandstone in a heavily bombed countryside in World War II. Mark said in the woods by his house in a bomb crater, "I found an echinoid fossil when I was six or so, and that was my first discovered treasure, I suppose." That first discovery interested Mark in geology, so he began collecting rocks and minerals and bringing his collection home.

*Mark is keen to present his ideas while listening to experts in his field*

After graduating from Kings College, Mark started working for BP International in the 1980s and "lived in more than 12 countries, seeing some of the world's petroleum systems with BP". While at BP in the 1990s, he had an assignment working with Mexico. While there, Mark found "one of my favorite petroleum systems: the Sureste Basin of Mexico." In 2014, after 32 years with BP, Mark joined a private equity start-up called "Sierra Oil & Gas Mexico." Leaving BP in 2014 was his choice. BP post-Macondo "was a bit of a mess, and exploration was being downgraded as a core activity." "Sierra" was formed at a time when Mexico had just reformed its country's oil and gas rules to open leasing to international companies with the first deep water lease round in late 2016. The timing was perfect, and "Sierra" was lucky enough to acquire the block where the 2017 giant oil discovery called Zama was made.

Today, Mark is the Chief Technology Officer for Westlawn Americas Offshore (WAO), a portfolio company backed by a family office. Westlawn is tasked with building a long-term offshore oil & gas business, and our investors have a risk appetite for exploration.

**We Are The HGS** *continued on page 15*

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**Stan Teerman,** HGS member since January 2024

Stan Teerman became interested in geology at an early age as he was surrounded in his home state of Oregon by the shadows of the Cascade and Coast Range Mountains. Hiking over the beautiful Columbia River basalts, with its perfectly shaped columns and wonderous waterfalls, it sparked Stans' curiosity to learn about the process that formed these rocks and landscapes. As he began to study further, Stan wanted to "explore the origins and geological and geochemical expressions of sedimentary rocks."

*By joining HGS, Stan plans to keep up with the many vibrant geoscience activities in the Houston region*

Stan graduated with his BS degree in Geology from his home state at Corvallis at Oregon State University. Stan's first job was as a hydrologist working

**We Are The HGS** *continued on page 16*

*We Are The HGS is a series that highlights the careers and contributions of HGS members with the intention of building community. Would you like to be featured in We Are The HGS? Send a note to editor@hgs.org.*

## We Are The HGS continued from page 14

(*Chris Dauterive continued from page 14*) After graduating with his BS in geology, Chris started working as an intern with Houston Energy. Chris said, "I started my career at Houston Energy as an intern, knowing little about the oil and gas industry. Working at Houston Energy were 15 or so 20-year+ geoscientists, all veterans in generating prospects and finding oil." He knew he would need to get his master's degree but was also getting some valuable exposure to the industry at Houston Energy. The timing worked in Chris's favor as he was the first cohort at the University of Houston (U of H) to earn his MS degree by working nights and weekends. "It was one of the best decisions I ever made," said Chris. Houston Energy supported him in getting his MS degree, and after graduating, Chris thought he was probably the youngest geologist they had ever hired.

In 2010, after spending more than four years with Houston Energy working deepwater GOM, he saw an opportunity to get into unconventional space and gain operations experience. Plains Exploration had just purchased 60,000 acres in south Texas for the Eagleford play. Chris joined Plains Exploration and got into a very successful program from the beginning. "I learned operations, and our team slowly cracked the code of how to drill horizontals in the play." In 2012, Freeport McMoran purchased Plains Energy. Freeport, then, in 2014, experienced a plunge in copper prices and saw an opportunity to make some cash by selling their Eagleford acreage for a 7X price for what Plains originally purchased it for. The deal was made to sell to Encana in 2014, and Chris took a severance package.

Chris has been a consultant geologist with Energy VII for the last 7 years, generating conventional onshore prospects. Asked about what he enjoys about his work, Chris said he likes "creating a map or display which instantly conveys a complex concept to the viewer. So much of what we do as interpreters is very artistic, and I consider it a success when a layperson can look at my map and instantly see exactly what I am trying to convey with the data."

Chris' primary goal in joining HGS is to stay connected. He likes hearing about the challenges other people are having in their own work and how they are solving issues he might not have seen in his career. Of course, there are the famous HGS crawfish boils! ■

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(*Mark Shann continued from page 14*) Mark reflected on his career experiences: "I started off with a major corporation (BP International), where I was fortunate to learn the tools of my trade and gained a global perspective on many petroleum systems, but then I was lucky enough to make the transition to a small private equity start-up. Especially when I moved to private equity, I learned the value of looking outside your company for other partner viewpoints. It is not easy as they do not have the same biases and are naturally skeptical of ideas born elsewhere, but they can powerfully validate a good idea."

*Mark shared three key characteristics of effective working.*

### OBSERVATION LED SCIENCE

I have a simple but provocative saying: "Geoscientists are not entitled to their opinion per se". What I mean by that is we must all work by using observation-based good scientific principles based on careful data analysis. Finding the "one right observation that leads to seeing a play in a different light" can make all the difference in winning when the rest of the industry has dismissed an area/play concept based on more conventional and sometimes biased thinking.

### CHALLENGING DOGMA AND EMBRACING NEW IDEAS

Most successful companies and institutions have strong cultures and, in places, strong biases. This can make it difficult for "explorers" to present new ideas and get them endorsed. The bigger the institution, the harder it is to challenge the norm.

### LISTENING TO TEAMS AND CONSTRUCTIVE CHALLENGE

Listening is key, and constructive challenge is essential to good teamwork. I get the importance of encouraging diversity of views, which needs to be data-led, but it is fundamental to finding the next play opener, the next Guyana. Old ideas in old basins don't work. New ideas can obviously make all the difference.

Why join HGS? "HGS is one of the key professional communities where petroleum geoscientists interact, and I am delighted to be part of this. As a member, I am keen to present my ideas and, more importantly, listen to experts in the field of oil & gas exploration. Finding oil is about finding new ideas and continued learning." ■

**We Are The HGS** *continued on page 16*

## We Are The HGS continued from page 14

(*Stan Teerman continued from page 14*) for the USGS in Salem, Oregon. Still, he quickly realized that he wanted to learn more about geochemistry in oil and gas shales. Stan moved to attend Southern Illinois University, earning his Masters degree in geology. He continued his studies, earning his PhD in Geology from UCLA. Stan began working for Chevron in the La Habra research center, integrating geochemical and geological data, including reservoir characterization for global basin analysis. While there, Stan was asked to go to the Chevron office in Perth for a 4-week presentation. Personnel at the office there stated there must be a misunderstanding about the assignment but listened to Stans's initial presentation. The Chevron staff in attendance asked many questions and were so impressed that he stayed working in Perth for 5 years.

While in the Perth office, Stan worked the NW shelf in Australia, offering complete petroleum system modeling with geochemical studies. From the Perth office, Stan transferred back to the US and worked in Houston, New Orleans, and San Franciso offices, working in basins around the world. He collaborated with multifaceted earth sciences and engineering teams to integrate results into a petroleum system framework. Stan summarized the highlight of his career as the opportunity to work in many different petroliferous basins.

For the past two years, Stan became an adjunct professor at the University of Louisiana-Layfayette. As an adjunct faculty member, he works with students in the Houston area and focuses on urban geoscience and sedimentary earth system processes. Also, as part of Stans's interest in water, and municipal services, he became a board member of the Cinco Ranch municipal utility district 10 in Katy, Texas. Stan sees that there is significant potential to be involved in urban geoscience related to water resources, flood mitigation, and environmental restoration. In his "free time," Stan enjoys spending time with his family, being outdoors, biking, and doing volunteer work involving teaching jobs and computer skills. By joining HGS, he plans to keep up with the many vibrant geoscience activities in the Houston region.

# HGS-GESGB Africa Conference

## Africa 2024: The Future in Energy, Skills and Diversity

### PRESENTATION SCHEDULE

**September 24, 2024**

| | |
|---|---|
| 9:00 am | New Techniques & Technologies |
| 10:55 am | New Discoveries |
| 1:30 pm | Growing Value |
| 3:25 pm | Keeping Focus on the Future |

**September 25, 2024**

| | |
|---|---|
| 9:00 am | Petroleum Systems: New Concepts for an old Paradigm |
| 10:55 am | Africa Student Session and Interactive Polling of Attendees |
| 12:15 pm | Luncheon Keynote Anne Ekern - President of the Switch Energy Alliance |
| 1:30 pm | Challenging Thinking |
| 2:55 pm | Awards and Closing Remarks |

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# HGS-GESGB Africa Conference

## Africa 2024: The Future in Energy, Skills and Diversity

**09:00 – 9:05** **Welcome** **DAY 1**

### New Techniques & Technologies

| | |
|---|---|
| 09:05 – 9:25 | Machine Learning seismic interpretation of salt and stratigraphic horizons for regional exploration on a massive offshore kwanza dataset. *Dan Fernandez, Schlumberger* |
| 09:25 – 9:45 | AVO anomalies in Sierra Leone and Liberia – are these lithology or hydrocarbons? |
| 09:45 – 10:05 | Imaging complex structures in the shale diapir Zone of the deepwater Niger Delta. *Emily Kay, TGS* |
| 10:05 – 10:25 | Using geophysical methods to de-risk a frontier deep water basin offshore Somalia. *Marel Sanchez, Actus Veritas* |

### New Discoveries

| | |
|---|---|
| 10:55 – 11:15 | Novel insights into the evolution of the southern Orange Basin, South Africa. Implications for hydrocarbon prospectivity and basin evolution in a regional context. *Michael Parker-Nance, University o Cape Town* |
| 11:15 – 11:35 | Unlocking deepwater prospectivity in the distal Basin of Northern Gabon. *Emily Kay, TGS* |
| 11:35 – 11:55 | Hydrocarbon prospectivity of the deepwater Rio Muni Basin, offshore Equatorial Guinea, based on the 3D seismic characterization of hydrocarbon plays. *Jose Gorosabel-Araus, University of Houston* |
| 11:55 – 12:15 | Frontier Exploration in onshore Namibia – Integrating airborne and seismic datasets. *Paul Versnel, Metatek* |

**12:35 – 13:30** **Lunch**

### Growing Value

| | |
|---|---|
| 13:30 – 13:55 | Considerations to Achieve Production from Suspended Discovery Wells in Offshore Marginal Fields, Niger Delta. *Kelechi Igbokwe, Halliburton* |
| 13:55 – 14:15 | High impact exploration in Africa since 2019, *Jamie Collard, Westwood Global Energy Group* |
| 14:15 – 14:35 | An Innovative approach to evaluating the remaining undiscovered resource potential and US$ value of the West African margin. *Paul Ventris. GIS-Pax* |
| 14:35 – 14:55 | Development Of The Gamba Reservoir In The Etame Marin Permit, Offshore Gabon. *Jesse Ortega, Vaalco Energy, Inc.* |

### Keeping Focus on the Future

| | |
|---|---|
| 15:25 – 15:45 | Fan Deltas and Proximal Fans Underexplored Region Along Rift Margins of Africa. *Karen Carlson, KC Geoscience* |
| 15:45 – 16:05 | Revisiting the Luangwa Basin, Zambia-an inverted Karoo Rift in southern Africa. *James Granath, Independent Consultant* |
| 16:05 – 16:25 | Incorporating Downhole Monitoring For Enhanced Completion Techniques: Advancing Stimulation And Horizontal Drilling In Egypt. *Nick Kaprowski, Vaalco Energy, Inc.* |

**16:25 – 18:00** **Networking Reception**

# HGS-GESGB Africa Conference

## Africa 2024: The Future in Energy, Skills and Diversity

### Petroleum Systems : New Concepts for an Old Paradigm

| | |
|---|---|
| 09:05 – 9:25 | Tectonic history and transient full-lithosphere thermal modeling to predict thermal stress of source rocks within the Moroccan basin. *Kenneth Shipper, University of Houston* |
| 09:25 – 9:45 | *TBA* |
| 09:45 – 10:05 | Helping "Oddball Oils" find their Nearest Neighbors, *Craig Shiefelbein, GSI, Inc*. |
| 10:05 – 10:25 | Expanding the play fairway of hydrocarbon systems based on syn-rift Cretaceous source rocks, western Niger Delta, offshore Nigeria. *Jumoke Akinpelu, University of Houston* |

### Switch Africa Winners and Discussion

| | |
|---|---|
| 10:55 – 11:15 | *TBA* |
| 11:15 – 11:35 | Integrated Sustainable Energy Transition in Sub-Saharan Africa: A Case Study of the LightUP Kenya Project for Universal Electrification and Clean Cooking. O. T. *Emenaha, Uppsala University* |
| 11:35 – 11:55 | Youths: The Missing Link in Energy Transition. *Promise Nwogu, African Youths in Energy Network* |
| 11:55 – 12:15 | Interactive Survey of Conference Attendees. *Promise Nwogu, African Youths in Energy Network* |

**12:35 – 13:30 Keynote Address and Lunch *Anne Ekern, Switch Energy***

### Challenging Thinking

| | |
|---|---|
| 13:30 – 13:55 | Hydrocarbon Exploration of deepwater MSGBC post-Venus -Changing Preconceived Risks. *Felicia Winter, TGS* |
| 13:55 – 14:15 | Impact of the transition from a Jurassic volcanic to non-volcanic rifted margin on hydrocarbon prospectivity in northwest Africa. *Md Upal Shahriar, University of Houston* |
| 14:15 – 14:35 | Insights into the Occurrence, Formation Processes, and Characteristics of Sediment Waves on Contental Slopes and their impact on ponding reservoir sands: Offshore Tano Basin, Cote d'Ivoire and Ghana. *Marvel Makhubele, Tullow Oil* |
| 14:35 – 14:55 | Maximizing the success of Graff and Venus along the South Atlantic margin - perhaps we shouldn't be leaving Petroleum Systems Modelling to the Geochemists? *Douglas Paton, Applied Structure and Tectonics Expert* |
| 14:55 – 15:25 | *Presentation of Awards and Closing Remarks. Carlotta Danforth and Gbenga Olumurewa* |

**In recognition of the significant technical and leadership contributions of the Africa Conference founders, Al Danforth and Ray Bate, we are pleased to announce the inaugural presentation of the Danforth-Bate Speaker Award.**

# AFRICA CONFERENCE

SEPTEMBER 24-25, 2024

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# AFRICA CONFERENCE

SEPTEMBER 24-25, 2024

NORRIS CONFERENCE CENTER, HOUSTON, TX

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# The Smackover Limestone - Providing Bromine and Lithium elements

*By Ted Godo*

The Upper Jurassic Smackover Limestone Formation has long been a primary oil-producing target in the Gulf Coast. It was first discovered and named in 1936 (Bingham, 1937), and later that same year, the upper Smackover member (now bromine and lithium reservoir) was named the Reynolds oolite (Bruce, 1944). Oxley (1967) gave the name "Brown Dense" to the lower member. The upper "Reynolds oolite" oil is sourced from the middle and lower members and sealed by the overlying Buckner evaporites and evaporitic shale (**Figure 1**). The Reynolds member has good to excellent porosity and permeability. Worley (2019) analyzed 2,329 proprietary core plug samples within this member, yielding an average effective porosity of 11.2% and 202mD of permeability. Dickinson (1968) further described the three Smackover members: The upper member (Reynolds) was deposited as an ooidal beach or sand shoal. The middle member comprises pelletal lime mudstone to fossiliferous lime wackestone, and the lower member (Brown Dense) is algal laminated dark brown limestone with source rock. Overall, the Smackover carbonate members were all deposited in a ramp setting with a low-gradient slope. The Smackover play forms a large carbonate "belt" that rims the Gulf Coast states from South Texas through Arkansas, Louisiana, Mississippi, Alabama, and Florida and offshore into the Gulf of Mexico (Whidden, 2023). Brine waters associated with declining oil production from Smackover reservoirs steadily increased during the 1980s to where it is largely brine produced today. When mainly oil was produced, brine was considered a worthless by-product of drilling/pumping. The industry realized that the Smackover brine waters had variable but elevated bromine concentrations. Being entrepreneurial, operators realized the commercial potential of bromine (McCoy, 2014).

***In this article, you will learn more about Exxon, Equinor, and Pantera Minerals' recent entries into southern Arkansas to explore for Bromine and Lithium from the Smackover reservoir. Other companies, such as Albemarle, Lanxess, and Lithium Standard LTD, have been developing production of these critical elements in the same area.***

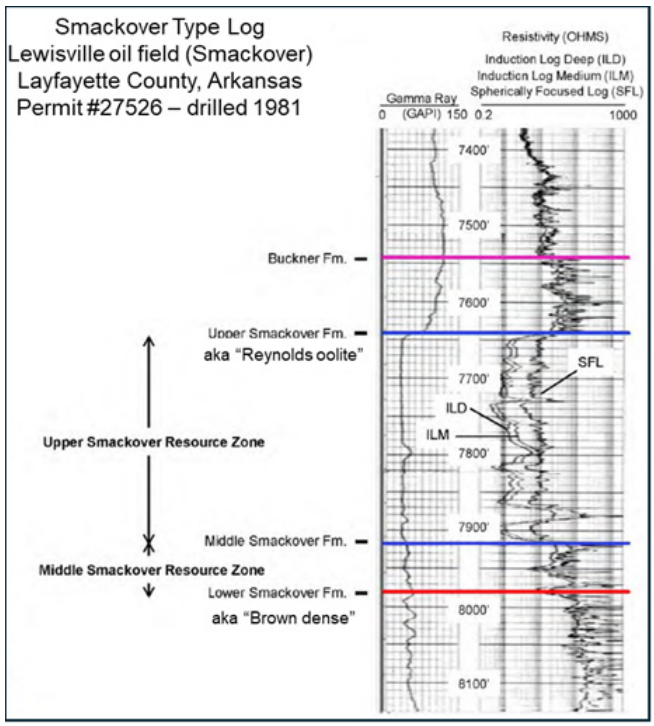



**Figure 1** *Smackover Type Log — Adapted from "Preliminary Economic Assessment of SW Arkansas Lithium Project (Std Lithium LTD)-Fig. 7-4.*

## BROMINE

You may not realize that the brine waters produced from the Smackover have significant concentrations of the element's bromine, lithium, potassium, and rubidium. It was in 1957 that the first commercialization of bromine from Smackover brine occurred in Union County, Arkansas. Production of bromine has been continuous ever since, and today, it is still the source of a quarter of the world's supply (McCoy, 2014). Albemarle and Chemura Production were the two companies producing bromine until 2007, when Lanxess acquired Chemura. Worldwide, the leading countries that produce bromine are the U.S., China, Israel, and Jordan (U.S. Geological Survey 2016). Separating bromine from the brine is a process where the first step is to oxidize the bromine-rich brine by adding chlorine. Then, the bromine is separated from water, and chlorine in a distillation column through rectification. After the bromine is extracted from the brine, the bromine-free brine, or tail-brine, is returned underground into the production formation via Class V injection wells regulated by the AOGC (Worley, 2019). Over the years, sixteen Smackover fields have produced bromine brine in south Arkansas (AOGC, 2018).

Elemental bromine is a highly corrosive, reddish-brown volatile liquid. Major bromine products include fire retardants, ingredients in bug and fungus sprays, antiknock compounds in leaded gasoline, and oil-well completion fluids. The remainder, as elemental bromine, is shipped to various chemical processors for use in chemical reagents, disinfectants, photographic preparations and chemicals, solvents, water-treatment compounds, dyes, insulating foam, and hair-care products. (AOGC website). The richness of lithium in Smackover brines is widely variable across the large subsurface **Smackover Limestone** *continued on page 23*

 continued from page 22



expanse of the Smackover reservoir. This is quite challenging for the explorer/producer to understand. When a rich lithium concentration is located, the concentration can range between 4,000 and 4,600 parts per million, 70 times the bromine concentration of normal seawater. The Arkansas Geologic Commission's original analyses of 4 brines describe that between 1.5 and 1.8 pounds of bromine are recovered from every barrel of brine processed (AOGS website).

## LITHIUM

Lithium production from the Smackover brine began later. Collins (1976) was one of the first workers to describe the chemical reaction in the Smackover brines to enrich lithium concentration. As with the bromine concentration variability, Lithium richness is also quite variable. The lithium concentration in a commercial venture for a brine is at least 80 mg/L of lithium, but some wells have over 300 mg/L of lithium. In contrast, other wells do not meet the minimum concentration. Developing an exploration model for the variable concentrations of lithium in the brine is subject to much debate and a challenge to geologists.

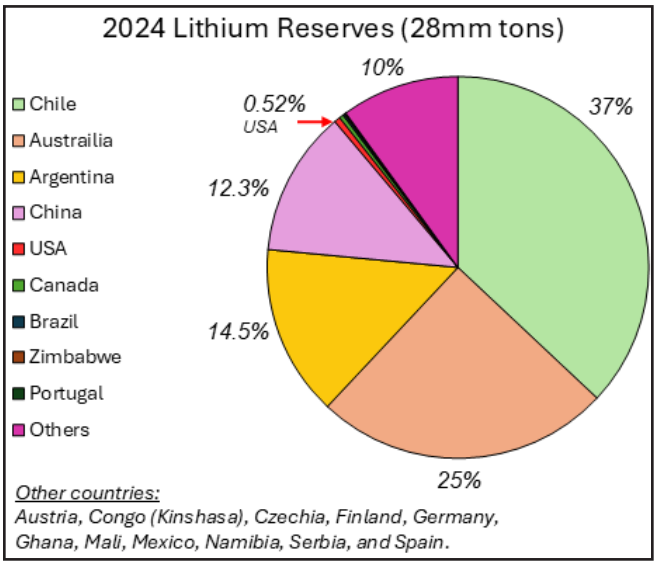



**Figure 2** *2024 Lithium Reserves of Top Global Countries*

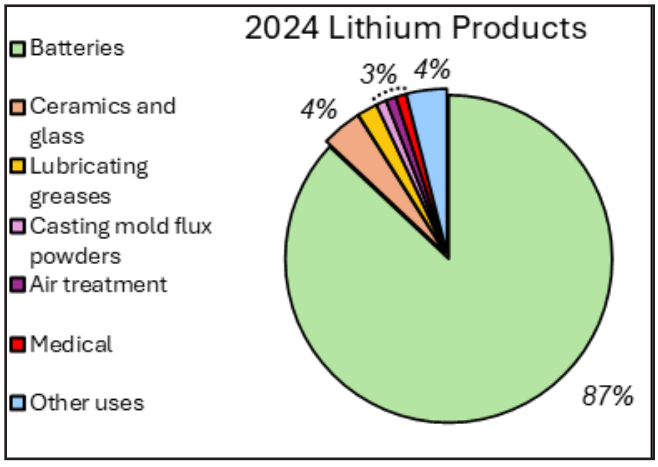



**Figure 3** *2024 End Products Using Lithium*

Extracting lithium from rocks is done by one of four methods worldwide: 1) mining pegmatites, 2) mining clay deposits, 3) extracting brine waters from continental brines, 4) "unconventional" brines that are geothermal, and 5) from oilfield brines. The U.S. began mining for lithium in 1898 in South Dakota. In the early 1900s, other pegmatite mines in California and New Mexico began producing lithium from granite pegmatites containing lithium-rich minerals such as spodumene, petalite, and lepidolite. The dominant lithium mining district was later found at Kings Mountain, North Carolina, from a 25-mile-long spodumene-rich pegmatite. In 1973, the US dominated the global supply (Norton, 1973). Other countries have begun extracting lithium today, and the U.S. is no longer a major producer. Using 2023 numbers, the world reserves report nearly 28,000,000 tons with a "resource number" of about 105 million tons (**Figure 2)** (Jaskula, 2024). While not a major lithium producer, the U.S. has significant lithium "resources" (Bradley, 2017). Resources must be continuously reassessed by considering new geologic knowledge, the progress of technology, and/or shifts in economic or political conditions. On the other hand, reserves may be considered a working inventory of mining companies' supplies of an economically extractable mineral commodity. Global demand for lithium continues to rise rapidly as it is a critical element. Chile and Argentina currently report the largest lithium reserves (**Figure 3)**. It is most used in the growing need for rechargeable Li-ion batteries in cell phones, laptops, and electric cars. Lithium is also used in ceramics, lubricating grease, and as an alloy with other elements to produce high-strength-to-weight metals. It is also used as a coolant in nuclear breeder reactors and as a critical ingredient in medicine to treat bipolar disease (**Figure 3**) (Garrett, 2004; Bunker, 2022).

Lithium is highly water-soluble and has the lowest concentration in seawater, as it is "stripped" from seawater to settle in deep-water clays. Typical lithium concentrations in various mediums (water and rock) are shown in **Figure 4** (Bunker, 2022). Lithium is also associated with magma and hydrothermal waters and brines originating from surface water runoff (Bunker et al, 2022) (**Figure 5**). Mining for lithium today has taken a backseat to the newer method of brine evaporation. Lithium production through atmospheric evaporation of saline brine is generally the most economically efficient extraction method (Daitch, 2018). Atmospheric evaporation is accomplished by evaporating brine water pumped to the surface and concentrated by evaporation in a succession of artificial ponds, each in the chain to concentrate the lithium. After a few months to a year, depending on climate, a concentrate of 1 to 2 percent Li is further processed in a chemical plant, yielding various end products, such as lithium carbonate and lithium metal. Due to their relatively low production cost, continental brines provide **Smackover Limestone** *continued on page 24*

 continued from page 23



approximately three-fourths of the world's Li production (Bradley, 2013). Continental brines rich in lithium are found in arid Quaternary basins.

Many working hypotheses exist about how specific lithium concentrations can vary widely, even in a single accumulation. However, many agree that six key characteristics contribute to lithium in subsurface brine waters. These characteristics are as follows: (1) arid climate/continental deposition; (2) closed basin containing a salar (salt crust), a salt lake, or both; (3) tectonically driven subsidence; (4) associated igneous and/or geothermal activity; (5) suitable lithium sources in the highlands; and (6) sufficient time to concentrate brine. (**Figure 6**) (Bradley, 2006; Bradley, 2013; Munk, 2016).

| Typical Li concentrations | Li (ppm) |
|---|---|
| | |
| Avg. seawater | 0.2 |
| Avg. mantle abundance | 1.6 |
| Avg. crustal abundance | 20 |
| Avg. granite | 40 |
| Avg. deep sea clay | 57 |
| Avg. shale | 66 |
| Cornish lithium hydrothermal brine | 220 |
| Salar de Atacama brine (Chile) | 1400 |
| Thacker pass (hectorite mine) Nevada | 3280 |
| Mt Holland (spodumene mine) (Austrailia) | 3400 |

**Figure 4** *Average lithium concentrations in different materials and in specific extraction locations*

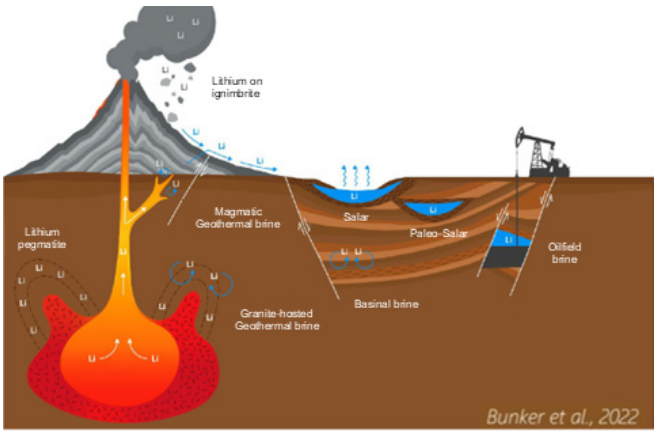



**Figure 5** *Conceptual illustration of the range of lithium (Li) deposits associated with magmatic and brine systems. These systems are connected by the flux of magma and water, which transport Li in solution.*

## LITHIUM FROM SMACKOVER OIL FIELD BRINE

The explorer/producer must understand the variability in the extent of lithium-brine concentrations in the large subsurface dimensions of the Smackover reservoir. Developing a model for exploring lithium-rich Smackover brine water requires integrating at least some known factors from Quaternary brines.

Let's examine how the lithium-rich Smackover brine water would address the six listed characteristics. First, the Louann through Smackover was deposited in an arid environment, as evidenced by the Norphlet dunes and very saline waters during the initial Smackover transgression (**Figure 7**). There was no evidence of life other than algal **Smackover Limestone** *continued on page 25*

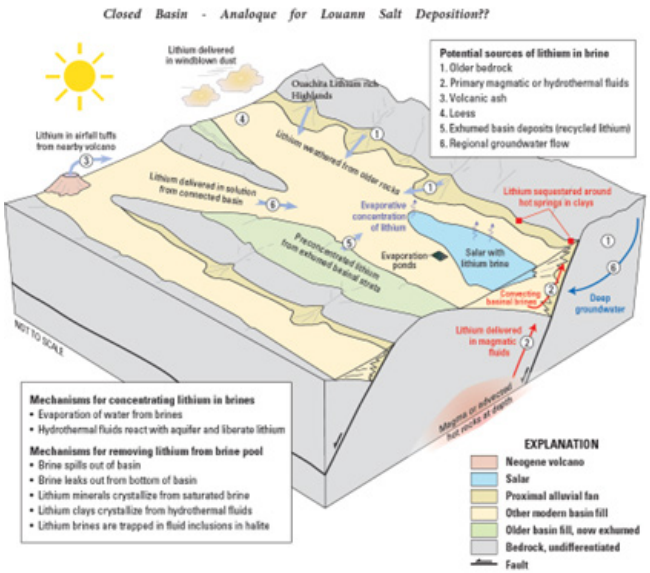
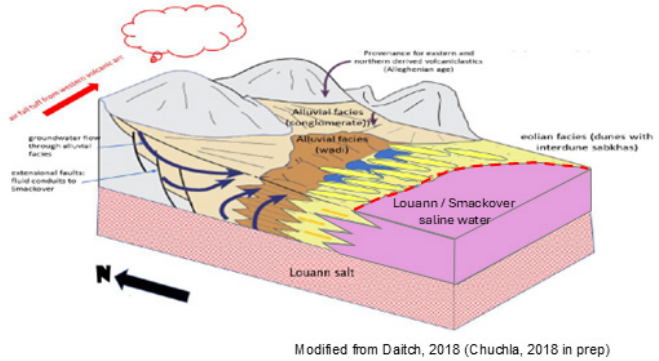



**Figure 6** *Conceptual model for lithium concentration in salars and paleo-salars. The model shows sources of lithium, pathways via faults, and drainage in depositional basins, and how it leads to enrichment and preservation. (modified after Bradley 2006, 2013 and Muck 2016)*




Modified from Daitch, 2018 (Chuchla, 2018 in prep)

**Figure 7** *Block diagram drawn at the time of Norphlet deposition. Concurrent deposition in the basin of saline waters of Louann salt continues with very high salinity water and the subsequent transgression of the basal Smackover limestone.*

 continued from page 24



blooms in this basal Smackover limestone. Algal "mats" only survived temporarily during freshwater runoff into the highly saline Smackover water (Godo, 2017). Second, the Louann salt appears deposited in an overall closed basin to concentrate the salt. However, there may also be more locally closed basins separated by local highs, such as Sabine Island or Wiggins Arch. Other authors have described more local paleo highs that were subaerially exposed even during Smackover deposition (Tedesco, 2002; Adams, 2009; Wilbourne, 2012). Kopaska-Merkel (1994) wrote that Smackover deposition near the updip depositional limit formed rims or islands around areas of paleohighs. Cross sections made by this author have shown that the depositional limit of salt occurs on the Sabine uplift in southeastern San Augustine, extreme north Jasper County, and portions of Sabine counties,

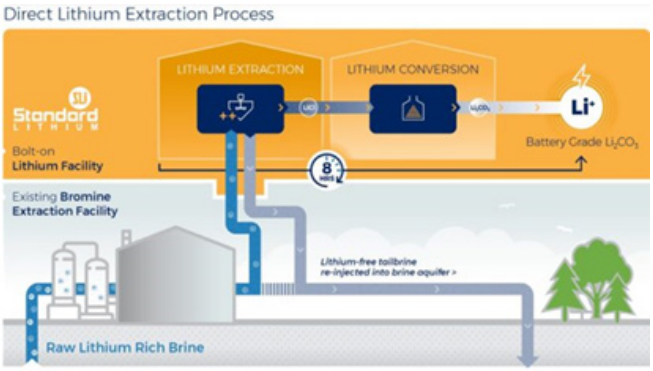



**Figure 8** *A generalized sequential process by Standard Lithium for extracting bromine first then lithium out of Smackover subsurface brine water in Southern Arkansas. in: Heaton, J and Rhymes, J.D. 2023*

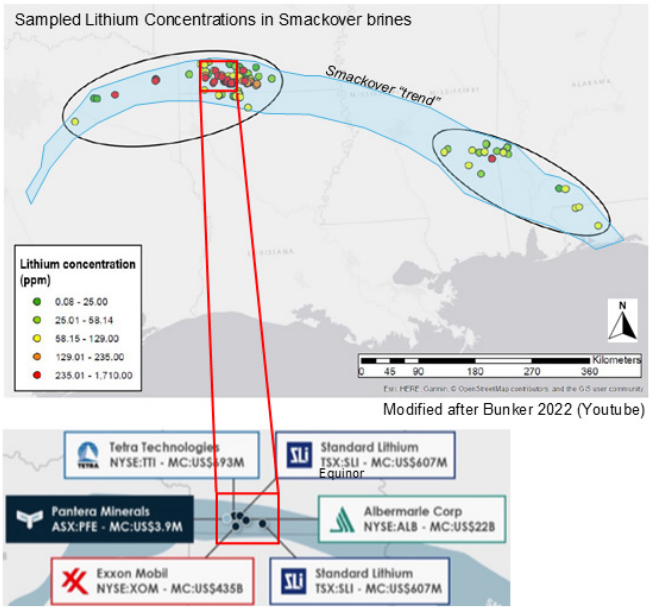



**Figure 9** *The top map shows the exploration trend of Smackover brine water with variable lithium concentrations sampled. The bottom map shows the recent activity of Exxon, Equinor, Tetra, and Pantera in the area pioneered by Standard Lithium and Albemarle.*

Texas, and Sabine Parish, Louisiana. Third, locally tectonic-driven subsidence occurred as evidenced by the horst and graben system of the Triassic-Mid Jurassic rifting with a depositional fill of the Eagle Mills – Louann salt. Fourth, having an igneous (intrusive or airborne) source present. Abundant igneous rocks intrude into the Eagle Mills sediment and airborne volcanic ash deposits in the Eagle Mills. Fifth, surrounding highlands rich in lithium-bearing rocks that would erode and inflow into the basin are present. The Smackover/Norphlet/Louann highlands to the north is the Ouachita Mountains range that extends from the southern Appalachian to West Texas. The Ouachita Mountains in Arkansas are relatively small in exposure today but represent the larger buried Paleozoic highlands that bound the southern states. Importantly, this highland belt was exposed and eroded during Upper Jurassic deposition, contributing to the sedimentary inflow of these sediments. Lithium in the Ouachita exposure is present in the widespread hydrothermal quartz veins containing cookeite, taeniolite, and lithophorite. (Stone, 1976). Sixth, the question "Has sufficient time been present for lithium to concentrate?" It is unknown and hard to quantify with this system's ancient Upper Jurassic age.

## CURRENT EVENTS – KEY PLAYERS IN THE SMACKOVER

While bromine production from the Smackover in Southern Arkansas has been ongoing for decades, lithium production from the same area has not yet been realized. The proposed lithium extraction from the Smackover is by "Direct Lithium Extraction" (DLE) (**Figure 8**). Unlike a conventional evaporation pond method to concentrate the lithium, DLE involves the selective extraction of lithium ions directly from lithium-rich solutions. DLE bypasses the need for evaporation ponds, which would be challenging in southern Arkansas's subtropical climate and rainfall totals. In addition, compared to conventional lithium extraction via evaporation, DLE can produce lithium in hours instead of months or years and use less land and water. Bloomberg predicts that if successfully commercialized, we should expect the lithium supply from evaporation and DLE technology to be roughly equal by 2030 (BloombergNEF, 2024). Although worldwide usage of DLE technology is in its infancy, it has been active at the Hombre Muerto project in Argentina and three plants in China.

In south Arkansas, where Albemarle has been producing bromine, they have begun designing a DLE extraction plant on the same property to extract lithium. Standard Lithium, however, has been ahead of most pre-construction peers since it became operational in May 2020, with the DLE pilot facility being trialed and optimized for the unique composition of the Smackover brine. Recently, Equinor, in 2024, joined with Standard Lithium, buying into a 45% interest for $160 million. In 2023, Exxon bought flanking acreage to Standard Lithium and Albemarle's acreage and plans to drill its first wells to appraise its own potential DLE operations. Dylan Vint, Exxon's lead drilling **Smackover Limestone** continued on page 26

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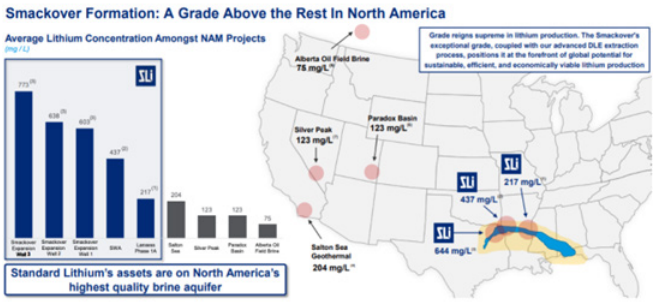


**Figure 10** *The lithium concentration in the Smackover brine water is compared to that in other lithium extraction locations in the U.S. and Canada. Silver Peak in Nevada is currently the only US location producing lithium extracted from the Clayton Valley playa.*

engineer on the project, says our "appraisal wells are gathering information about underground reservoirs and sampling the brine from which lithium can be extracted. Commercial production is targeted for 2027. By 2030, we aim to produce enough lithium to support the manufacture of about 1 million EVs." (ExxonMobil 2024). Also recently joining in acquiring acreage flanking Exxon's, Standard Lithium and Abelmarles acreage is Tetra Technologies and Pantera Minerals (**Figure 9**). Compared to other U.S. lithium brine plays, the Smackover has the richest concentration (**Figure 10**) (Epstein, 2024).

Finally, Director of Government Relations for Standard Lithium and critical minerals geologist Jesse R. Edmondson recently held the Arkansas Lithium Innovation Summit, declaring Arkansas the "Lithium State" and is open for business (AMP, 2024). Perhaps this new development for lithium from the Smackover will create interest and opportunity for geologists, geophysicists, and engineers to unlock additional areas and criteria for lithium development across the southern Gulf Coast. ■

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**WORD BRECCIA – A GEOLOGY WORD JUMBLE**

Unscramble the words below and rearrange the circled letters to find the answer to the clue.

RANHACB __ ○ __ __ __ __ __

RDSECSOB __ __ ○ __ __ __ ○ __

RPILEP __ __ __ __ ○ __

EUDNRTINE ○ __ __ __ __ __ __ __ __

CHAAVLNEA __ __ __ __ ○ ○ __ __ __

Sand Facies found in __ __ __ __ __ __ __ environments

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# Smackover-Norphlet Downward Charge Failures in Deep Water Gulf of Mexico: Additional Quantification of the First Critical Success Factor

*By Ted Godo, Geodog Exploration LLC; Joe Landry, Petrophysical Solutions, Inc*

The Upper Jurassic Norphlet Play, in the deep-water Gulf of Mexico (GOM), has made seven discoveries with developable reserves of over 1.2 BBO (Appomattox MC392, Vicksburg MC393, Ballymore MC607, Rydberg MC525, Fort Sumter MC566, Dover MC612, Gettysburg MC398; see also; BOEM, 2021). This success story is not limited to just the larger Norphlet structures but also extends to smaller structures that provide economical "tie-back" volumes to "Hub" discoveries. However, it's not all smooth sailing, as some prospects have encountered dry holes. There are four recent dry holes which are the focal point of this report. All four wells found sandstones of aeolian facies and have permeability within the range of other discovery wells. Two of these wells found wet Norphlet sands; one had oil shows, and the other (drilled near the crest) found a skinny, uneconomic oil column (Yarrow MC434, and Twickenham MC610). The other two wells found good reservoir rock with mature source rock, yet no evidence of charge or oil shows. These two prospects are Fourier Deep MC 522 and Daylight MC 522/523.

Most Norphlet fields in the deep-water offshore play are underfilled with oil. The only possible exception is the Appomattox South field, which can be argued to be underfilled, but it is close. What are the reasons for this? The Smackover source rock, which charges the Norphlet, is a fair quality source rock but only perhaps 20 percent as good as the Tithonian. However, when charging the Norphlet reservoir, the Smackover migration losses are minimized as the source rock sits directly on the reservoir. Stratigraphically, though, this overlying relationship of the source rock requires a downward charge, which "struggles" to overcome natural oil buoyancy and less overburden force overlying the source rock. The questions the paper will address are:

- Why are most traps underfilled? and
- is there a previously overlooked critical factor that, if found, will fill the structure to economic levels or, as in the case of Appomattox, a giant oil field?

To find successful Norphlet oil reserves, three critical success factors are required to see significant oil accumulations in the Norphlet (Godo, 2019). This paper will propose an additional quantifier for the first critical success factor (in italics below) specific to the deep-water Norphlet play. As a review, the three published essential factors of success are:

1. The presence of a permeable aeolian reservoir with lateral continuity is crucial. It creates a relatively less fluid-pressured environment immediately overlain by a relatively higher pressured maturing source rock, facilitating a downward charge into the reservoir. A structure with a total column height exceeding 2000 feet as measured from the crest to the deepest part of the fetch basin is needed to maximize a downward charge (**Figure 1**). *A large column height enables the deeper portion of the column (the area deeper than the pressure centroid position) to experience a more significant pressure differential between the overlying and maturing Smackover source rock and the Norphlet reservoir. This greater pressure differential seems necessary for more significant and economical oil volumes to be found. Of course, a prospect with a larger aerial footprint or fetch area (say greater than 2500 acres) also helps deliver significant oil volumes to the prospect.*
2. To fill the structure more completely, a threshold level of Smackover source rock maturity of 0.9-1.2 vitrinite reflectance (VR) equivalence is needed.
3. For a trap to retain the oil charge, the peak charge window should be less than 15 million years; otherwise, the trap will leak away most of the trapped reservoired oil.

**Smackover-Norphlet Downward Charge Failures** *continued on page 30*

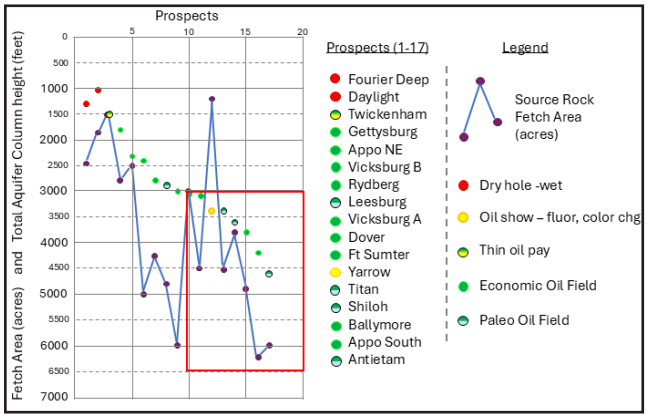


**Figure 1.** *The four recent failure wells (Fourier Deep, Daylight Twickenham, and Yarrow) have the most minor fetch areas of all drilled prospects, and three have the most diminutive aquifer column height. Only prospect Twickenham has a moderately good-sized aquifer column and the smallest fetch area of all prospects. Interestingly, the well did penetrate an oil show with a red-to-gray color change, likely within a hundred feet of an oil-water contact (see also Figures 6 and 7 in Godo, 2019).*

# Smackover-Norphlet Downward Charge Failures continued from page 29

Drilling experience has shown that mini basins with well-connected and laterally continuous sandstones have found the pressure in these sandstones to be relatively underpressured flow units having less pressure than their bounding shales. As a result, wells drilled in this flow unit at deeper depths down the structural flank or in the syncline require lower equivalent mud weights (pounds per gallon or ppg) compared to a higher mud weight used to drill this same flow unit at or near the structural crest. This phenomenon would define the centroid concept (pressure lateral transform), which assumes a "center" or a mid-point along a dipping reservoir. At this centroid position, the flow unit between two seals is at pressure equilibrium in both (Shaker, S 2005; Flemings, 2021). The centroid concept is used in this analysis.

Specifically, in the Norphlet play, this relative amount of under-pressuring in the permeable aeolian sandstone would likely be more significant with greater aquifer depths than compared to the structural crest. In addition, the overlying Smackover source rock would have a higher pore pressure in deeper structural positions as the kerogen would fill all available microporosity in the limestone and begin oil expulsion. For structures with flatter dips or flatter areas with smaller areas of deeper depths, the "under pressuring" of the reservoir may be less effective in assisting the down-charging of oil by the Smackover source rock. (**Figure 2**). Combining a more under-pressured Norphlet with a more mature and higher pressured source rock in the synclinal areas would thus enable a larger amount of oil to fill the prospect more completely.

Data was publicly released on the four subject wells over the last three years. In a post-mortem study on all wells, we noticed that the aquifer column height of the wells and the total fetch area appear to show an important trend. Those prospects with larger aquifer columns and larger fetch areas combined to form larger fields, while a minimum column height and fetch area are needed to find a commercial oil column. Seventeen Norphlet drilled prospects were used to measure 1) the total aquifer column height as measured from the structurally deepest of the Smackover/Norphlet contact and 2) the total fetch area that would include everywhere from the syncline to the structural crest. In defining the fetch in the Norphlet play, we have observed that faults present during an oil charge act as seals for oil accumulations and, hence, would be barriers limiting the fetch area to the area between the faults. Wells drilled at Appomattox and Vicksburg oil fields show that despite having apparent Norphlet sand-on-sand juxtaposition, the fault seals each side where different oil-water contacts are present (Godo, 2019). Different filling levels suggest that at the time of hydrocarbon filling, the fault would define two fetch cells, one for each side of the fault block.

As earlier stated, the Norphlet reservoir in all four wells encountered aeolian sandstones with a high net-to-gross sandstone ratio, typical of all other discoveries made in the play. More full descriptions of the four recent wells will now follow.

## FOURIER DEEP (MC522 #3BP1)

Fourier Deep (FD) was drilled structurally in a small area of the fetch and structural crest, all located in the west half of Mississippi Canyon Block 522 (**Figure 3** and **4**). The point of the Norphlet penetration is some 725 feet below the structural crest. The top Norphlet has a measured depth of 28,120 feet. The first 55 feet of Norphlet has an average porosity of ~11%. Also, this low porosity zone is found in Mobile Bay wells (at much higher temperatures) and is called the "Tight Zone." This zone has less complete

**Smackover-Norphlet Downward Charge Failures** continued on page 31

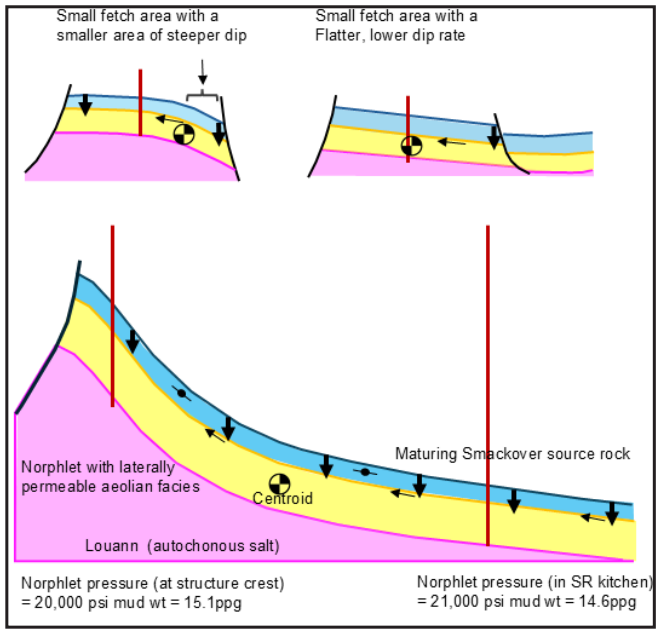


**Figure 2.** *Illustrations of the shape and depth range of the Aquifer column to the centroid position. The upper two cartoons illustrate the additional smaller fetch areas found in prospects Fourier Deep and Daylight.*

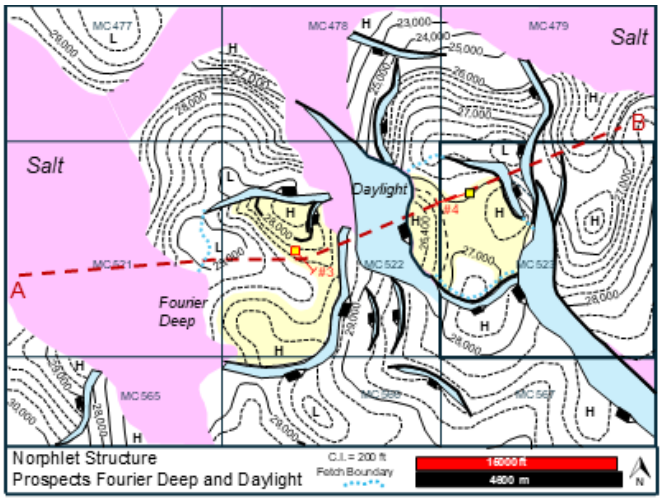


**Figure 3.** *Prospect Fourier Deep and Daylight with structural closures on the top Norphlet structure shaded in yellow.*

# Smackover-Norphlet Downward Charge Failures continued from page 30

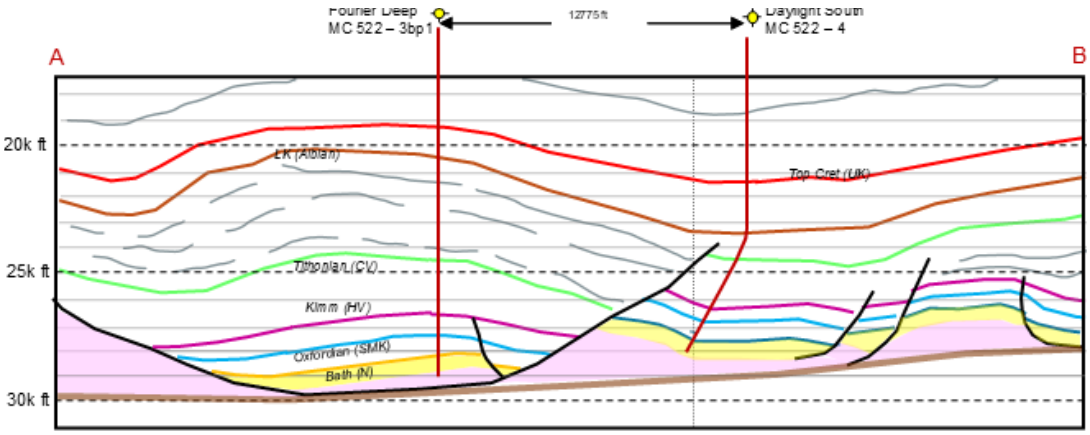


**Figure 4.** *Structural cross-section through prospects Fourier Deep and Daylight. The overall Mesozoic structure of Fourier Deep is an inverted "turtle" structure while the Norphlet Structure at Daylight is a three-way dipping fault closure.*

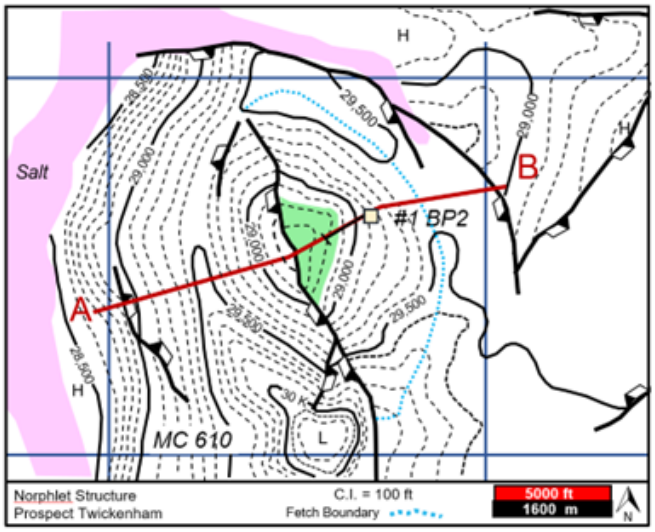


**Figure 5.** *Prospect Twickenham (MC 610) – Thin Oil Pay near the Structural Crest*
*Top Norphlet structure map at Twickenham as the Norphlet penetration point is about 200 feet off the crest. The source rock fetch area is the dashed blue line.*

chlorite clay coating, likely removed from dune slumping under transgression. Removal of even partial clay coats causes quartz cementation later in burial diagenesis. This lower porosity zone is not an oil barrier. As a note, this "lower porosity zone" is variably thick in most of the Norphlet deep water discovery wells. Back to Fourier Deep, for the next 200 feet, we see porosity with a 19% average and permeability estimated to be around 100 millidarcies, based on comparing porosity, permeability, and effective stress in other wells. Below this zone permeability greatly increases up to 2,000 mD/cP by 28,750' md as measured by the XPT tool. Then, from 28,750md to the base of Norphlet at 28,991md, porosity shifts lower to an average of 15%. There are no oil shows in terms of fluorescence at any depths, nor are there any color changes from red-brown sandstone in the cutting descriptions. This suggests the Norphlet has never received an oil charge.

The suspected reason for a charge failure despite a permeable reservoir is a combination of a small aquifer column height and a small fetch area (**Figure 1**). The deepest part of the structure, with some 500 feet of column height, only covers about a third of the total area (**Figure 3**). Hence, it is suspected that the Norphlet would have less "under pressuring" over the entire structure. Thus, it would significantly reduce the chance of any economic oil to fill the structure. Certainly, there is a possibility that some charge was generated and moved upward to the crest of the structure with perhaps as much as a couple hundred feet of oil. However, no evidence of an oil charge exists at the position on

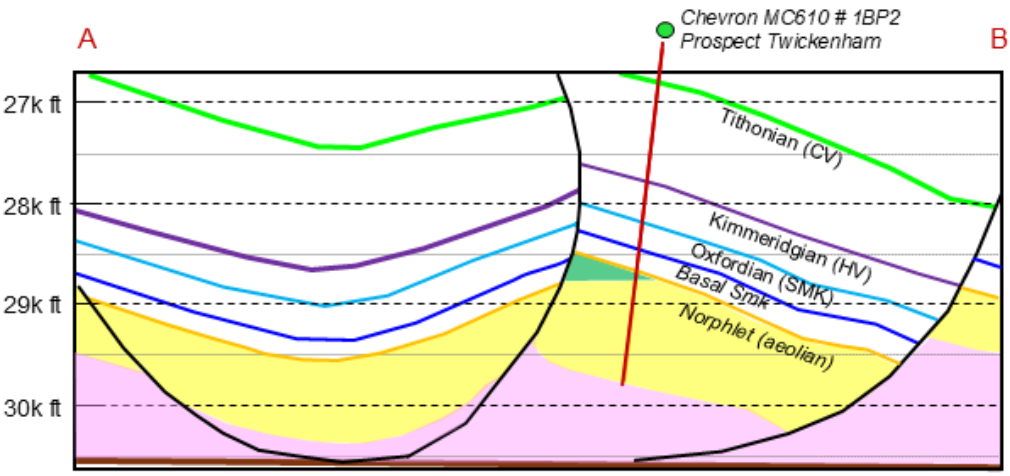


**Figure 6.** *Structural cross section over the Twickenham well.*

**Smackover-Norphlet Downward Charge Failures** *continued on page 32*

# Smackover-Norphlet Downward Charge Failures continued from page 31

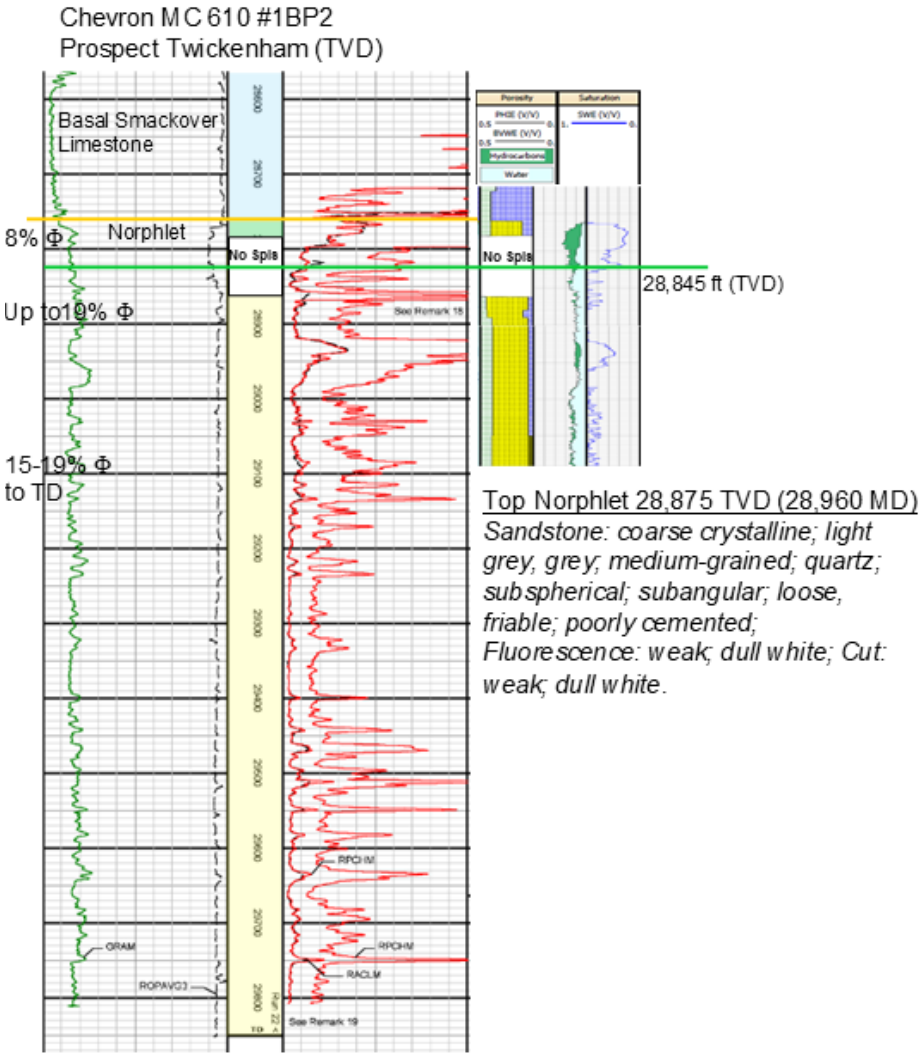


**Figure 7.** *True Vertical Depth (TVD) log of Twickenham showing in green color, the sample description is from the Norphlet just above the lost circulation zone (in white).*

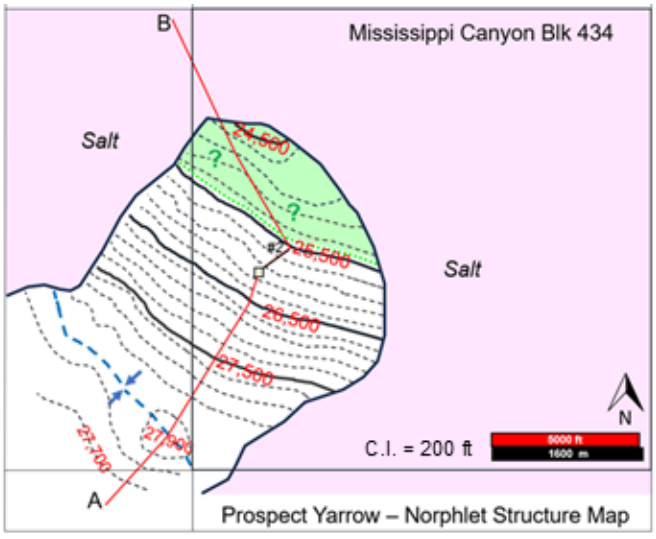


**Figure 8.** *Top Norphlet structure map at Yarrow showing the well penetrating below a potential oil water contact. The small closure and fetch area is contained in about a quarter of an OCS block that cover MC 433 and 434.*

the structure where the well penetrated the Norphlet.

### DAYLIGHT (MC 522 #4)

Prospect Daylight is also located in a small area immediately east of the FD well in about a quarter of an offshore lease block area, covering MC 522 and MC523 (**Figure 3**). The blue dashed line in the figure shows the fetch area for FD and Daylight. The top Norphlet at Daylight has a measured depth of 27,390 ft. The first thirty feet of the Norphlet have the characteristic lower porosity (11% avg) and with no-shows. The sand color is a typical red color, indicating that no oil accumulation occurred at this penetration point on the structure. Continuing below this zone, the sand maintains a red color with no-shows. The porosity increases to 19% with a suspected higher permeability like the oil-filled Norphlet in the Ballymore Field (MC 607). With prospect Daylight having good porosity and permeability, the suspected reason for a charge failure is a combination of a small aquifer column height and fetch area (**Figures 3** and **4**). Overall, the structure has a lower dip than most Norphlet prospects. (**Figure 1**). The centroid position of the permeable Norphlet would have similar pore pressures along this low-angle dipping bed such that the needed extra pressure differential in a syncline would not be much different than at the structural crest. This would lessen an effective downward charge for the prospect, delivering only a minor oil charge. There is a possibility that some oil may have migrated to the structural crest, but with the well penetration point located some 400ft lower than the crest, there is no evidence that this occurred.

### TWICKENHAM (MC 610 #1 BP2)

Prospect Twickenham is a faulted four-way dip closure, with the well penetrating the Norphlet very high on the structure. The well penetration point is about 200 feet below the crest (**Figures 5** and **6**). The Norphlet logged 1,075ft of sandstone of aeolian facies (**Figure 7**). A 50-foot oil column is interpreted at this near structurally crestal position. This is based on a saturation profile and mudlog sandstone description of light gray sandstone with cut fluorescence (**Figure 7**). There was a circulation loss just below the first 20 feet of Norphlet penetration, and a short trip was made. For the next

**Smackover-Norphlet Downward Charge Failures** *continued on page 33*

# Smackover-Norphlet Downward Charge Failures continued from page 32

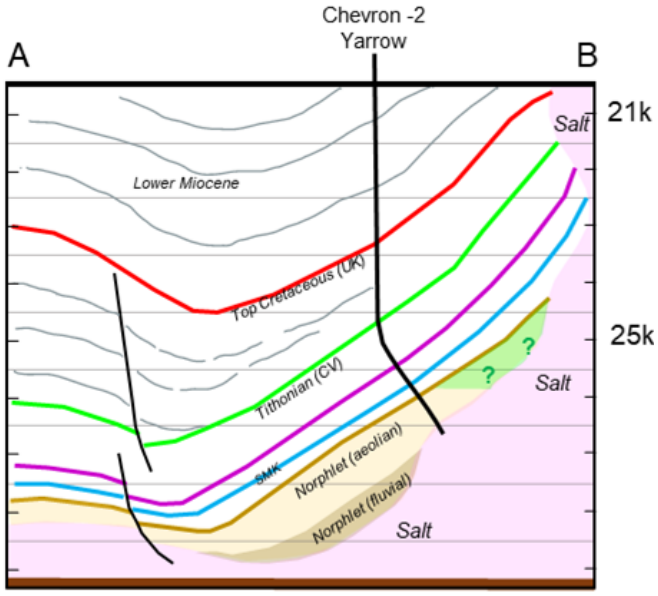


**Figure 9.** *Structural cross-section through Yarrow suggesting and updip oil accumulation might exist*

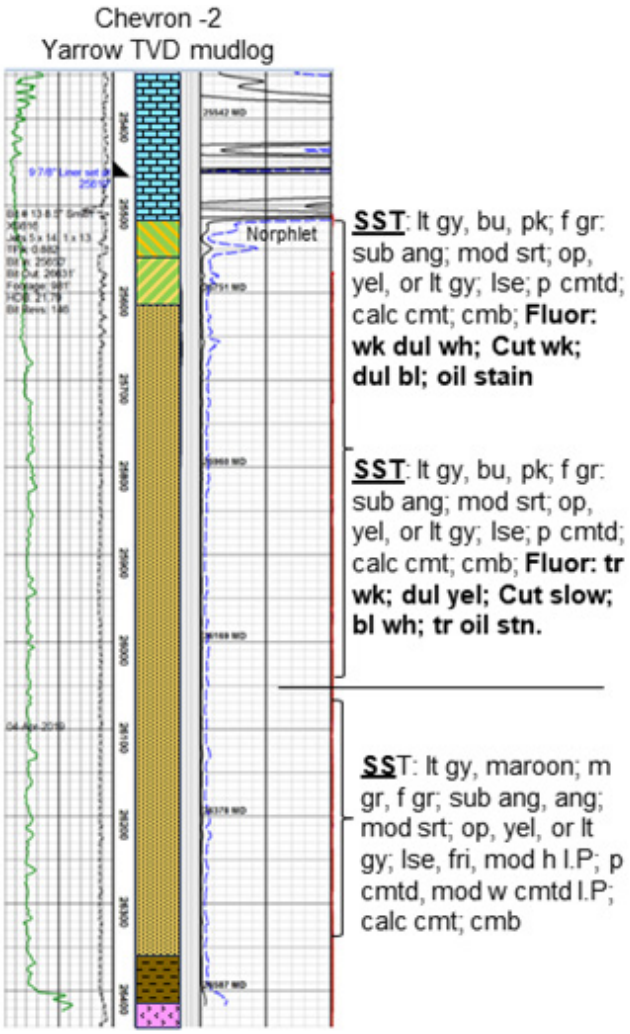



**Figure 10.** *A gamma ray and resistivity log with the center column reflecting the mudlog with the description at the right*

80 ft (TVD), no samples were recovered. Petrophysically, the first 225 ft of Norphlet porosities range from 8% to 19%, averaging 12%. Below that, porosity increases to an average of 15% with improving permeability, but the sandstone color changes from gray to red sandstone, indicating no oil fill in the red sandstone. Based on log evaluation, the oil-water contact occurred at 28,845 ft (TVD) over the interval where cutting samples were lost during the short trip. Based on finding the oil-water contact (OWC), Twickenham could be considered a geologic success but not economical. The likely volume using the OWC and the structure map, a recovery volume estimate, is between 5 to 10 MMBOE.

## YARROW (MC 434 #2)

Structurally, Prospect Yarrow is a monocline dip of the Norphlet truncated on three sides by salt. (**Figures 8** and **9**). Yarrow has an aquifer column height of 3,400 feet, which plots comfortably in the range of Norphlet discovery analogs (**Figure 1**). However, with only 1200 acres of source rock fetch area, it is the smallest area of all wells drilled. The Norphlet penetration point was drilled somewhat low on structure as it penetrated the Norphlet 1100 ft below the crest. The well found no oil saturation, but there is strong evidence in the show and color change from red to gray that the penetration point is likely very near an oil contact (**Figure 10**). The mudlog shows cut fluorescence with oil staining on gray sandstone. Petrophysically, there is good porosity development, ranging from 23%-28% (25% avg), and permeability in the order of 500mD – 1500mD based on Norphlet core data. Yarrow at the well penetration point found wet sandstone. Nevertheless, considering it was drilled 1100 feet below the structural crest and with the oil show and color change, it is suggested that an up-dip volume could be in the range of 20 MMBOE.

## CONCLUSION

This paper analyzed the drilled deep-water prospects in the Norphlet play, measuring the total column height of the structure and the source rock fetch area. These two measurements may enable a better understanding of more effective downcharging by the Smackover source rock. Based on this analysis, an additional quantification to characterize the more successful exploration of Norphlet oil fields is added to the first of the three critical success factors for the play. All three critical success factors are listed here, with the underlined sentences in the first critical success factor being the subject of this paper.

**Smackover-Norphlet Downward Charge Failures** *continued on page 34*

## Smackover-Norphlet Downward Charge Failures continued from page 33

- The presence of a permeable aeolian reservoir with lateral continuity is crucial. It creates a relatively less fluid-pressured environment immediately overlain by a relatively higher pressured maturing source rock, facilitating a downward charge into the reservoir. A structure with a total column height of over 2000 feet measured from the crest to the spill point is needed to maximize a downward charge. A large column height enables the deeper portion of the column to experience the greater pressure difference between the overlying and maturing Smackover source rock and the Norphlet reservoir. This greater pressure differential seems necessary for more significant and economical oil volumes to be found. Of course, a prospect with a large aerial footprint or fetch area greater than 2500 acres also helps deliver significant oil volumes to the prospect.
- To fill the structure more completely, a threshold level of Smackover source rock maturity of 0.9-1.2 vitrinite reflectance (VR) equivalence is needed.
- For a trap to retain the oil charge, the peak charge window should be less than 15 million years; otherwise, the trap will leak away most of the trapped reservoired oil.

A more significant accumulation should target a structure with 3500 feet of column and 3500 acres or greater. ■

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**Wednesday September 11, 2024**

**HGS E&E Dinner Meeting**

**Social 5:30 p.m., Dinner 6:30 p.m., Presentation 7:30- 9:00 p.m.**

**Pre-registered HGS Members $35**
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*To guarantee a seat, pre-register on the HGS website and pay with a credit card. You may walk up and pay at the door if extra seats are available. Please cancel by phone or email within 24 hours before the event for a refund. Online & pre-registration closes Wednesday, at 5:00 a.m.*
**Los Tios • 9527 Westheimer Rd • Houston, TX 77063**
**https://www.hgs.org/civicrm/event/info?id=2592**
**Event Contact: Troy Meinen • troymeinen@gmail.com**

***Michael D. Campbell, P.G., P.H., C.P.G.***
***Henry M. Wise, P.G., C.P.G.***
***Bruce Handley, P.G.***
*The I2M Corporation*

# A Tale of the Re-Discovery of the Brookshire Uranium Deposit Whose Time has Come

Once upon a time many years ago, back in the early 1980s, a young geologist had just graduated with a master's Degree from the University of Texas at El Paso. He went to work for the US Steel uranium group looking in frontier areas in Texas where new uranium deposits might be found. Eventually US Steel transferred him to their South Texas uranium mines to develop a new uranium deposit and to develop other US Steel South Texas Uranium mines in the area. In 1981, he was hired by Cambridge Royalty Company where he began to examine hundreds of geophysical logs produced by oil & gas companies in Texas. He ran across one well log in particular that caught his attention, the Humble #1 well, located on the southeastern flanks of the San Felipe Salt Dome near Brookshire, Texas. It showed remarkable activity in the gamma log, the unmistakable signs of uranium mineralization in the form of so-called "roll-front" deposits. He also found such signs in surrounding oil & gas well logs.

He recommended to his company that a few exploration holes be drilled and logged. One hole was drilled. And then another, until some 300 holes were drilled following the fluvial sands over miles of mineralized trends. Unfortunately, his company lost interest in the project resulting from the news of a drop in the price of yellowcake and loss of interest in the future of nuclear power. The company project was shut down after spending more than $1,000,000 and the assets were sold off. He heard that all the drilling data were being sent off to the trash. He retrieved as much data as he could, consisting of summary drilling tables and maps, but the important geophysical logs disappeared and were assumed lost. After that, he pivoted his professional career into opportunities in the rapidly expanding environmental field and that was that. He spent the next three decades managing environmental projects, mostly under company contracts with the TCEQ.

Meanwhile, back in the deep subsurface of the floodplain south of Brookshire, where the long trends of uranium mineralization he had previously identified has existed for millions of years, specialized bacteria, energized by methane or hydrogen sulfide escaping up the nearby faults from the oil & gas deposits deep below, continued to excrete uranium in the dark, carbon-rich environment while migrating slowly, very slowly, in the groundwater of the sands down the hydraulic gradient.

In 2008, signs indicated nuclear power was emerging once again and the uranium price began to rise but a few years later tidal waves hit Japan and damaged one of the four nuclear power plants at Fukushima. Although the ensuing meltdown was managed without casualties, Japan, Germany and other countries were panicked by the world media and began to shut down their nuclear power plants. That created an excess of uranium in the market supplies and the price of uranium once again plummeted.

About a decade later, in the 2010s, nuclear power surged back into the public consciousness driven by new technologies, the superior safety record of nuclear power, and the need for climate-friendly energy sources. This new technology was to first replace the burning of coal, then, in time, other fossil fuels and ultimately to replace wind and solar installations because of their numerous shortcomings. They are currently serving in the transition period prior to the onset of new nuclear power construction by the end of the decade led by the development of small modular reactors (SMRs) that will likely be built around the U.S. and the world as the focus of local power grids.

As the price of yellowcake surged upwards beyond $60/pound, with no signs of future impediments, the uranium mining industry also has begun to gear up to again produce yellowcake, supported by new federal bans on the importation of Russian uranium, which has awakened the search for new uranium deposits. This was the sign it was the time to take another look at the Brookshire uranium deposit.

Based on the extensive exploration drilling in the 1980s, it is known that the San Felipe Salt Dome area contains extensive deep uranium deposits that could now be economic to recover uranium and produce yellowcake. But, what about the risks involving potential damage to the surface and shallow water-

**E&E Dinner Meeting** *continued on page 37*

continued from page 36



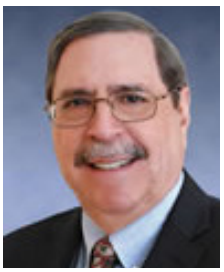
table wells caused in some way by the in-situ uranium mining operations? To address these issues, the geologist who made the discovery was encouraged by other highly qualified, licensed senior geologists and hydrogeologists in the I2M Corporation to explore the possibilities of the area once again and to address the issues involved.

In this presentation, the authors present a review of the Brookshire uranium occurrence and how oil & gas has played a vital role in creating the uranium deposits and how the oil & gas wells' geophysical logs led to identifying the uranium deposits. They also will review what the development of these deposits would involve in terms of the likely location of these mineralized trends and how the deep uranium would be extracted by the well-known and well-proven in-situ uranium recovery method.

Part of the review being conducted by the I2M Corporation focuses on the characteristics of the uranium deposits and whether the uranium could be produced economically and then whether such development could be accomplished without damage to the land or shallow drinking-water aquifers. Located amidst numerous producing oil and gas wells in the San Felipe Oil Field, the residents and landowners have the potential environmental and economic issues on their minds. The surface owners wonder if their land will be damaged or left with a mess to clean up. Is there danger from radioactivity or from the possible contamination of the water wells? Lastly, has the presence of uranium in the subsurface affected the lands' real-estate values? The mineral-rights owners wonder if this is the right time to develop the uranium deposit where the royalties can be optimized. I2M personnel have been looking into all these issues and more and have prepared a position paper for the local landowners' consideration.

The geological, hydrogeological, and social issues will be discussed in some detail with regards to whether this is the time to recover the uranium from the deep subsurface sands of the Brookshire area. With the backgrounds of the I2M personnel involving many years of environmental, oil & gas, and uranium-mining experience, I2M offers a uniquely qualified team to manage and provide oversight of such a project both in terms of its economic viability and its potential impact on the local environment. ■

## BIOGRAPHICAL SKETCHES

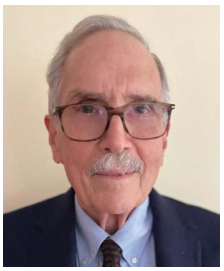


**Mr. Campbell** received a bachelor's degree in geology and hydrogeology from the Ohio State University and a master's degree in geology and geophysics from Rice University under a Mills Bennett Fellowship. Over a professional career approaching 60 years, Mr. Campbell has over the past two decades served the AAPG's Energy Mineral Division (EMD) as Chairman of the Uranium & REE Committee and was elected President of the EMD in 2010. He has produced more than 200 publications and reports and four books, including a recent memoir. Upon graduation, he was appointed Manager of the Alternate Energy, Mining and Environmental Group of Keplinger and Associates, Inc., a major oil and gas consulting firm in Houston and Tulsa. He managed a staff of six professionals and produced numerous reports of investigations on uranium, coal, and geothermal projects in the U.S. and overseas. While with K&A, he and associates produced the text: "Geology of Alternate Energy Resources," published by the Houston Geological Society. Law Engineering and Environmental Company in Houston, and after a few years, he was promoted to Corporate Chief Hydrogeologist covering Law's 50 officers nationwide. He later was offered a position at DuPont as the Regional Technical Manager within the Dupont Environmental Group with line responsibility for a staff of about 70 professionals in five departments: geology, special services, engineering design and construction, and deep-well disposal services. See Mr. Campbell's more recent activities (https://www.i2massociates.com/downloads/CampbellBioContinued.pdf).

**Mr. Wise** obtained a bachelor's degree in geology from Boston University and a master's degree in geology from the University of Texas, El Paso. He has 47 years of experience in South Texas uranium exploration and production, and environmental remediation consulting for various private companies and federal, state, and private sector clients. His successful uranium activities includes exploration and in-situ recovery mine development and production. For 25 years he worked for Republic Services and was responsible for three TCEQ contracts, PST State Lead, PST emergency response, and spill-emergency response. He has extensive experience in UST and RCRA facilities, Minimum Site Assessments, Plan A Risk Reduction Environmental Site Assessments, and the Texas Risk Reduction Program (TRRP). Also experienced in site remediation, RCRA Part B applications, deep well disposal, and pipeline permit applications. He also has produced 25 technical papers on uranium and nuclear power, mostly with Michael D. Campbell. Mr. Wise has been serving over the past 20 years as Vice-Chair – Industry on AAPG's Energy Minerals Division's Uranium and REE Committee. He also has been serving as the President of the Texas Chapter of the American Institute of Professional Geologists (AIPG). Beyond his current consulting practice, Mr. Wise is serving as Vice President – Operations for the I2M Corporation in developing a uranium mining project of a deposit he discovered in the 1980s. (See his CV for additional details – https://www.i2massociates.com/downloads/HenryWise2024bio.pdf).

**E&E Dinner Meeting** continued on page 38

## E&E Dinner Meeting continued from page 37



**Mr. Handley** entered the University of Wisconsin-Madison after his honorable discharge from the United States Air Force. After switching majors and working to establish residency in Wisconsin, he earned a bachelor's and a master's degree in Geology and Geophysics. He started his career in oil and gas exploration at the Sohio Petroleum Company, doing field work and seismic basement mapping in the Appalachians. When Conoco merged with Phillips Petroleum he departed the oil and gas industry. Mr. Handley enrolled in the Institute of Environmental Technology (IET), a program developed by Mr. Michael Campbell to cross train displaced oil and gas professionals into the environmental field. He graduated 2nd in a class of 97 students from this 4-month training program. He began his environmental consulting career that year and served with large and small consulting firms, including Conestoga Rovers and Associates and The Benham Companies. It was during this period that Mr. Handley was exposed to nearly every facet of the environmental consulting industry, including health and safety, due diligence, permit compliance, subsurface interpretation, and remediation. After more than 20 years, he decided to step away from the consulting business, but some long-time clients still needed his experience and Michael D. Campbell, the President and CEO of I2M Corporation and Mr. Handley's long-time mentor, was one of these. As a previous associate at I2M Consulting, LLC in other projects, Mr. Handley was selected to join the I2M team exploring for energy minerals in Texas. One aspect of his experience that adds value to this team is his demonstrated respect for the natural world and our need to act ethically as responsible stewards of the environment. (See his CV for additional details – https://i2mconsulting.com/bruce-handley/).


*Mid Jurassic (Callovian) Todilto carbonate source rock overlying the aeolian Entrada sandstone (blue line). Oil has been found in the Entrada reservoir by downward charging from the overlying Tolilto carbonate source rock in several SW San Juan Basin fields in New Mexico. Photograph taken at the Echo Canyon Amphitheater, New Mexico, courtesy of Ted Godo.*

**Monday, Monday, September 16, 2024**

**Social Hour 5:30 pm**

**Dinner 6:30 pm, Presentation 7:15 pm**

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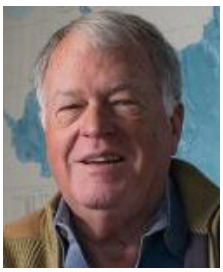
***John B. Anderson***
*Rice University*

# Holocene Versus Historical Response of the Gulf Coast to Sea-Level Rise and Climate Change: From Coastal Stability to Rapid Demise

Climate Change has rapidly forced the Earth into conditions that have not existed historically, leaving us without analogs for current and future change. The historical acceleration of sea-level rise has resulted in rates that have not occurred for more than 7,500 years, a period of rapid change. However, current rates of coastal change are exacerbated by natural and anthropogenic influences. This talk summarizes three decades of research focused on how different coastal environments responded to sea-level rise and changes in climate during the Holocene and how these changes compare to those occurring today.

NOAA models show extensive wetlands loss by the year 2050, especially in Louisiana and Texas, with most of the Mississippi Delta and Louisiana-east Texas Chenier Plain inundated. Gulf Coast estuaries are also experiencing widespread drowning of their bayhead deltas, vital components of estuarine ecosystems. This is a stark reversal of the growth of these coastal settings during the last four thousand years. Likewise, barrier islands, peninsulas, and mainland beaches are experiencing rapid erosion following a long history of stability and growth. Our studies show that current rates of coastal change are similar to or exceed those that occurred during the early Holocene. This is largely due to accelerated sealevel rise and human alteration of sediment supply and dispersal systems. The best approach to slowing the rate of coastal change is large-scale sediment nourishment. This calls for large volumes of sediment and will require large-scale coastal sediment budget analyses. Unfortunately, Gulf Coast states have been slow to recognize the problem, and widespread coastal change is inevitable and irreversible. ■

## BIOGRAPHICAL SKETCH



**Dr. John Anderson** is the W. Maurice Ewing Professor of Oceanography-Emeritus at Rice University, where he was a faculty member for 43 years before his retirement. John's research focuses on the history of the Antarctic Ice Sheet and the evolution of the Gulf Coast in response to sea-level rise and climate change. This research has included 24 marine geological expeditions to Antarctica and the acquisition of an extensive collection of data and scientific publications on the Gulf Coast. He has authored two books *Antarctic Marine Geology* (Cambridge University Press) and *The Formation and Future of the Upper Texas Coast* (Texas A&M Press), and co-edited five books, including a 2022 Geological Society of America Memoir entitled "Holocene Evolution of the Western Louisiana–Texas Coast, USA: Response to Sea-Level Rise and Climate Change". He has published over 280 peer-reviewed papers and mentored 70 graduate students, a number of them currently engaged in Antarctic and coastal research. Dr. Anderson received the 1992 Gulf Coast Association of Geological Society (GCAGS) Outstanding Educator Award, the 2019 Doris Curtis Outstanding Educator Award, and the 2007 Shepard Award from the Society for Sedimentary Research. His other awards include the Rice University Graduate Teaching Award and the Rice University Presidential Mentoring Award. He has served on numerous scientific committees and advisory boards, is a fellow of the Geological Society of America, and was the past president of the Society for Sedimentary Research.

**Tuesday, September 25, 2024**
**Social 11:15 AM, Luncheon 11:30 AM- 1:00 PM**
**Cost: $40 pre-registered members**
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**Event Contact: Bryan Guzman | bryan.guzman85@gmail.com**

***Alessandra Simone***
*Ryder Scott*

# Hydraulic Unit Characterization & Modeling for Underground Injection

The underground injection of $CO_2$ demands precise characterization and modeling of hydraulic units to ensure efficiency and safety. Identifying functional units in their dynamic behavior enables the convergence of static models and dynamic simulations at multiple scales. This talk will share methodologies for selecting, calibrating, and modeling hydraulic units, from injection to baffles to seals. We will review key parameters to understand the contribution of each unit within the UI containment system based on publicly available case studies. We will delve into the processes of assessing reservoir properties, including porosity, permeability, relative permeabilities, and mechanical properties, reviewing lessons learned and recommended measurements (lab and field). By strategically integrating calibration data with relevant simulation scenarios, we can enhance our UI capabilities to optimize injection rates and minimize pressure buildup and leakage risks.

## BIOGRAPHICAL SKETCH

**Alessandra Simone** is a Petroleum Engineer with 28 years of international oil and gas experience. During her 17 years with Shell, she worked at five international locations. Next, Alessandra joined Geostock Sandia as an underground injection specialist to work on various underground injection (UI) projects, managing projects and providing regulatory support for $CO_2$, chemical waste injection, and hydrogen storage.

After Geostock, she joined Ryder Scott in 2024. Her duties on CCS projects ranged from due diligence to subsurface simulations, economic analysis, and ISO verifications.

She has 20 years of direct, commercial experience in CCS and has deployed her technical skills in 11 large-field CCS projects, including field and laboratory $CO_2$ injection.

Alessandra holds a PhD in Petroleum Engineering from the University of Houston, an MSc in Energy from Heriot-Watt University, and a BSc in Aeronautical Engineering from Rensselaer Polytechnic Institute.

*Cimarrona Peak with Williams Creek Reservoir in the foreground near Pagosa Springs, Colorado (photo courtesy of Ted Godo)*

# September 2024

| SUNDAY | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY | SATURDAY |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 **HGS Annual Student Expo** *https://www.hgs.org/civicrm/event/info?id=2554* | 10 | 11 **HGS E&E Dinner Meeting** *Re-Discovery of the Brookshire Uranium Deposit* *Page 36* *https://www.hgs.org/civicrm/event/info?id=2592* | 12 **HGS NeoGeos Happy Hour** *https://www.hgs.org/civicrm/event/info?id=2587* | 13 | 14 |
| 15 | 16 **HGS General Dinner Meeting** *Holocene versus Historical Response of the Gulf Coast to Sea-Level Rise and Climate Change* *Page 39* *https://www.hgs.org/civicrm/event/info?id=2563* | 17 **HGS New Energies Luncheon Meeting** *Hydraulic Unit Characterization & Modeling for Underground Injection* *Page 40* *https://www.hgs.org/civicrm/event/info?id=2595* | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 **HGS-GESGB Africa Conference** *https://www.hgs.org/civicrm/event/info?id=2555* | 25 | 26 | 27 | 28 |
| 29 | 30 | | | | | |

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**RESERVATIONS** The HGS prefers that you make your reservations online 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, contact the HGS office at OFFICE@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.**

## INSTRUCTIONS TO AUTHORS

Materials are due by the first of the month for consideration to appear in the next month's publication. Submissions should be emailed to editor@hgs.org. The Editor reserves the right to reject submissions or defer submissions for future editions.

Text should be submitted as a Word file. Figures or photos may be embedded in the document or submitted separately. The following image formats are accepted: tif, .jpg, .png, .psd, .pdf.

Feature submissions, e.g., Rock Record, should be approximately 600 words. Technical papers should be approximately 2000 words or less (excluding references).

# HGS 2024 Summer Internships at the Houston Museum of Natural Science

*By Dorene West, Science Fair Committee chair and Penny Patterson, President, Houston Geological Society*


**Figure 1.** *HGS members visit summer interns at the HMNS on June 25, 2024. In the photograph are: (from left to right): Carolyn Sumners (HMNS), Penny Patterson (HGS President), Victoria Velasquez (GSH sponsored intern), Prachi Natoo (HGS sponsored intern), Ashley Fong (AMNH supported intern), Heba Saeed Badat (HGS sponsored intern), Shri Chada (HGS sponsored intern), and Dorene West (HGS Science Fair Committee chair).*

This summer, the Houston Geological Society funded four scholarships for internships for high school students to conduct STEM research and complete a final project for their research. Two of the four students received full sponsorships from HGS, whereas two students were funded, in part, by HGS and, in part, by NASA. The students who received internship scholarships are:

- Shri Chada (full sponsorship; HGS 1st Place Senior Division Special Award at SEFH)
- Prachi Natoo (full sponsorship; HGS 2nd Place Senior Division Special Award at SEFH)
- Heba Badet (half sponsorship by HGS; half sponsorship by NASA)
- Ram Magathala (half sponsorship by HGS; half sponsorship by NASA)

Carolyn Sumners, Ed.D., the HMNS's Curator of Astronomy, is a passionate science educator who specializes in space education. Carolyn mentored and inspired the four students throughout their internship at HMNS.

On June 25, 2024, Dorene West, Penny Patterson, and Larry Welch visited HGS intern Prachi, working with fellow intern Ashley Fong (**Figure 1**). Their research project involved learning about our universe and its many galaxies using a visualization room at the HMNS. Ashley ran the software and Prachi narrated as they took us on a tour of the universe. The tour started with a close up view of the HMNS building. Then it zoomed out to earth, the solar system, to the observable universe sphere with blue to red whispers of light from the big bang sound wave and butterfly gap behind the Milky Way (the gap seems to be a data acquisition artifact of the 2 surveys used to generate the visualization/mapped universe). Then we returned to our solar system and got a tour of the International Space Station. After our tour by Prachi, Penny, and Dorene were able to learn about the software and program by turns moving around in the Milky Way Galaxy. At the end of the tour, Penny and Dorene showed Prachi and Ashley modern geological features on Earth

**HGS 2024 Summer Internships** *continued on page 43*


**Figure 2.** *From left to right: Carolyn Sumner (HMNS), Shri Chada, and Dorene West (HGS Science Fair Committee) in front of the new dome/astronomy presentation theater.*

## HGS 2024 Summer Internships continued from page 42

that are similar to those observed on Mars, including the dunes of Namibia and the mountains and alluvial fans in the Turpan Depression, China.

On July 11, 2024, Dorene, Penny and Larry visited HGS interns Ram and Heba. Their project centered on a visualization tour of the newly constructed geodesic dome (**Figure 2**) that all four interns helped build with Carolyn's guidance. The dome mimics the interior of the Pantheon and can be used to visualize the night sky and explore constellations within our solar system (**Figures 3, 4**). Ram gave the first presentation of the day and his work focused on the history of astronomy and why it is important to us. In his presentation, Ram discussed seven ancient astronomers, including Imhotep, Hanno, Aristarchus, Aristotle, Eratosthenes, Hipparchus and Ptolemy, and highlighted their contributions to astrology.

The second presentation was by Heba Badat, who spoke on astronomy in Islam. Heba then discussed three famous Islamic astronomers who contributed to our knowledge: Al-Farghani, Al-Battani, and Abd al-Rahman al-Sufi. Heba said that her work increased her knowledge of the stars and added to an understanding of our rich universal cultural heritage.

On July 19, 2024, Dorene and Larry visited Shri Chada, at the HMNS where she gave her final presentation on astronomy in India. Shri discussed the famous Indian astronomers, Aryabhata, Brahmagupta, and Lagadha, and also key celestial bodies, including Dhruva (Polaris/North Star), Saptharishi (Ursa Major), Shani (Saturn), and Surya (the Suand ended her presentation by commenting that Indian astronomy spans thousands of years and that keen observations and mathematical insights enable Indian astronomers to lay the foundations for predicting critical events, develop calendars, and explore the universe. ■

**Figure 3.** *View from Inside the dome with Carolyn Sumners presenting an introduction for the first presentation in the new dome.*


**Figure 4**. *Visit on July 11, 2024 to see the research projects by the summer interns and their research.*

# Remembrance

## Al Danforth

**Al Danforth,** a long-time HGS leader, passed away on July 4, 2024. He was 79.

Al Danforth excelled as the organizer of the first Africa Symposium in Houston, Texas, in conjunction with the Petroleum Exploration Society of Great Britain (PESGB). He was a co-founder in 2002 of the highly successful African Conference that has occurred each year since the first Africa Symposium in London. The conferences held in Houston had Al as Chairman every other year, including the conference in Houston, Texas, September 11-12, 2012.

Danforth was the organizer of the first Africa Symposium in Houston, Texas, in conjunction with the Petroleum Exploration Society of Great Britain (PESGB). He was a co-founder in 2002 of the highly successful African Conference that has occurred each year since the first Africa Symposium in London. The conferences held in Houston had Al as Chairman every other year, including the conference in Houston, Texas, September 11-12, 2012.

Al Danforth was an Emeritus Member of the American Association of Petroleum Geologists (AAPG) and, was awarded Honorary Life Membership in the Houston Geological Society (HGS) for his continuing efforts on behalf of the Society and its members. He was a major resource to HGS, especially managing the International Explorationists group. Since his first talk to the HGS in October 1998, "Petroleum Systems of the Kwanza and Benguela Basins, Angola", he encouraged his fellow authors to prepare presentations about new information that rapidly changed the interpretation of offshore Africa.

Al was chair of the Technical Programs of the International Explorationists group of the HGS 1999-2001 and then became the Chairman of the International HGS group 2002-2005.. Al shared his extensive international experience when he was on the Organizing Committee of the HGS Continuing Education Committee in the programs "The Business of International Exploration Symposium", February 2000, and "Doing Business in Latin America Symposium, January 2002. He thoroughly investigated regional seismic lines and collaborated with fellow authors in well-illustrated talks about regional tectonic offshore Africa and adjacent areas.

Danforth earned a Bachelor of Science in Geology from Edinboro University of Pennsylvania and attended graduate school at Miami University in Oxford, Ohio, specializing in Sedimentology and Stratigraphy, Sedimentary Environment, and Petroleum Geology

**Memorial : Al Danforth had many HGS friends and coworkers. Here are some memories from his friends.:**

From Brian Horn " Like many geoscientists, I had the privilege to work with Al for ten years on multiple regional projects in Africa and India for ION E&P Advisors. In the ION office we used to say, "It would be great if we knew half of what Al had forgotten about African geology." Danforth was instrumental in developing conjugate margin thinking, working with many scientists in GCSSEPM, GSL, and AGU. He was loved by many, and his colleagues have shared numerous stories of work and personal experiences."

From Steve Henry "Al and I were introduced to each other when I was writing West African sales brochures for WesternGeo and just after he retired from Texaco in 1998. We both worked on that project which led to our first publication together using Western's, at that time, NEW Deepwater Seismic Grid, for offshore Angola. We traveled together to a lot of meetings, and had FUN! We were able to generate new ideas on petroleum systems in the deepwater of the South Atlantic and how the South Atlantic opened. Al's recollection of old exploration wells from his days as a regional geologist kept us on track. Al was not just a good scientist and colleague, but a devoted husband, father, and one of my best friends. I'm going to miss Al, and our conversations."

**Al Danforth** *continued on page 46*

# *Remembrance*

## Leighton Felker Young Jr.

**11/09/1937 - 06/03/2024**

**Leighton Felker Young Jr.**, 86, of Houston, passed away on June 3, 2024. Leighton was born November 9, 1937, in Houston, Texas, to Leighton and Sarah Young. He is survived by his wife, Joan, who is 67 years old. Joan and Leighton met on a blind date during the last few weeks of their senior year of high school.

Leighton, a native of Houston, Texas, was a distinguished geologist. He earned his degree in Geology from the University of Notre Dame in 1959 and furthered his education at Rice University. His career began at Austral Oil Company, and he later became an independent geologist. He co-founded Irish Oil & Gas Company, leaving a lasting impact on the industry. His professional affiliations included HGS, AAPG, AIPG, Canadian Society of Petroleum Geology, SIPES, SPEE, and many more, reflecting his deep involvement and expertise in his field.

At Notre Dame, he was a Golden Glove champion boxer. He was a four-year letterman and reached the finals of the Bengal Bouts each year. He was the Bengal Bouts champion in 1959 and named the most valuable boxer. Later, he took those skills to the ice.

As a young adult, Leighton enjoyed playing ice hockey in Houston and made lifelong friends through this association. They traveled to Mexico City to play the Mexico Olympic team and played a team from Russia. His love for the game led to him working with others to establish the first youth hockey organization (HYHO) at Winterland Ice Arena. He supported professional hockey in Houston by being the goal judge for the Apollos and the Aeros. He put his heart and soul into saving the WHA for Houston.

Leighton was a man of strong faith and deep love for his family. He was a regular participant in the Bible Study Fellowship for over 15 years. His faith was also reflected in his membership in St. Cyril of Alexandria and St. John Vianney Catholic Communities. He was known for his quiet acts of kindness and his belief that 'There is always a way.' His devotion to his family was evident in his unwavering support at their sporting events and other extracurricular activities, showing his active involvement in their lives. He is preceded into death by his parents, Sarah and Leighton Young, his brothers, John and Thomas, and his great-granddaughter, Hendrix Vernon.

He is survived by his children - Cindy Young Vernon, Melanie (Devin) Heasley, Trey (Sarah) Young, and Julie (Mike) Rucker and grandchildren Nick (Caroline) Heasley, Trevor (Candy) Vernon, Brandon (Hope) Heasley, Jared Vernon, Megan Rucker, Jake (McKenna) Rucker, Travis Rucker, Haley (Garrett) Heasley Tolivar, Leighton Young IV, Hardy Young, and May Young and 7 great-grandchildren, Sisters-in-law Carole Hobbs and Jan Young, and many nephews and nieces.

# Remembrance

## Harold Illich

**12/17/1940 – 7/15/2024**

We regret to announce the passing of **Harold Illich**, a renowned and respected geologist and geochemist. Born on December 17, 1940, in Kansas City, Missouri, Harold passed away on July 15, 2024, in Dallas. Harold's educational journey began at Arlington Heights High School in Fort Worth, followed by the University of Texas at Austin. He then pursued a Master's degree at the University of Montana. Harold's career was not just a job, but a lifelong love affair with geochemistry. His journey began at Sun Oil Company, where he made significant contributions. He continued to inspire at Oryx, GeoMark Research, and Pioneer Resources, always eager to connect with those who shared his passion. His pride in mentoring young scientists was a reflection of his dedication and love for his work.

Harold is survived by his beloved wife, Nanette, and their three children: Niles (Amanda), Karli (Hunter), and Collin (Katie). He also leaves nine cherished grandchildren: Angelica, Skylar, Dobie, Susan, Hailey, Cora, Elaine, Walter, and Corbin. Additionally, Harold will be missed by his faithful dogs, Sherlock, Murphy, and Bruno. Harold's legacy of passion for geochemistry and dedication to mentoring will be fondly remembered by all who knew him.

## Al Danforth *continued from page 44*

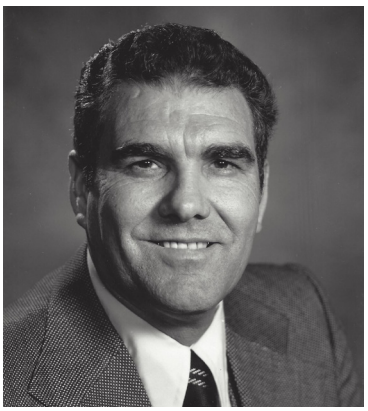
From Bill Dickson "Ray Bate and Al alternated as Chairs of the PESGB (now EGSGB) & HGS Africa Conference from its inception in 2002 through 2013 with Al chairing five conferences, as you wrote in the obituary. However, Al continued contributing as an advisor to the Technical Chair on subsequent conferences. Mark Odegard was VP and Manager of US Operations for GETECH from 1999 - March 2005 during which time Al contributed to a joint study my company did with GETECH." Al's consultancy to DIGs ran through much 1999 and into early 2000. Through the ION-GXT connection and his deep knowledge of African geology, Al contributed to the initial Ed Purdy Memorial Project, Exploration Fabric of Africa (EFAfrica.com) until late 2011 or early 2012. EFA was a joint project with AAPG and Lynx Information Systems."

From Linda Sternbach "Al Danforth was an important mentor to me while I was working Offshore Africa for Globex Energy. I was a frequent attendee to the International Explorationists Group meetings while Al was chairing the group ,and also attended the Africa Conferences he organized. Al was very popular as a leader because he was a "people person" and always interested in what other geoscientists were learning and discovering. Meetings and networking were in this life force and he enjoyed the company of other geologists working his favorite plays in Africa and conjugate margins in South America." ■

# *Remembrance*

## Jesse Thomas Perry, Jr.

**June 10, 1936 – July 17, 2024**



On the evening of July 17, 2024, **Jesse Thomas Perry, Jr.** passed away peacefully at his residence in Houston, Texas at the age of 88. Jesse was born on a small rice farm in Indian Bayou, Louisiana a small farming community about 16 miles southeast of Lafayette and where he spent his childhood. He was a star athlete and an excellent student earning All-State honors in basketball and graduating as Valedictorian at Indian Bayou High School in 1954.

Upon graduation, Jesse accepted a basketball scholarship to McNeese State College, where he was a four-year letterman and played on its 1956 NAIA Championship Team. 1958 he graduated with a B.S. in Geology and received an ROTC commission as a 2nd Lieutenant. Immediately after graduation, Jesse was assigned to the Army Signal Corps and spent his two-year tour in Fort Monmouth, NJ. After completing his service tour, Jesse returned to Louisiana and was hired as a Mud Engineer by May Brothers, a small drilling mud company in Eunice. He quickly moved up the management ranks and became district manager when his company was bought by International Mineral and Chemical Company (IMCO) and later by Halliburton. He rose within the Halliburton corporation and became the European Operations Manager stationed in England. The Mud Division of Halliburton was sold to Dresser Magcobar and became M-I Drilling Fluids, and Jesse moved back to Houston and retired several years later. He started his own company, which he maintained for several years until his final retirement.

Even in his later years, Jesse continued to play basketball. When he returned to Houston, he began playing with a team at the Houston Club in downtown Houston. In 1996, the Houston Club team won the Olympic Gold Medal in Atlanta.

Those left to mourn his passing are his wife Jan and his two sons Chan and Duane (Lisa), his sister Dorothy Fay Brown and his brothers Gerald and Byron (Carolyn), his grandchildren Jake, Brittany, Brooke, and Brina, great-grandchildren, and numerous nieces and nephews. He was a loving husband, a devoted father, and a cherished family member. He was preceded in death by his parents Jesse T. (Bebo), Sr. and Dollie Spell Perry.

There will be a Memorial Service for Jesse at the Forest Park Funeral Home on Westheimer, followed by a burial at the Indian Bayou Community Church Cemetery.

# H G S

# GOLF

## TOURNAMENT

**October 21, 2024**
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# HGS ANNUAL
# GOLF TOURNAMENT
## 21 OCTOBER 2024 | STERLING COUNTRY CLUB


# SPONSORSHIP FORM

**Sponsorship deadline: October 14, 2024**

### Title Sponsorship $2,250
- Sponsor LOGO signs on courses
- Company LOGO prominently displayed on sponsor recognition board at registration and awards banquet
- Company LOGO displayed on driving range and practice putting green signs
- Company LOGO displayed on beverage carts
- Set up on 2 holes (Meet & Greet, Swag and Food)
- Tournament entry for one team (4 people)

### Beverage Sponsorship $2,000
- **(**All beverages must be purchased from the Club)
- Sponsor LOGO on HGS website and social media
- Company LOGO prominently displayed on sponsor recognition board at registration and awards banquet
- Company LOGO displayed on beverage carts
- Set up on 2 holes (Meet & Greet, Swag and Food)
- Tournament entry for one team (4 people)

### Lunch Sponsorship $2,000
- Can BBQ onsite, bring in caterer, or have HGS pick the food
- Sponsor LOGO on HGS website and social media
- Company LOGO prominently displayed on sponsor recognition board at registration and awards banquet
- Set up on 2 holes (Meet & Greet, Swag and Food)
- Tournament entry for one team (4 people)

### Breakfast Sponsorship $500
- Breakfast Tacos
- Sponsor LOGO on HGS website and social media
- Company LOGO prominently displayed on sponsor recognition board at registration and awards banquet
- Set up on 1 holes (Meet & Greet, Swag and Food)
- 1 complimentary Registration

### Nicklaus Sponsorship $1,000
- Sponsor LOGO signs on courses
- Company LOGO prominently displayed on sponsor recognition board at registration and awards banquet
- Company LOGO displayed on driving range and practice putting green signs
- Set up on 1 hole (Meet & Greet, Swag and Food)
- 2 Complimentary Registrations

### Hogan Sponsorship $500
- Sponsor LOGO signs on courses
- Company LOGO displayed on sponsor recognition board at registration and awards banquet
- Set up on 1 hole (Meet & Greet, Swag and Food)
- 1 complimentary Registration

### Trevino Sponsorship $250
- Sponsor LOGO signs on courses.
- Company NAME displayed on sponsor recognition board at registration and awards banquet
- No Complimentary Registration

### Individual Sponsorship $150
- Sponsor LOGO on HGS website
- Company NAME displayed on sponsor recognition board at registration and awards banquet
- No Complimentary Registration

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# HGS ANNUAL
# GOLF TOURNAMENT
## 21 OCTOBER 2024 | STERLING COUNTRY CLUB


# TEAM APPLICATION

**Entry Deadline: October 16, 2024**

Come join us for golf, food, friends, and fun at the annual HGS Golf Tournament at Sterling Country Club and Houston National Golf Club ( www.sccathn.com ). There will be prizes awarded for closest to the pin and long drive, putting games before we start, as well as many great door prizes for participants.

**Entry Fee: $200.00/Golfer or $800.00/Team.**

**Pre Order:** Individual Mulligans $25ea (3), Team Mulligans $100 (12)

Raffle Tickets $10.00ea x _____

Total amount to be charged _____

Individual entries will be grouped with other individual golfers to make a foursome. Entries are limited to and will be accepted on a first-in basis.

### Schedule of Events

**8:00am - 9:45am** Registration, free use of driving range and mini games
**10:00am** Shotgun start
**3:00pm** Cash bar, open buffet
**3:30pm** Door prizes and awards presentation

**Companies or individuals interested in sponsoring the event should contact the HGS Office at office@hgs.org or 713-463-9476. If paying by check, please make check payable to HGS or Houston Geological Society. Sponsorship deadline is October 14th.**

Team Captain: _____ Phone:_____ Amount Enclosed:_____

Company: _____ Email: _____

Card Number: _____ Exp. Date:_____ CVC:_____

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| Foursome Members | Company | Phone | Email |
|---|---|---|---|
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| 4. _____ | | | |

*Please print and provide email addresses for ALL team members, as all communications will be done via email.*

# HGS
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**November 22, 2024 | 7:30AM - 1:30PM**

**Gun Raffles, Door Prizes, Lunch, Drinks & Mulligans for purchase**

**Westside Sporting Grounds**
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# HGS Membership Application

**Houston Geological Society**
**14811 St Mary's Lane Suite 250 Houston**
**TX 77079**
**Phone: (713) 463-9476**
**Email: office@hgs.org**

## Active Membership

In order to qualify for Active Membership you must have a degree in geology or an allied geoscience from an accredited college or university or, have a degree in science or engineering from an accredited college or university and have been engaged in the professional study or practice of earth science for at least 5 years. Active Members shall be entitled to vote, stand for election, and serve as an officer in the Society. Active Members pay $36.00 in dues.

## Associate Membership

Associate Members do not have a degree in geology or allied geoscience, but are engaged in the application of the earth sciences. Associate Members are not entitled to vote, stand for elections or serve as an officer in the Society. Associate Members pay $36.00 in dues.

## Student Membership

Student membership is for full-time students enrolled in geology or an allied geoscience. Student Members are not entitled to vote, stand for elections or serve as an officer in the Society. Student Member dues are currently waived (free) but applications must be filled out to its entirety. Student applicants must provide University Dean or Advisor Name to be approved for membership.

## Membership Benefits

### *Digital HGS Bulletin*

The HGS Bulletin is a high-quality journal digitally published monthly by the HGS (with the exception of July and August). The journal provides feature articles, meeting abstracts, and information about upcoming and past events. As a member of the HGS, you'll receive a digital copy of the journal on the HGS website. Membership also comes with access to the online archives,with records dating back to 1958.

### *Discount prices for meetings and short courses*

Throughout the year, the various committees of the HGS organize lunch/dinner meetings centered around technical topics of interest to the diverse membership of the organization. An average of 6 meetings a month is common for the HGS (with the exception of July and August). Short courses on a variety of topics are also planned throughout the year by the Continuing Education Committee. These meetings and courses are fantastic opportunities to keep up with technology, network, and expand your education beyond your own specialty. Prices for these events fluctuate depending on the venue and type of event; however, with membership in the HGS you ensure you will always have the opportunity to get the lowest registration fee available.

### *Networking*

The HGS is a dynamic organization, with a membership diverse in experience, education, and career specialties. As the largest local geological society, the HGS offers unprecedented opportunities to network and grow within the Gulf Coast geological community.

**Please fill out this application in its entirety to expedite the approval process to become an Active/Associate member of Houston Geological Society.**

Full Name _____ Type *(Choose one)*: Active Associate Student

Current Email *(for digital Bulletin & email newsletter)*_____

Phone _____

Preferred Address for HGS mail_____

This is my home address _____ business address _____

Employer *(required)*_____ Job Title *(required)*_____ Will you volunteer? ____ (Y/N) Committee choice: _____

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OPTIONAL Scholarship Contributions- Calvert/HGS Foundation-Undergraduate **$5.00**_____

**Total remittance**_____

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Check #_____

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Signature: _____ Date: _____

*To the Executive Board: I hereby apply for membership in the Houston Geological Society and pledge to abide by its Constitution & Bylaws.*

**Company***(required, mark 'in transition' if unemployed)*_____

**Company Address** _____

**City** *(Work)* _____ **State** *(Work)* _____ **Postal Code** *(Work)* _____

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**Year Graduated** _____

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**Years Work Experience** *(required)*_____

Please submit a brief statement regarding your work experience in the practice or application of earth science or an allied science.

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**Signature:** _____ **Date:**_____

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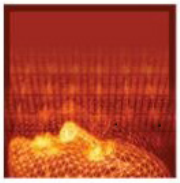

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