HGS Bulletin

Volume 67, Number 2

Houston Geological Society

OCTOBER 2024

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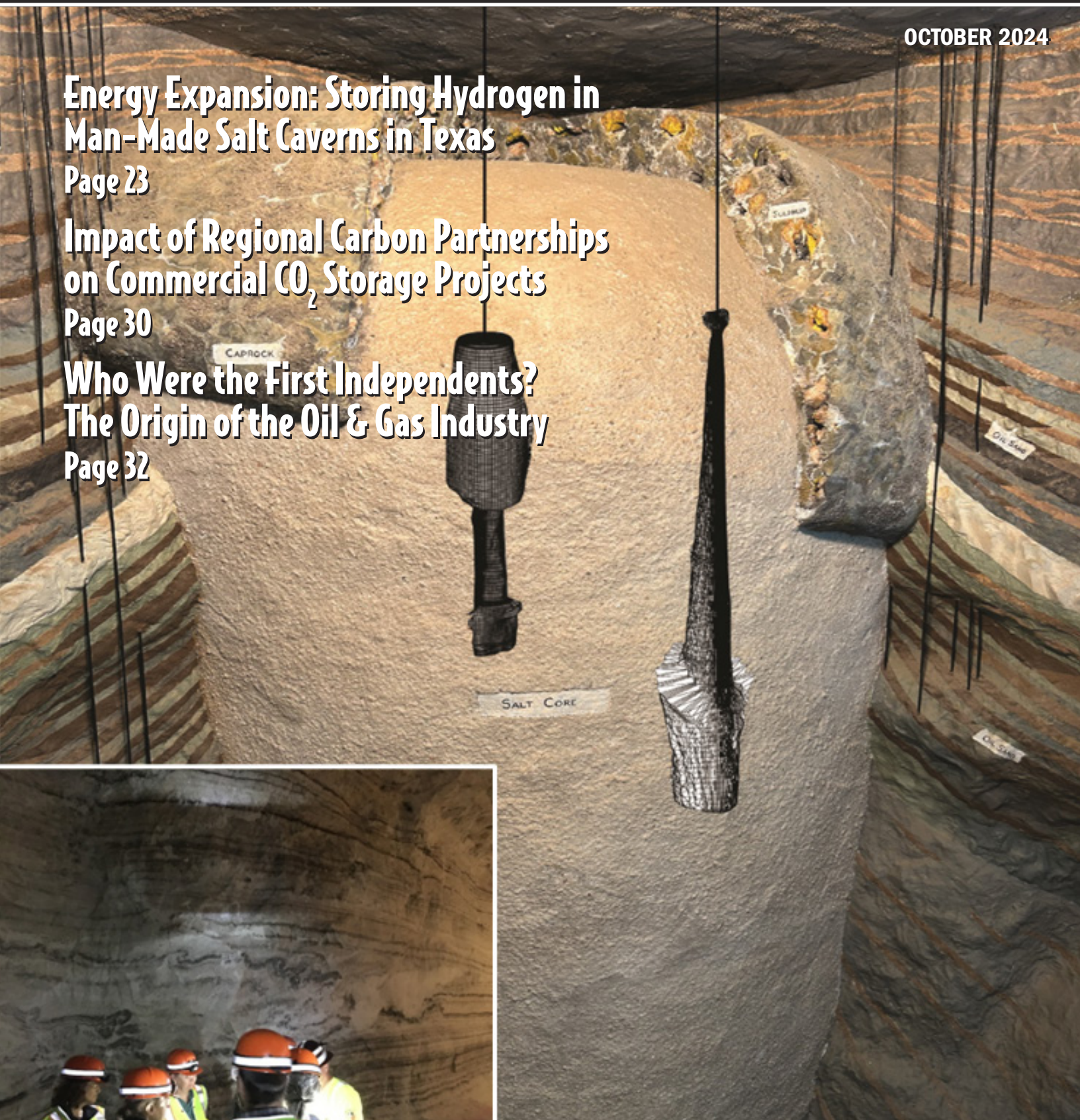

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In Every Issue

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Technical Meetings

Features

About the Cover: The cover photo is a montage of three images. The salt dome is a photo of a model of the Barber's Hill Salt Dome in Chambers County TX (designed by R. Janssen and displayed at BEG)—courtesy of Lorena Moscarelli. The additional two black and white objects placed on the modeled dome are sonar data of salt caverns acquired to monitor the shape during leaching and maintenance. The inset photo of people with hard hats is courtesy of Julie Bloxson and was taken of Silurian age salt in the mine operated by Cargill located beneath Lake Erie offshore of Cleveland OH.

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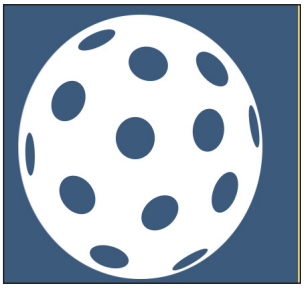

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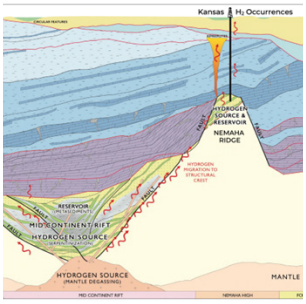

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Penny Patterson
penny70@att.net

Membership Matters

Membership Matters is not just another cliché—membership matters for all the organizations I have been involved in over the years. Membership in an organization brings together people with common interests and goals, such as improving one's 6-wicket croquet strategies, learning about care of hybrid roses, improving one's road race running times by meeting runners for Saturday morning "fun runs", learning about 1929 Essex antique car maintenance, and, of course, expanding one's geoscience knowledge through networking in several geoscience organizations. I have been a member of these eclectic organizations for many years. These organizations provide support for my hobbies, interests, goals, etc. They helped me gain knowledge and expertise in various subjects. And most importantly, they are a source of companionship and camaraderie. Membership in an organization, though, is not a one-way street. In turn, I have given back to these organizations through mentoring, assisting in social events, working on their organization's board, and giving financial contributions.

Therefore, *Membership Matters* equally applies to the Houston Geological Society. HGS was founded in 1923 as an organization that promotes geoscience advancement and integrity and, in addition, provides a networking platform for the exchange of technology, ideas, and camaraderie for our geoscience community. Although these two fundamental mission statements of promoting the advancement of geoscience and the exchange of technology sound relatively easy goals to aspire to, they do necessitate individuals in our geoscience community to join and be engaged in HGS's goals. Easy… right? Well, fundamentally, HGS is an organization of scientists who enjoy expanding their understanding of the geological world that we live in. The method to improve our knowledge is to communicate with fellow scientists. So, as an HGS member, we need you to invite a friend to become a member, and then, we need your friend to invite their friend to become a member, and so on and so forth. We also ask that HGS members who have not had the chance to renew their membership to do so this month! Yes, now! In that way, HGS will increase its membership. Through increasing HGS's membership, we will be able to broaden our depth of geoscience knowledge, expand our breadth of geoscience expertise, and improve our awareness of our earth.

HGS MEMBERSHIP BENEFITS

HGS membership brings many benefits to engage with and grow in diverse geoscience disciplines. If I had to pick my top HGS membership benefit, I would choose both the HGS *Bulletin* and the HGS website. The HGS *Bulletin* is a key resource for technical articles and timely information on geoscience events and community activities. The HGS website provides access to HGS's current and past *Bulletin*s and is the key portal for information and registration for upcoming activities in the Houston area.

HGS membership also provides a networking platform for the exchange of geoscience advancement through informative technical presentations at HGS's dinner and luncheon meetings. HGS's Engineering and Environmental Committee and the New Energies Group host monthly meetings with talks focused on their fields. On November 14, 2024, HGS will co-host a one-day seminar with the Geophysical Society of Houston (GSH) on "Lessons from Missed Opportunities and Surprise Successes". This is an outstanding event to share learnings and network with fellow geoscientists.

From the President *continued on page 7*

Ted Godo, HGS editor 2024-25
editor@hgs.org

Interviewing the Interviewers

A couple of weeks ago, on September 9th, I attended the HGS-sponsored Student Expo at the Norris Center. It was my first time at the event. There were twenty tables, each with several representatives recruiting for all oil and gas companies. The companies ranged in corporate size from major oil companies such as BP, Chevron, Exxon/Mobil, and Total, to mid-sized companies like Murphy Oil and several smaller companies. These companies interviewed students for internships and full-time employment to work on the onshore US and offshore Gulf of Mexico. The process was that companies first accepted all resumes, answered questions, and scheduled private and more in-depth interviews in adjacent rooms at scheduled times. I walked around the floor that Monday afternoon, talking with students waiting in line but focused on Interviewing the Interviewers during moments when they appeared to be on a quick break. I kept it brief, but I wanted to know things like 1) had they recruited here before, 2) why they recruited at this event, and 3) specific reasons or examples that made this venue good. I spoke with at least 10 of the 20 companies that said they had all recruited here in at least the past three years, with only one company exception.

Being your HGS editor meant I needed to open my eyes more and listen

Every company interviewed said the HGS Student Expo was the most productive venue for finding people for jobs. Specifically, several companies said that all the student candidates shared similar characteristics of being enthusiastic, well-focused, and having good questions. They also have a strong desire to explore for oil and gas. The students came to this event from states all over the US. One recruiter said they interviewed a student from a state where they were unaware that the school had a geology program. I also spoke with job-seeking students at the event. One person told me that someone in their school class saw a post on social media "from a 3rd-degree contact" that advertised the HGS Student Expo. This information got around the department, and several classmates decided to carpool to Houston because of this posting.

Also, check out the "We are the HGS" section in this *Bulletin* issue. In there, you will read about two new members, Jonathan Membrano and Austin Warren, employed at Arena Energy and received their job offers at the Student Expo. The third new member, Rachel Campbell, also was hired at the Student Expo, but it was a few years ago when AAPG ran it before HGS took it over. Remember earlier I mentioned that one of the companies was here for the first time? I followed up by asking them what motivated their company to recruit here. They smiled and said, "We were tired of the Student Expo event hiring students before this same company had a chance to interview them on campuses." They said, "That's why we're here to get them first." I am very proud that HGS sponsors this successful event that energizes and sustains our industry.

This issue features two articles on Hydrogen as an increasing resource need. As your editor, I have focused, for several decades, exclusively on hydrocarbon exploration. But now, in this role, I have found things like hydrogen and lithium exploration (the last issue) entirely new, and I have essentially no experience in these areas. I suppose I just had my "head in the sand" while focusing on what I knew, which was oil and gas exploration. This "focus" occurred despite the political debates around the speed of the energy transition. However, being your HGS editor meant I needed to open my eyes more and listen to my colleagues whose current efforts were to find new resources. The recent reports I wrote have been a kind of investigative journalism.

Frankly, writing and seeking others in these fields have energized me more than I thought because it caused me to think about different geological concepts. The learning curve for these new ideas is steep. For me, this means that my brain would be working any time of the day or while also engaged in any other activity due to my fixation, some might say, on geology. The feature article on "Hydrogen: The color spectrum" was written because of a post I read on LinkedIn. That post was from someone who had been employed for 11 years at a major oil company and posted that they were "leaving the company to explore for Orange Hydrogen." I thought to myself, this person is leaving a major oil company to explore for what?

I had no idea what orange hydrogen was. So, I began researching papers and talking to more knowledgeable people and discovered various ways of producing hydrogen (the colors) and exploring for it naturally. I thought I would write this primer to give members an overview of hydrogen production and exploration.

From the Editor *continued on page 7*

From the President continued from page 5

In addition, HGS hosts several social events, including the HGS NeoGeos group, which meets every month for fun and networking with peers; the HGS Golf Tournament, which will be held on October 21, 2024; and the HGS Sporting Clays Shoot, which will be held on November 22, 2024. Finally, HGS hosts and supports several educational programs, such as Earth Science Week, which will be held October 13 – 16, 2024, at the Houston Museum of Natural Sciences.

So, if someone asks you: What is the Houston Geological Society? Or Why should they be interested in becoming a member of HGS? I highly recommend inviting them to one of HGS's many meetings, social events, and networking opportunities and letting them "see HGS in action". Through these many venues, it is readily apparent that HGS is true to its mission statements of promoting the depth and breadth of geoscience knowledge and awareness and supporting (facilitating?) communication and engagement of all in our geoscience community.

HGS membership also provides a networking platform for the exchange of geoscience advancement through informative technical presentations

- The Student Expo, held September 9 – 10, 2024, was an extremely successful recruiting and networking event for our geoscience community. Over 300 graduate students from across the country and recruiters from 22 companies participated at the Expo. Registrations for students and companies exceeded last year's attendance. This was an outstanding opportunity to engage and connect with our future geoscientists.
- The HGS-GESGB Africa Conference, "Africa 2024: The Future in Energy, Skills, and Diversity," held on September 24-25, 2024, was an excellent networking opportunity. Over 80 attendees attended, and 28 presentations focused on current oil and gas activities in Africa and new techniques and technologies being developed in Africa.

In closing, let me repeat that *Membership Matters* to the Houston Geological Society. I encourage all our members to bring a friend or two to an HGS meeting and invite them to join HGS to help us grow our geoscience community. ■

I'm looking forward to seeing everyone at HGS events!

HGS EVENTS IN SEPTEMBER

September started in a flurry, with HGS hosting two exciting networking and informative events.

From the Editor continued from page 6

The same was true for the lithium article I wrote last month. Although I have been working the Norphlet and Smackover onshore and offshore for decades, I was unaware of the lithium richness in Smackover brine waters. These examples relate to last month's "Welcome letter," where I described a need or hunger for learning about Geology. Understanding subsurface geology, imaging with geophysics, and extracting fluids with engineering techniques are fundamental crafts that will always be needed despite changing economic or political desires. Being the best geologist I can be is my true nature; with that, I can continue to learn new things, whatever the specific needs are and be employed. Again, thank all of you for this opportunity to have opened my eyes and given me more to learn. ■

WELCOME TO NEW MEMBERS, EFFECTIVE SEPTEMBER 2024

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GEOGULF2025

NACOGDOCHES

6-8 APRIL 2025

Open call for abstracts

Open Sept 1 - Dec 1

Sessions Include:

- *Gulf Coast Geology*
- *Seismic Applications*
- *Salt Studies*
- *Lithium and Critical Minerals*
- *Haynesville, Eagle Ford & Other Shale Plays*
- *Deepwater GOM*
- *CCUS*
- *Geothermal*
- *Special Session: East Texas Basin*
- *ML, AI & Data Analysis*
- *And more*

For more information visit:

www.geogulf2025.org

Or email

Kurt.Ley@kingwoodexploration.com

Hosted by:

GSH/HGS Integrated Case Studies: Lessons from Missed Opportunities and Surprise Successes

1-day Program
Thursday, November 14, 2024, 816 Town & Country Blvd. Ste. 210, Houston, TX 77024

"Case Study Academy"

Co-Chaired by Katya Casey (GSH) and Charles Sternbach (HGS)

Morning Schedule

Networking Breakfast 7:00-7:45 am

Session 1 "Practical Paths to Informed Decisions"

- ❑ **Integration as a Key Exploration Practice-Case Studies of Missed Opportunity and Surprise Success** Jeff Lund, Portfolio Exploration LLC
- ❑ **The DHI, the "Miss," and the Discovery-Shwe Gas Complex Offshore Myanmar** Steve Cossey, Cossey & Assoc., David Kim, Total Energies
- ❑ **The Giant Appomattox Discovery-- An Overnight Success, 10+ Years in the Making!** Ted Godo, retired from Shell and Murphy Oil

Session 2 "Look Back Studies and New Ideas In Mature Areas"

- ❑ **Reducing Reservoir Image Uncertainty with Multiple Working Models.** Juan Francisco Arminio, U3 Explore Value Network
- ❑ **Can We Find New Discoveries in Proven Basins? Linking Geologic Thinking and Business Results** Brian Frost, retired, Anadarko.

Event Includes Luncheon and Two Networking Breaks, Plus Interactive Discussions led by Mike Forrest (retired, Shell), Charles Sternbach, Star Creek Energy, Brian Horn, Next Era, President-Elect AAPG, and Joe Reilly (retired Exxon) President-Elect SEG with Presidential Comments from Mihai Popovich GSH, and Penny Patterson, HGS

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Member Price	$275
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Join or Renew @ HGS or GSH

HGS/GSH Integrated Case Studies: Lessons from Missed Opportunities and Surprise Successes
Nov 14, 2024, Norris Center, Houston

Afternoon Schedule

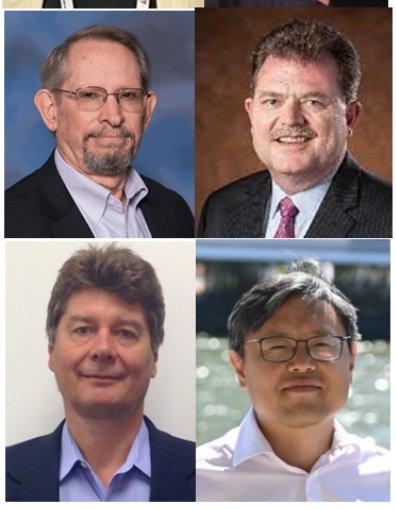
***Special Luncheon Presentation,* Jeff Nealon, Geophysics Manager, Chevron**
Advancing the Frontiers of Imaging for Exploration: GOM to the Globe

Session 3 "Petroleum System Fundamentals"

- ❑ **Plate Tectonics Controls on Continental Margins and their Differences in Petroleum System Development** Katya Casey, U3 Explore and Catie Donohue, Murphy Oil
- ❑ **Paradigm Busting- Combining Regional Seismic Data, Source Rock Observations, and Creativity to Define New Super Basins** Karyna Rodriguez, Searcher
- ❑ **Reducing Risk in Exploration Portfolios Exploration Portfolio Analysis: Lumping, Splitting, and Heuristic Pitfalls** Kevin Schofield, GEOadvisors, U3 Explore Value Network
- ❑ **Key Elements to Oil Exploration Prospect Risking – Personal Lessons From the Dark Side** Mark Shann, Westlawn

Session 4 "Geophysics in Play-Based Portfolios"

- ❑ **Accurate DHI Evaluation Requires Accurate Geological Evaluation** Rocky Roden and Henry S. Pettingill, Rose DHI Consortium
- ❑ **Ocean Bottom Nodes Acquisition Empowers Full Waveform Inversion** Denes Vigh, Schlumberger
- ❑ **Full Wavefield Inversion Case Studies on Earth Property Estimation and Subsurface Characterization** Young Ho Cha, ExxonMobil.



End-of-Day Networking Reception:
Food and Beverage 5:30 to 7:30 pm
Continuing Education Credits- 8 hrs

Welcome to the first *Case Study Academy*
"Academy: a society or institution of distinguished scholars, artists, or scientists aiming to promote and maintain standards in their field."

HGS NEOGEOS OCTOBER HAPPY HOUR

PICKLEBALL TOURNAMENT

Thursday October 17 2024

Happy Hour: 6:00 - 9:00 PM

Tournament Starts At 6:15 PM

Team Registration

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TOURNAMENT REGISTRATION

BOTH PLAYERS MUST REGISTER SEPARATELY THROUGH GOOGLE FORM (QR Code)

We Are The HGS

Rachael Campbell , HGS member since August 2024

Rachael Campbell is a new member of the HGS and is currently employed by Occidental Petroleum after first working for Anadarko in 2015. Rachael is from North Texas, northeast of Dallas, where she was born. Her family was in the energy industry, but she had her own interests, beginning with her first love, horses. Rachael is an avid equestrian who grew up traveling and competing in events. She and her younger sister were nationally ranked and represented the USA several times. For example, in 2012, Rachael traveled to London as a member of Team USA, assisting others in the Paralympics. After graduating from a large public high school, she wanted to attend a private university with smaller classes and focus on a liberal arts curriculum to satisfy her hunger for broader learning. She chose to attend SMU in Dallas and added that, "it helped that SMU was close to the stable" where she rode. At SMU, she earned a double undergraduate major in anthropology and geology. Rachael said the double major was natural because she likes "old, buried things and reconstructing ancient settings." Initially, she thought she would take more classes in the business school at SMU, but after taking an intro earth science course (a credit to her liberal arts education), she followed the often and thankfully common path to change her major to geology.

she hopes to engage further and connect with the larger Gulf Coast geoscience community

We Are The HGS *continued on page 13*

Jonathan Membreno , HGS member since March 2024

Jonathan Membreno is a new member of the HGS who was born and raised in Houston, Texas.

His family originates from El Salvador, and Jonathan often visited them as a child. El Salvador is known as the "Land of Volcanoes," these captured his interest early in his childhood. Jonathan said, "Any chance I would get in school to do projects, they would always be related to explaining volcanoes or seismic activities." The most recent eruption from the San Miguel volcano was in May 2023. Jonathan is also interested in and gifted in mathematics, enabling him to understand earthquakes/seismic activity more fully. In his hometown, the University of Houston offered him scholarships, which allowed Jonathan to focus more on his schoolwork and his passion for problem-solving. After taking petroleum geology courses, Jonathan wanted to integrate his passion for geophysics, as in seismic, into the energy industry.

He joined HGS because of the many talented individuals who helped him get to where he is today

After visiting several graduate schools, Jonathan said Rice University showed an "unparalleled" resource and commitment to academic excellence, making it an obvious choice to enroll in. Jonathan wanted to "hone in" on the energy side of geoscience at Rice. Jonathan still had time in graduate school to do a geothermal project re-quantifying the amount of geothermal potential in Ahuachapán, El Salvador. He was able to extensively work on traditional oil and gas concepts, carbon capture utilization and storage, and geothermal energy. In carbon capture, Jonathan was able to jointly work with Dr. Hon-Chung Lau on Geologic CO_2 storage in the Gulf of Mexico on a research paper.

We Are The HGS *continued on page 13*

Austin Warren, HGS member since April 2024

Austin Warren was born in Madrid, Spain, while his parents worked on an overseas assignment.

When Austin was 5 years old, the family moved back to the US to Minnesota, where he spent his childhood through high school. Austin loved to be outside no matter what he was doing. Still, Minnesota only had comfortable temperatures for about four to five months before sub-zero temperatures and snow precluded many of his outdoor activities. Austin was an excellent baseball player in high school and was even recruited by Texas A&M Corpus-Christi (TAMUCC). More about that school later. But living in Minnesota in the winter still didn't stop Austin from enjoying the outdoors. He would ice fish, ski, drive trucks on the frozen lakes, build igloos, and have bonfires.

Austin joined HGS for the networking and career building exposure

We Are The HGS *continued on page 13*

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 12

(Rachael Campbell continued from page 12) While she was earning her BSc and MSc degrees in geology, she interned for three summers with Hunt Oil Company in Dallas. She worked on projects in the lower 48 states and international basins. Rachael was offered a full-time position at graduation but received an internship offer from Anadarko from the Student Expo. She declined Hunt's offer and took the internship with Anadarko to "see what Houston had to offer in terms of opportunity and technical training." After her internship with Anadarko, they offered her a full-time position and then moved to Oxy after the consolidation of the two companies. I asked Rachel, "Why did you join HGS, and what would you like to gain from your membership." She responded that with her HGS membership, she hopes to engage further and connect with the larger Gulf Coast geoscience community. She went further and said that HGS offers opportunities to meet technical professionals, exchange ideas, and grow her network. I say welcome, Rachael it's good to have you with us. ■

(Jonathan Membreno continued from page 12) During the summer of 2023, Jonathan interned with Shell Oil in Houston in a deep-water imaging department. When asked what he enjoyed most as an intern at Shell, he answered that it was meeting and learning from some of the most brilliant individuals. They helped him learn some difficult concepts and how others think about problem-solving.

In January of this year, Jonathan entered the profession with a position at Arena Energy in The Woodlands. Jonathan connected with Arena through the annual HGS student expo, which connects various companies and graduate students. At Arena Energy, his job is to look for new prospects or opportunities for our company to grow. Jonathan said developing new ideas and problem-solving also makes the job fun. He joined HGS because of the many talented individuals who helped him get to where he is today, and the sense of community is so important. Jonathan is also on the HGS-Student Expo Committee now. They were instrumental in my transition from academic to professional, I hope to do the same with future students. I'm hopeful to give "ten times" back to the community. ■

(Austin Warren continued from page 12) It's a funny story about how he got his nickname "Audie" from his grandfather. The story goes that one day, he and his younger brother were outside building a fort. While creating it, Austin's little brother stepped on a hornet's nest, and both took off running. Austin was in the lead but soon sensed his brother was not behind him. It turns out that his brother, allergic to bee stings, had been stung and lying on the ground. Austin immediately turned back to get him and picked him up, carrying him home to get an Epi-pen. When Austin's grandfather heard the story, he jokingly said it sounded much like how Audie Murphy got his Medal of Honor in World War II. So, from then on, he was known as Audi.

After high school, Austin enrolled in college at the University of Arizona. Initially declaring a business major, he found the classes to be uninteresting. His father was in the international oil and gas business, and Austin thought that might be a more interesting job. So, in his sophomore year at Arizona, he took an introductory geology course to satisfy a general education requirement. His professor in this class was a geologist and an inspiring teacher. Austin said, "he had one of the coolest careers I could imagine." He decided to change his major in Arizona, but they told him he would have to "repeat my first and second year to apply to the geology school in my junior year". So, he decided to transfer to a college where he could continue his geology study. Remember the baseball recruiter from TAMUCC? Through connections from high school, he visited TAMUCC and then enrolled to complete his BS in geology.

After graduation, Austin wanted to get a geologist job, but opportunities in Corpus Christi were limited, and most employers required a master's degree. Austin wanted to get to work, so he became a mud logger for "DataLog" and worked in West Texas and New Mexico for about seven months. He decided to get his master's degree in geology, and he enrolled at Rice University. At Rice, Austin was captain of the school's participation in AAPG's Imperial Barrel contest. While at Rice, he also had a summer internship with AMNI, gaining more experience. While in Houston, Austin participated in the HGS Student Expo, where he interviewed with and was hired by Arena Energy, where he now works. When asked what he enjoys most about his work, Austin answered, "it's a lot like treasure hunting" … "It's exhilarating the feeling you get when you find a prospect in a region that a previous operator missed." Austin joined HGS for the networking and career building exposure gained in education, though courses, and seminars hosted by HGS. ■

The Color Spectrum of Hydrogen Production

By Ted Godo

Hydrogen, a pivotal element in the energy transition, is gaining significant attention for its potential as a clean energy source. Traditionally, fossil fuels (coal and gas) have been the primary sources of hydrogen production, powering the electrolysis of water molecules to separate them into hydrogen and oxygen. In this article, we will explore various methods of hydrogen extraction, paving the way for a cleaner, more sustainable energy future.

Hydrogen is an invisible gas. Combustion of it does not create carbon emissions. Hydrogen is produced today by different processes. Nicknames are given to this invisible gas, which is tied explicitly to the processes by which it is formed: green hydrogen, blue hydrogen, brown hydrogen, yellow hydrogen, turquoise hydrogen, and pink hydrogen. The color names of hydrogen are used within the energy industry to differentiate between how the hydrogen is produced. However, there is no visible difference between the different types of hydrogen. There is no universal naming convention either; the color definitions may change over time and even between countries. However, hydrogen's end uses and properties are interchangeable across all types. In the future, some hydrogen colors will lessen in importance while others will become more important while looking for greener alternatives to reduce dependence on fossil fuels. At the end of 2021, nearly 47% of global hydrogen is produced from natural gas, 27% from coal, 22% from oil, and only 4% from electrolysis (GlobalData). According to the International Energy Agency (IEA), the low-carbon hydrogen database currently has approximately 2,296 hydrogen plants supporting the transition to renewable hydrogen. Green hydrogen accounts for 90% of these plants, blue hydrogen amounts to 8%, while turquoise and pink are third and fourth place, at 1%, from 20 and 19 plants, respectively (GlobalData). Next, a brief description will be given, summarizing the colors ascribed to different types of hydrogen production.

Green hydrogen is the most widely discussed type of hydrogen and is produced using electricity from surplus renewable energy sources like solar or wind power. This process, known as electrolysis, splits water into its hydrogen and oxygen components, emitting zero-carbon dioxide. While producing green hydrogen is expensive, it is a significant step towards a sustainable energy future. Green hydrogen is carbon neutral and eligible for production tax credits passed in the Inflation Reduction Act. When green hydrogen is explicitly produced through solar energy, it is sometimes called yellow hydrogen.

Pink hydrogen is produced using nuclear energy also through an electrolysis process. Nuclear-produced hydrogen can also be referred to as purple hydrogen or red hydrogen.

Turquoise hydrogen is a newer color with a newer production process, proven only in pilot or test cases. Hydrogen is produced by using methane pyrolysis to produce hydrogen and solid carbon. In the future, turquoise hydrogen may be valued as low-emissions hydrogen if the carbon can be stored permanently or used. It also depends on qualifying as low emission if the powered thermal process uses renewable energy.

Gray hydrogen is currently the most common form of hydrogen production. Natural gas or methane is heated with steam and in the presence of a catalytic material, splitting it into hydrogen and CO_2, which is not captured in the process. Blue hydrogen is

The Color Spectrum of Hydrogen *continued on page 16*

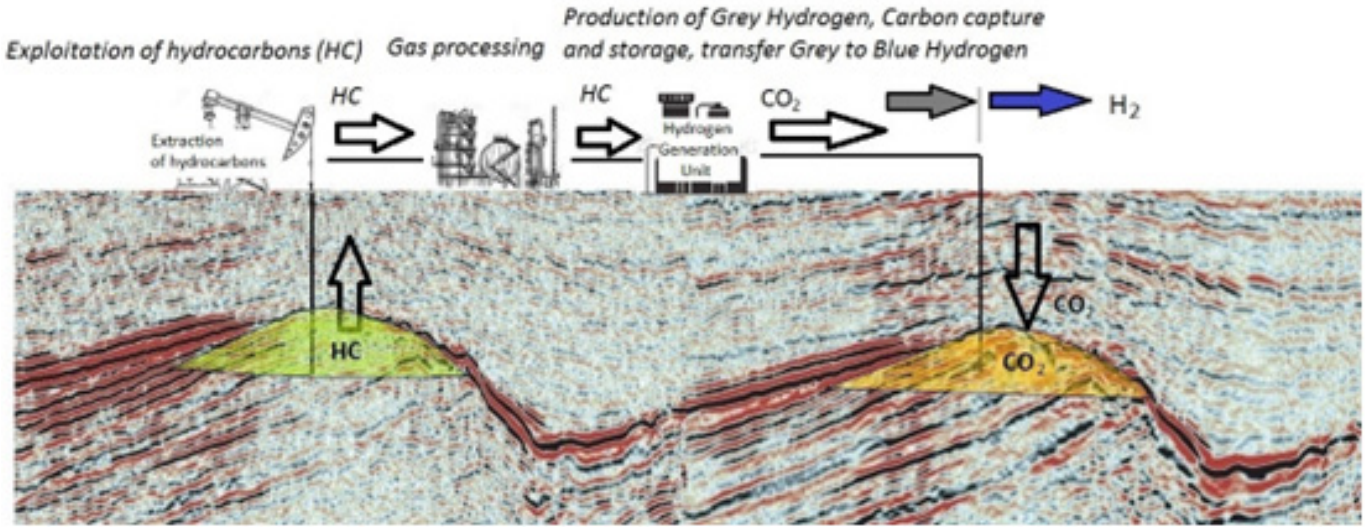

Figure 1 *Figure taken from EFG 2021, Schmatic of hydrogen production from hydrocarbons, in conjunction with carbon capture and storage: transfer of grey hydrogen to blue hydrogen.*

The Color Spectrum of Hydrogen continued from page 15

essentially made the same way, but the CO_2 is captured in gaseous form and stored, making it a low-emissions type of hydrogen (**Figure 1**). It is eligible for some types of IRA tax credits and is also described by some as 'low-carbon hydrogen'. Blue hydrogen is uneconomical and only works with CCUS tax credits.

Brown and Black hydrogen use fossil fuels through gasification to power the process of extracting hydrogen. Brown hydrogen burns lignite, while black hydrogen burns coal. Black and Brown hydrogen are made using the opposite process of green hydrogen in the color spectrum.

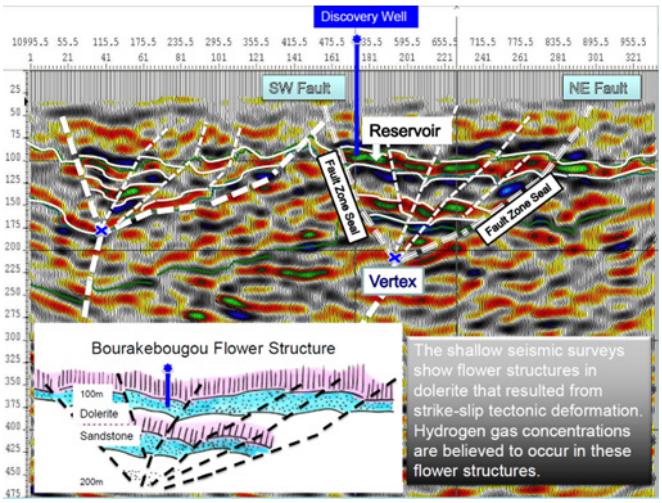

Figure 2 *Figure taken from Briere, 2017 slide #5. Interpreted strike-slip "flower structures"*

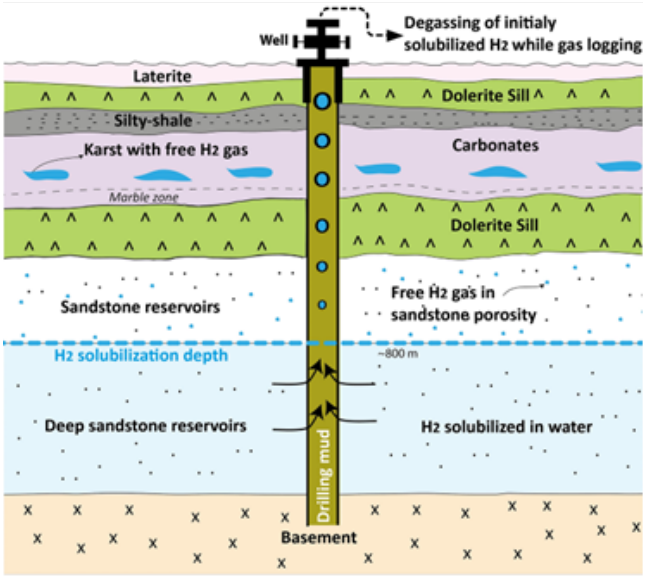

Figure 3 *Synthetic diagram showing the presence of a free gas phase in the uppermost carbonate and samdstone reservoirs, with the gas mostly dissolved at depth, especially in the deeper sandstone reservoirs, then degassed in the rising drilling fluids. It also shows the dolerite intrusions and marble location. (Maiga 2023; figure 9)*

White hydrogen, also called gold hydrogen, is naturally occurring and not produced in a lab or through other industry processes. White hydrogen is hydrogen extracted naturally from underground sources. Much less is known about exploring natural hydrogen than exploring for gold or diamond mining or oil and gas. Many more likely places for natural (white) hydrogen are thought to be too deep, too hot, or in too deep of water. Some additional natural hydrocarbon sources would include 1) volcanic activity, 2) hydrothermal vents, 3) serpentinization of ultramafic rocks like olivine and pyroxene, and 4) conventional oil and gas generation. The naturally occurring "white hydrogen has a big cost advantage over other ways of extraction. Recent work by Rystad Energy reports that as of 2023, 40 companies were searching for natural hydrogen deposits, up from 10 companies in 2020" (RystadEnergy, 2024).

The famous "accidental" discovery of natural hydrogen occurred 37 years ago, in 1987, in the village of Bourakebougou, Mali. A water well was drilled while an engineer lit a cigarette near the well. This caused a small explosion, revealing that the well produced nearly pure hydrogen. Since 2012, hydrogen has been purposely produced here, capturing 50,000 cubic feet per day. The hydrogen percentage is high at 96% (Moretti, 2021). The fuel generates power for a small turbine producing electricity for the village's 1500 inhabitants. This natural occurrence is geologically located in the Taoudeni Basin. This discovery has led to the additional drilling of 24 more boreholes by Hydroma. Most wells are as shallow as 100 meters in Proterozoic-aged carbonate reservoirs covered by dolerite sills (**Figure 2**) (Briere, 2017; Maiga, 2023). Deeper sandstone reservoirs have also been identified (**Figure 3**). A free gas phase may be present in the deeper sandstones. However, at shallower depths, hydrogen separates and is more concentrated, especially in the pockets of the karstic carbonate horizons where it is produced. In determining where the hydrogen is generated, iron oxidation is an important process in producing natural hydrogen. Iron is oxidized in the presence of serpentine and antigorite in the deeper dolomitic and sandstones. This raises the question of whether hydrogen generation occurs at depth in these lithologies. (Maiga, 2023).

In the United States, natural hydrogen is found in and around the McCauley field in Arizona and along the Nemaha ridge in Kansas and Nebraska. McCauley field, located in the Holbrook Basin in Arizona, has long been associated with Helium production. However, some wells have shown enough hydrogen to power local needs in the field for both Helium and Hydrogen production. Desert Mountain is the company leading the efforts in this basin. The Nemaha Ridge is an extensive buried structural ridge of pre-Cambrian basement extending from Omaha, Nebraska, south into Oklahoma (**Figure 4**). A company named HyTerra is actively exploring natural hydrogen production. HyTerra has

The Color Spectrum of Hydrogen *continued on page 17*

The Color Spectrum of Hydrogen continued from page 16

two projects on the Nemaha Ridge in Kansas (project Nemaha) and Nebraska (project Geneva). In Kansas (project Nemaha), HyTerra's groundwork studies report more than 10 historical occurrences with up to 92% hydrogen and 3% helium in wells. They have drilled their own wells recently in Kansas and have reported a concentration in wells around 50% hydrogen (Evans, 2024). Helium is also a prospective element to be produced along the Nemaha ridge. In Nebraska (project Geneva) HyTerra's Hoarty NE3 well was recently drilled to 11,200 feet and flared hydrogen gas with flow testing beginning in 2023 (Evans, 2024).

Orange hydrogen is the new "green" form of energy. It explores natural hydrogen (white) and combines it with carbon sequestration. Orange hydrogen was named after a process developed by the CNRS (French National Centre for Scientific Research). Producing orange hydrogen requires finding an iron-rich permeable reservoir. Orange hydrogen is formed by pumping a CO_2-enriched water solution into reactive, iron-rich rock formations (**Figure 5**). Geochemical reactions quickly precipitate solid carbonates and hydrogen gases when the CO_2 solution interacts with iron, magnesium, and calcium oxide under sufficient geothermal heat and pressure. The color refers to the solution color of oxidized iron. The key impact of orange hydrogen exploration is that the same formation that naturally produces hydrogen can also be used for carbon sequestration.

One company, Csiro, focuses on "understanding the stimulated hydrogen generation induced by geochemical reactions between CO_2-saturated water and mafic/ultramafic rocks through experimental studies at high-pressure, high-temperature conditions and sophisticated geochemical modeling techniques." (Csiro website). Orange hydrogen requires more energy than White hydrogen production, but the outputs should be significantly higher, while production costs may likely remain under Blue/Green ones (Osselin, 2022).

To summarize, there are many processes to extract and explore for hydrogen. Several "colors" describe these various processes. Gray hydrogen is the most common color of hydrogen production, accounting for over half of global production. Green and blue are the next most common, but they all extract hydrogen from split water via electrolysis. Only White or Orange color looks for naturally occurring hydrogen, while the orange method involves carbon sequestration. ■

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The Color Spectrum of Hydrogen *continued on page 18*

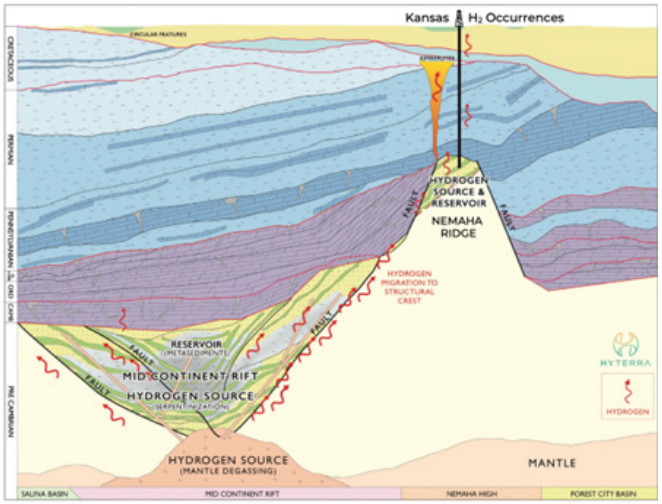

Figure 4 *The Nemaha is part of a range of the ancestral Rocky Mountains in eastern Kansas. The current elevation differences from the Precambrian basement to the remnant ridge peaks are 2300 to 3300 feet. During the Pennsylvanian time, easter Kansas might have appeared as the Rocky Mountain front range. The Hy dro gen and Helium source may be the interaction of the matle degassing and the Preterozoic metasediments on the west side of the ridge. Figure taken from Evans, 2024 (Hyterra)*

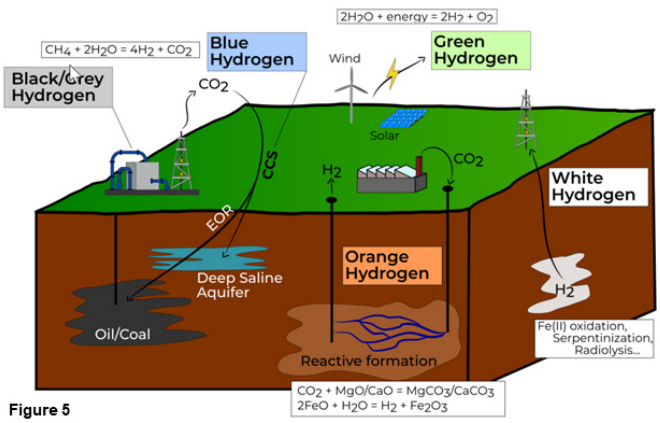

Figure 5

Figure 5 *The different colors of Hydrogen. Black/grey H_2 is from steam reforming. It turns Blue by adding CCS through permanent storage (e.g., deep saline aquifers) or enhanced Oil Recovery(EOR). On the other end of the spectrum, Green hydrogen is produce by electrolysis using renewable energies. White hydrogen corresponds to the exploitation of subsurface-sourced natural hydrogen. Orange hydrogen is a proactive take on White hydrogen, injecting a carbib-enriched solution in a reactive formation. Geochemical reactions lead to the precipitation of solid carbonates while hydrogen is formed and recovered from the fluid. (This is Figure 1 Osselin, 2022)*

The Color Spectrum of Hydrogen continued from page 17

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The Houston Geological Society Continuing Education Committee Presents

Practical Aspects of Core Analysis

Dr. Alfonso Quaglia
Thursday, October 24, 2024, 8:00am – 4:00pm
Sponsored by Stratum Reservoir
5200 North Sam Houston Parkway West, Suite 500, Houston, Texas 7708
Attendees will receive a Certificate of Continuing Education for 7 PDH

COURSE DESCRIPTION

This course is designed for energy industry professionals, including physical geoscientists, production geologists, operational geologists, reservoir engineers, petrophysicists, log analysts, sedimentologists, drilling engineers and geophysicists, etc. It focuses on a comprehensive overview of the applications of core analysis in petrophysical interpretation and reservoir characterization. It aims to reduce uncertainties in reservoir data by providing representative in-situ information. The course covers theoretical concepts and practical exercises, emphasizing the importance of core acquisition protocols, handling, and corresponding analyses according to the purpose of the investigation. The course combines practical exercises, case studies, and short group discussions to provide a comprehensive learning experience and the opportunity to improve your understanding of core analysis techniques and their applications. Upon completion, each participant will have mastered fundamental concepts of the practical aspects of core analysis, thus contributing to more accurate reservoir evaluations and more informed decision-making.

PRICING

$250.00 for HGS Members
$140.00 Emeritus
$75.00 Student/In Transition
$350 Non-Members or
Non-Members can submit an application and pay their dues before registering to get the member price. Please call the HGS office at 713-463-9476 to be registered only AFTER your application and dues are submitted.

Highlights of Key Learnings are:

- A better understanding of the value of core analysis in reservoir studies.
- Learning about core preservation techniques to minimize rock alteration.
- Consider best practices for sample preparation in routine core analysis (porosity, permeability, saturation).
- Gaining knowledge of special core analysis and the most important applications in reservoir characterization (relative permeability, wettability, capillary pressure).
- Identify some uncertainties in the core analysis process.

Case Studies and Discussions:

- Porosity variability caused by core sampling and handling.
- Representativeness of water saturation measurement.

Registration closes Tuesday, October 15, 2024 at 1:00 pm.
Register online www.hgs.org
(https://www.hgs.org/civicrm/event/info?id=2605)
or call 713-463-9476

BIOGRAPHICAL SKETCH

Dr Quaglia has taught several topics and courses in Geosciences, Petrophysics, Subsurface Integration and Petroleum Engineering Departments for several Universities (University of Houston, University of PATAGONIA Argentina, University GRM Santa Cruz Bolivia, UDO, UCV, ULA, LUZ Venezuela) for undergraduate and graduate courses, advising numerous Theses; as well as Oil & Gas Important companies (REPSOL, PEMEX, PDVSA, CHEVRON, Quantum Management Resources, Lewis Energy, SHELL, PLUSPETROL, VAPA, etc…) in LATAM and USA.

Education: 1991 – Geological Engineering with a Minor in Hydraulic Resources. Universidad de Oriente, Núcleo de Bolivar, Venezuela; 1999 – Diploma. Petrophysics & Subsurface Integration. Tulsa Technology Center – BP/AMOCO, OK. United States of America; 2018 – Master Sc Geology and Mineralogy. Sebastian Francisco de Miranda International University. Venezuela; 2021 – PhD Higher Education. Formation Evaluation Research Line. Consortium: Cambridge International University. Spain. Email: quagliaa@inter-rock-ca.com

Professional Affiliations: SPE, SPWLA, SCA, HGS, VAPA, SVG. Publications: 40+ publications including articles in Geosciences, Petrophysics, Subsurface Integration, Environmental Engineering, Rock Physics and Characterization of Conventional and Unconventional Reservoirs.

The Houston Geological Society Continuing Education Committee Presents

Prospect Evaluation Methods for Seismic DHIs

Henry Pettingill and Rocky Roden
January 23, 2025, 8:00am – 5:00pm
Core Lab, Building 2, 6323 Windfern, Houston, TX 77040
Attendees will receive a Certificate of Continuing Education for 8 PDH and digital course notes

COURSE DESCRIPTION

One-day survey class covering all aspects of evaluating exploration prospects supported by seismic anomalies known as Direct Hydrocarbon Indicators (DHIs). The class is shortened from a longer version taught to Members of the Consortium and has the proprietary Consortium content removed.

- The class has a strong practical orientation and uses actual prospects and realistic exercises to illustrate the applications of the various concepts and analytical procedures used in the technical evaluation and investment decision process of DHI-supported prospects.
- The course leverages over 20 years of learnings and workflow developments that have emerged from the Rose and Associates' DHI Interpretation and Risk Analysis Consortium.
- The course also gives the participants a global context of DHI-driven exploration, including analog learnings from the Consortium's 390-well calibration database.
- After taking this course, participants will have familiarity with all concepts and techniques in the risk and resource evaluation of DHI prospects.

PRICING

$280 for HGS Members
$140.00 Emeritus
$50 Student/In Transition
$350 Non-Members or
Non-Members can submit an application and pay their dues before registering to get the member price. Please call the HGS office at 713-463-9476 to be registered only AFTER your application and dues are submitted.

WHO SHOULD ATTEND

Geoscientists, engineers, and managers involved with evaluating exploration opportunities in seismic DHIs.
The course work assumes the participant has a basic working knowledge of subsurface Exploration concepts.

For more information on the Rose and Associates DHI Consortium, visit https://www.roseassoc.com/dhi-consortium.

BIOGRAPHICAL SKETCHES

Henry S. Pettingill (Principal Consultant and DHI Consortium Chairman) is a Petroleum Geologist and Exploration Manager who has been in the oil and gas industry since 1983. He joined Rose and Associates in 2018 after 16 years with Noble Energy Inc., where he finished his career as Chief Geoscientist. Prior to that, he served as Director of Business Innovation from 2013-2015, and as Director of Exploration Technology from 2002-2013. His responsibilities included overseeing the Global Exploration Portfolio, Risk Analysis, Geoscience Technology, and Staff Development. Prior to joining Noble, he held various technical and managerial positions within Repsol and Shell. His assignments have focused on Deepwater Exploration and Appraisal, International Exploration/ New Ventures, Exploration Risk Analysis, and Portfolio Management. Henry has authored over 100 conference presentations and technical papers, and has taught classes in Exploration Risk Analysis, Creativity and Innovation for E&P Organizations, and a Deep Water Clastics field trip in the Spanish Pyrenees. In 2017, he was recognized by AAPG as one of the industry's "100 Explorationists Who Made a Difference."

Mr. Pettingill holds a BA degree from the University of Rochester and an MSc degree from Virginia Tech (USA). He is an AAPG Certified Petroleum Geologist and an active member of AAPG, SEG, and SPE. He is a Trustee Associate of the SEG and AAPG Foundations. Pettingill is chairman of Rose & Associates' DHI Consortium. **Continuing Education** *continued on page 20*

January 23, 2025, 8:00am – 5:00pm • Core Lab, Building 2, 6323 Windfern, Houston, TX 77040
Please make your reservations online https://www.hgs.org/civicrm/event/info?id=2607
For more information about this event, contact HGS Office 713-463-9476 • office@hgs.org

Continuing Education continued from page 20

He serves on the Advisory Board of Virginia Tech Department of Geosciences.

Rocky Roden has owned his own consulting company, Rocky Ridge Resources, Inc., for the last eighteen years and works with numerous oil companies around the world on interpretation technical issues, prospect generation, risk analysis evaluations, and reserve/resource calculations. He has authored or co-authored over 40 technical publications on various aspects of seismic interpretation, AVO analysis, amplitude risk assessment, and geoscience machine learning. He has over 45 years in the industry as a Geophysicist, Exploration/Development Manager, Director of Applied Technology, and Chief Geophysicist.

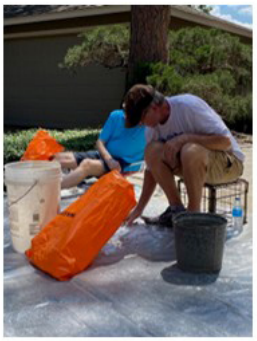
He has been a principal in the Rose and Associates DHI Risk Analysis Consortium since 2001. He works with Geophysical Insights on the integration of advanced geophysical technology in machine learning software applications. He is a proven oil finder with extensive knowledge of modern geoscience technical approaches (past Chairman, The Leading Edge Editorial Board). As Chief Geophysicist and Director of Applied Technology for Repsol-YPF (retired 2001), his role comprised advising corporate officers, geoscientists, and managers on interpretation, strategy and technical analysis for exploration and development in offices in U.S., Argentina, Spain, Egypt, Bolivia, Ecuador, Peru, Brazil, Venezuela, Malaysia, and Indonesia.

He has been involved in the technical and economic evaluation of Gulf of Mexico lease sales, farmouts worldwide, and bid rounds in South America, Europe, and the Far East. Previous work experience includes exploration and development at Maxus Energy, Pogo Producing, Decca Survey, and Texaco. He holds a BS in Oceanographic Technology-Geology from Lamar University and a MS in Geological and Geophysical Oceanography from Texas A&M University.

Salt Rock Party

On Saturday, September 21, the HGS Held the Annual Salt Rock Party at Janet Combes' Home.

Janet had Chuck Caughey pick up nine "potato sack-sized" bags of Jurassic-aged Louann salt rocks donated by the United Salt Corporation from their mine in the Hockley Salt Dome. Several volunteers, in addition to Janet, included Marsha Bourque, Ted Godo, Ken Green, Barbara Hill, Jim Tucker, and Gregg Zelewski. The team broke the large rock samples into smaller hand samples. Then, it labeled and bagged them for handouts to students and teachers at multiple outreach events, such as the Earth Science Week celebration at the museum, the Houston Gem and Mineral Show (HGMS), and scouting events. The volunteers enjoyed working with the rocks, visiting each other, and watching the squirrel acrobatics.



HGS is very thankful to the United Salt Corporation and the many volunteers who give away Jurassic-aged salt to younger people to excite their interest in geology.

Houston Geological Society

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Energy Expansion: Storing Hydrogen in Man-Made Salt Caverns in Texas

By Lorena Moscardelli, Lucy Ko, Edna Rodriguez-Calzado, C. Nur Schuba, Ander Martínez-Doñate, Leandro Melani, Leopoldo Ruiz-Maraggi, Ning Lin, and Mark Shuster
Bureau of Economic Geology, Jackson School of Geosciences
The University of Texas at Austin

ABSTRACT

The world needs energy while decarbonizing energy systems to reduce atmospheric carbon dioxide (CO2) emissions. Low-carbon natural gas- and renewable-derived hydrogen (H2) can help society diversify energy sources. Currently, hydrogen has various uses, notably refining petroleum and producing fertilizers. It is feasible to utilize hydrogen to power vehicles through fuel cells, generate electricity, power industrial processes, and provide heating for residential and commercial properties. As the hydrogen economy is still nascent, developing successful hydrogen value chains is crucial for achieving our decarbonization goals.

Several elements within this burgeoning hydrogen economy rely on subsurface resources—from accessing natural gas and water as feedstocks to exploring natural sources of hydrogen. Yet one of the most vital components within a hydrogen value chain is large-scale storage. Geological storage, especially in salt formations, offers higher capacity storage at lower cost compared to other options. This work discusses various options available for the geological storage of hydrogen with an emphasis on aspects related to utilizing salt formations. We also emphasize that geoscience expertise is not just relevant, but crucial for many years to come as part of current efforts linked to the low-carbon energy expansion.

INTRODUCTION

The world needs energy; however, it is also imperative to decarbonize our energy systems. The hydrogen molecule (H2) can help society decarbonize energy sources. Currently, hydrogen has various uses, notably refining petroleum and producing fertilizers. It is feasible to utilize hydrogen to power vehicles through fuel cells, generate electricity, power industrial processes, and provide heating for residential and commercial properties. The strategic adoption of hydrogen for decarbonization purposes could significantly reduce atmospheric carbon dioxide emissions (CO2), especially for hard-to-abate sectors. These industries engage in processes that are highly energy-intensive including steel and chemical production, cement manufacturing, refining, and heavy-duty transport. The urgency of reducing greenhouse emissions is clear, and hydrogen has an important role to play toward the achievement of this goal. Nonetheless, while the new hydrogen economy is still nascent, developing successful hydrogen value chains requires significant infrastructure expansion to achieve our decarbonization goals (Fig. 1).

Several elements within this burgeoning hydrogen economy rely on subsurface resources—from accessing natural gas and water as feedstocks to exploring natural sources of hydrogen (Hand, 2023). Yet one of the most vital components within a hydrogen value chain is large-scale storage; although multiple mechanisms exist for storing hydrogen, geological storage remains the sole method enabling bulk power management—defined as delivering gigawatt-scale power over discharge periods ranging from days to months (Matos et al., 2019). This study will explore various options available for the geological storage of hydrogen with an emphasis on aspects related to utilizing salt formations (Fig. 1).

GEOLOGICAL STORAGE OF HYDROGEN

There is limited experience with storing hydrogen as a component of "town gas," a mixture of several gases that might include methane and hydrogen. Town gas containing 50% hydrogen was stored in a saline aquifer in Beyens, France, with a capacity of 385 million standard cubic meters (st-m^3) between 1956 and 1972. However, intense bacterial activity degraded the hydrogen via methanogenic reactions (Tarkowski, 2019). The biodegradation of hydrogen within porous media is one of many challenges

Energy Expansion: Storing Hydrogen *continued on page 24*

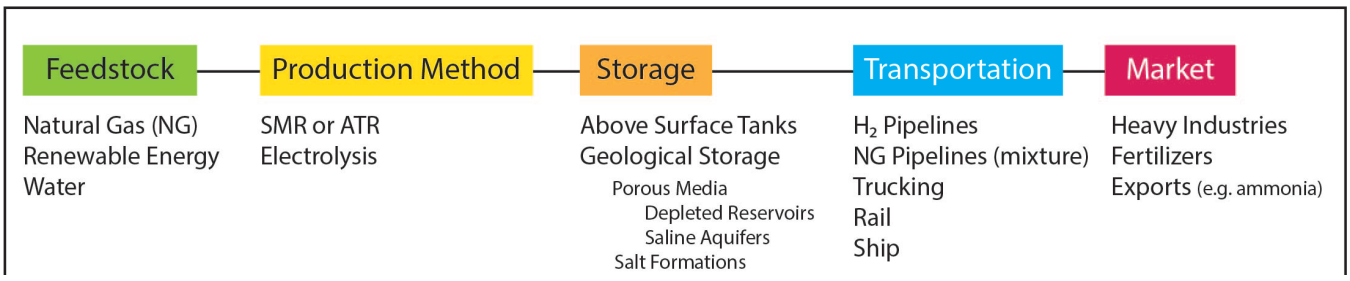

Figure 1. *Simplified version of H_2 value chain. Several elements of the H2 value chain will require geoscience expertise including but not limited to natural gas exploration and production, aquifer studies, characterization of porous media and salt formations, etc. SMR: Steam methane reforming, ATR: Autothermal methane reforming.*

Energy Expansion: Storing Hydrogen continued from page 23

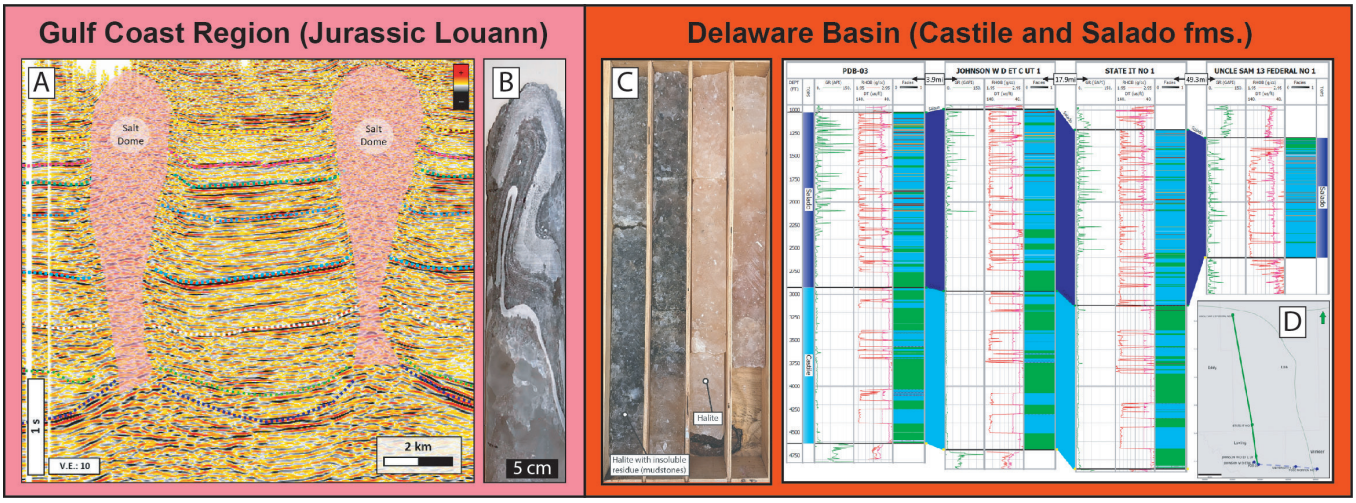

Figure 2.. *A) Seismic line showcasing salt domes in the Mississippi Salt Basin, notice the challenges associated with imaging intra-salt structures, B) salt core from the Vacherie salt dome, notice that halite is deformed and not homogeneous with different colorations and crystallization intensities, C) salt core from the Salado Formation, notice heterogeneity in terms of colors and textures, D) well cross section in the Delaware Basin correlating bedded salt units from the Castile and Salado formations (Modified from Schuba and Moscardelli, 2023; Martínez-Doñate et al., 2023; and Melani et al., in prep.)*

associated with storing this gas in saline aquifers and/or depleted reservoirs, and this remains a very active area of research today.

In contrast, hydrogen has been successfully stored in salt caverns for decades; however, its application for decarbonization purposes remains an unproven concept given that there is need for 1) significant upscaling of hydrogen storage capacities (Shuster et al., 2021), 2) management of high-frequency injection and withdrawal cycles (Ruiz-Maraggi and Moscardelli, 2023), and 3) improved salt formation characterization given the unique properties of the hydrogen molecule (Duffy et al., 2023). Additionally, not all salt formations (a.k.a. evaporitic sequences) are created equal. Bedded salt formations, such as the Castile and Salado formations in the Permian Basin of West Texas (Martínez-Doñate et al., 2023), present very different characteristics in terms of stratal architecture, internal structures, and mineralogical composition compared to domal salt formations, such as the Jurassic Louann salt domes in the Gulf Coast region (Schuba and Moscardelli, 2023) (**Figure 2**).

There are four facilities where hydrogen has been strategically stored by the refining and petrochemical industry (see **Table 1**). The nature of the storage is strategic because cycling operations are infrequent, and reserves are only accessed when there are hydrogen supply disruptions to the industrial facilities. Public access to operational data and other details regarding infrastructure, design, and subsurface conditions of the caverns in the Gulf Coast facilities is very limited. However, Passaris et al. (2018) provided some insights into the architecture and characteristics of the Teeside facility, where three caverns were originally developed by the British company ICI and are currently operated by SABIK UK Petrochemicals Ltd., supporting hydrogen distribution to chemical plants in the Teeside chemical complex.

HYDROGEN, SALT CAVERNS, AND TEXAS

Man-made salt caverns are created via solution mining. During this process, a well is drilled into the salt formation, and freshwater is injected to dissolve the salt while the resulting brine is produced. The produced brine can be used as a feedstock for the chemical industry (e.g., the chlor-alkali process produces chlorine, caustic soda, and H_2 as a by-product); however, disposal wells are often drilled to inject the brine back into a suitable formation in the subsurface. Alternatively, desiccation ponds can be used to

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	Teeside, UK	Clemens Dome, TX	Moss Bluff, TX	Spindletop, TX
Type of salt formation	Bedded salt	Salt dome	Salt dome	Salt dome
Geometrical volume (m^3)	210,000	580,000	566,000	906,000
Mean cavern depth (m)	365	1,000	1,200	1,340
Amount (H2/metric tons)	810	2,400	3,690	8,230
Net energy stored (GW h)	27	81	123	274

Table 1 *Metrics of hydrogen storage in existing salt caverns (Modified from Maarten, 2020)*

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Salt Dome	Location	No. Caverns	Storage Capacity (million barrels)
Bayou Choctaw	Iberville, LA	6	76
West Hackberry	Cameron, LA	21	220.4
Big Hill	Jefferson, TX	14	170
Bryan Mound	Brazoria, TX	19	247.1
Totals		60	713.5

Table 2 *Number of caverns and storage capacity (liquid hydrocarbons) for the 4 facilities owned by the United States Strategic Petroleum Reserve (Source SPR webpage)*

process the brine, but this process is more disruptive and costly. Salt caverns and solution mining have been around for a long time, with salt caverns having a variety of uses, including brine production, waste disposal, and hydrocarbon storage. The best-known user of salt caverns in the United States is the Strategic Petroleum Reserve (SPR), which owns approximately 60 salt caverns in four salt domes along the Gulf Coast region, where they exclusively store liquid hydrocarbons (see **Table 2**). Salt cavern engineering is a thriving field that brings together a diverse range of engineering and geoscience professionals (the Solution Mining Research Institute is a good source of information for professionals interested in this field). The Gulf Coast region of the United States has great potential for the upscaling of hydrogen storage in salt caverns, as recently noted by the work of Ruíz-Maraggi and Moscardelli (2024).

Salt caverns are also common in the Permian Basin of West Texas. In fact, the famous Waha Hub is composed of a series of salt caverns within the Salado Formation (**Figure 3**). The

Energy Expansion: Storing Hydrogen *continued on page 26*

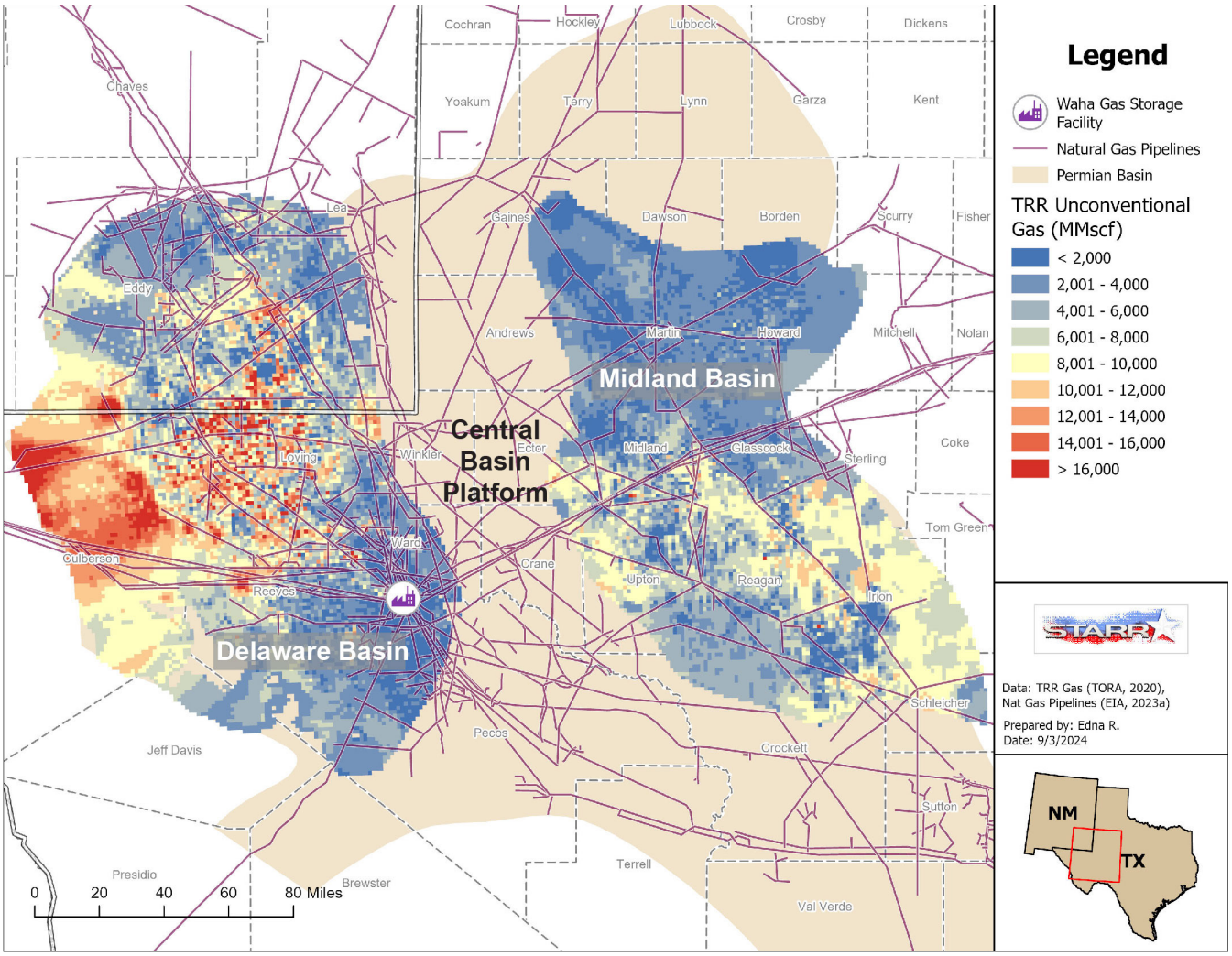

Figure 3. *Technically recoverable unconventional gas resources, natural gas pipelines, and location of the Waha Hub in the Permian Basin of West Texas. Sources: TORA IA at BEG, EIA (2023a).*

Energy Expansion: Storing Hydrogen continued from page 25

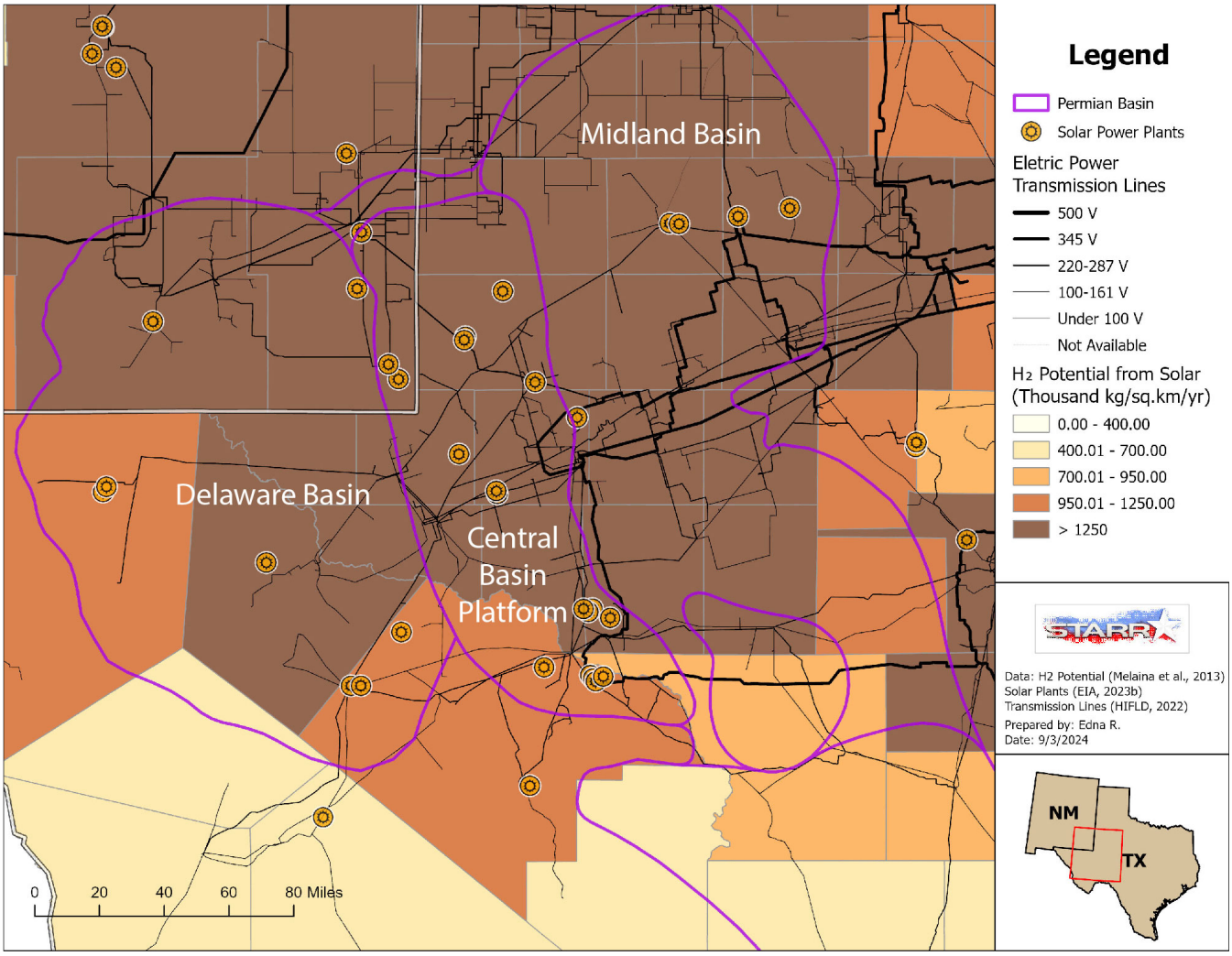

Figure 4. *Hydrogen generation potential from solar in the Permian Basin and location of existing solar power plants. Sources: EIA (2023b), HIFLD (2022), and Melaina et al. (2023).*

Permian Basin of West Texas presents unique conditions for the development of a hydrogen economy. Key factors include favorable subsurface conditions for the placement of salt caverns for geological storage, abundant natural gas production for the manufacture of natural gas derived hydrogen, and a demand for carbon dioxide (a byproduct of methane reforming) for CO_2 enhanced oil recovery in Permian oil fields (Ko et al., 2023). The viability of carbon capture and sequestration (CCS) in the Permian Basin is more contended due to competition for pore space (e.g.: produced water injection), seismicity concerns, and the risk of interference with oil and gas production.

Renewable energy is also abundant in the Permian Basin of West Texas, and low-carbon hydrogen can be produced via electrolysis (**Figure 4**). Although H_2 production is perceived to be water-intensive, the volumes needed for electrolysis, steam methane reforming (SMR), or autothermal reforming (ATR) are considerably less than the current water needs associated with power generation, fracking operations, and agriculture. Lin et al. (2024b) estimated that for steam methane reforming, the total system water consumption is around 4.85 gallons per kilogram of H_2, while water consumption for oil production in the Permian Basin is close to 38 gallons of water per barrel. Although the aggregate water usage for hydrogen production is less than that of the oil and gas or agriculture sectors, managing water resources at specific locations remains important due to the significant variability in water availability and quality across Texas.

DISCUSSION AND FINAL THOUGHTS

The hydrogen economy, within the context of energy decarbonization, is incipient. As a consequence, immature value chains are posing a challenge to the development of new markets. However, in the Permian Basin of West Texas, high fertilizer consumption in the Southern High Plains could represent a good opportunity for developing a local market linked to the agricultural sector (Lin et al., 2024a). On the other hand, the Gulf Coast region is home to many hard-to-abate industries where hydrogen could

Energy Expansion: Storing Hydrogen *continued on page 27*

Energy Expansion: Storing Hydrogen continued from page 26

fuel various industrial processes (e.g., steel, cement, etc.). Easy access to ports (e.g., Corpus Christi and Houston) could also incentivize hydrogen exports in the form of ammonia (Lin et al., 2024b). Considering market development and access in the early stages of project conception is crucial to ensure a successful kick-start of the hydrogen economy in Texas.

The United States Bipartisan Infrastructure Law allocated USD 9.5 billion to fund hydrogen programs between fiscal years 2022 and 2026. From this amount, USD 7 billion was awarded to seven regional hydrogen hubs, with investments expected to double via matching funds from industry (**Figure 5**). These are demonstration projects, not pilots, and the main objective is to prove that upscaling hydrogen value chains is possible. In Texas, the HyVelocity Gulf Coast Hydrogen Hub was awarded. The project includes seven core industry participants, including the AES Corporation, Air Liquide, Chevron, ExxonMobil, Mitsubishi Power, Orsted, and Sempra Infrastructure. The variety of industry partners demonstrates how these new projects are driving the participation of a wide range of industrial expertise.

Additionally, several other projects, driven by private capital, are starting to evaluate the feasibility of developing hydrogen projects across Texas, with particular emphasis on the Permian Basin and South Texas (e.g., Hydrogen City near the Piedras Pintas salt dome). All these projects will require a deep understanding of the subsurface, necessitating various studies, including overburden characterization, salt formation characterization, and natural gas exploration and production (feedstock). One of the main messages for geoscience professionals and students looking for opportunities to develop their professional interests within the context of the energy transition (or energy expansion) is that the subsurface will continue to play a key role in developing emerging "green" economies within Texas and beyond. The world will continue to need geoscientists. ■

ACKNOWLEDGEMENTS

This work is funded by the State of Texas Advanced Resource Recovery (STARR) program and the GeoH2 Industrial Associate program at the Bureau of Economic Geology, Jackson School of Geosciences at The University of Texas at Austin.

Energy Expansion: Storing Hydrogen *continued on page 28*

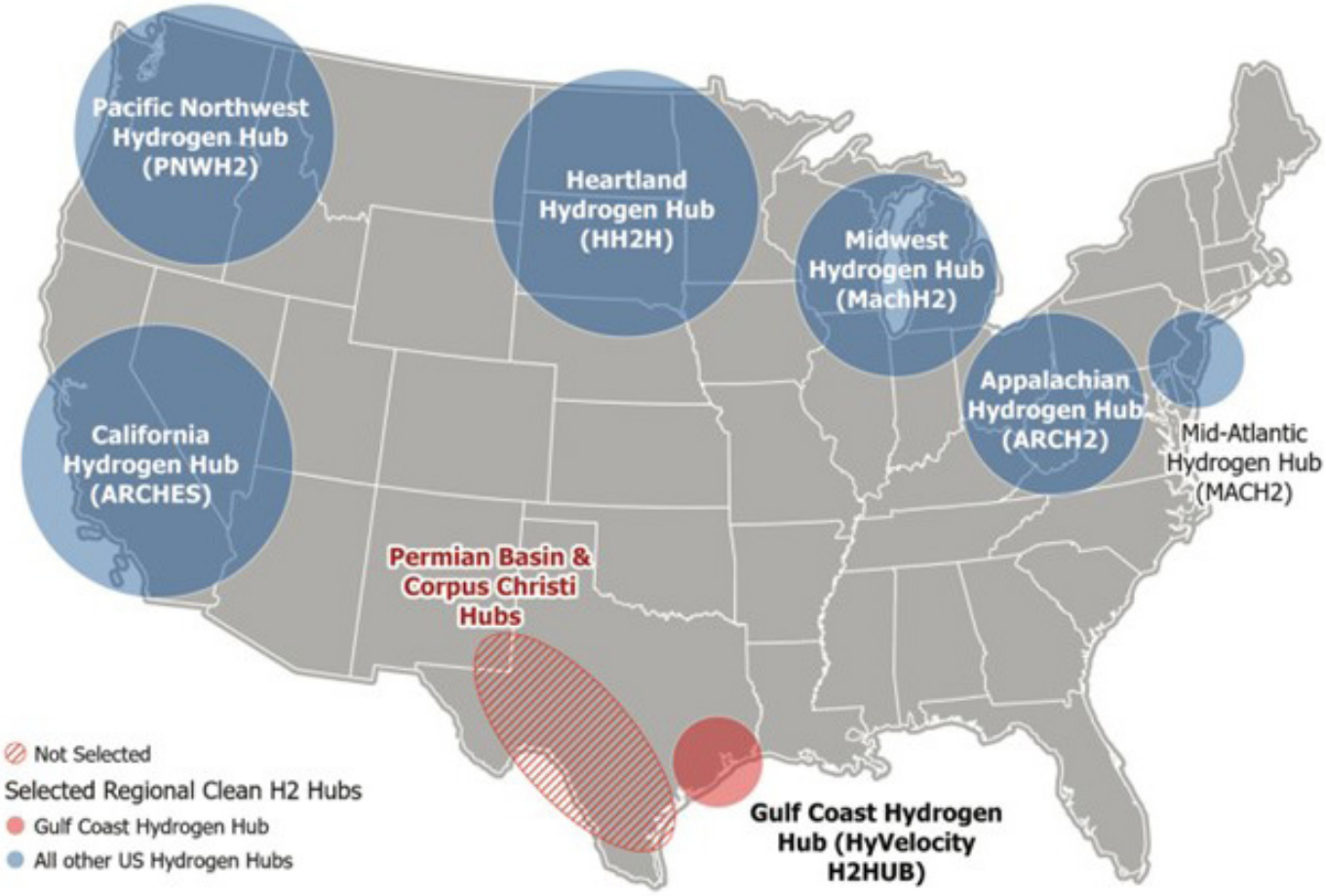

Figure 5. . *The map shows the seven 2023 DOE selected regional hydrogen hubs where a total investment from the federal government will reach USD 7 billion. Texas submitted two applications with the HyVelocity H2HUB (red circle) securing funding from DOE. The Horizon & Trans Permian proposal, a joint proposal between the Permian Basin and the Corpus Christi region, was not successful; however, there are private investors and capital studying the feasibility for low carbon hydrogen projects in this region.*

Energy Expansion: Storing Hydrogen continued from page 27

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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.

HAIGENT ○ __ __ __ __ __

ASOPDSLI ○ __ __ __ __ __ __

BNONCOAIZDTEARI _ _ _ _○_○_ _ _ _ _ _ _ _

EEHREUOGNS ○ __ __ __ __ __ __ __ __ __

EEHREUOGNS __ __ __ ○ __ ○

Products and terms used in storing this element

__ Y __ __ __ __ __ __


Houston
GIS Day
Nov 21-22
Houston-Galveston Area Council
LIMITED SPONSORSHIPS AVAILABLE
GIS Industry Influence
Targeted Exposure
Networking Opportunities
Houston Area GISday
SECURE YOUR SPONSORSHIP

Tuesday, October 15, 2024

Luncheon 11:30 AM- 1:00 PM
Cost: $40 pre-registered members
$45 for non-members/ALL walk-ups
$40 for Emeritus/Life/Honorary
Students: $30 if pre-registered
Greenway Occidental Petroleum Corporation - 5 Greenway Plz Ste 110, Houston, TX 77046 Room C.106 Auditorium 1 (MTR)
https://www.hgs.org/civicrm/event/info?id=2596
Event Contact: Bryan Guzman | bryan.guzman85@gmail.com

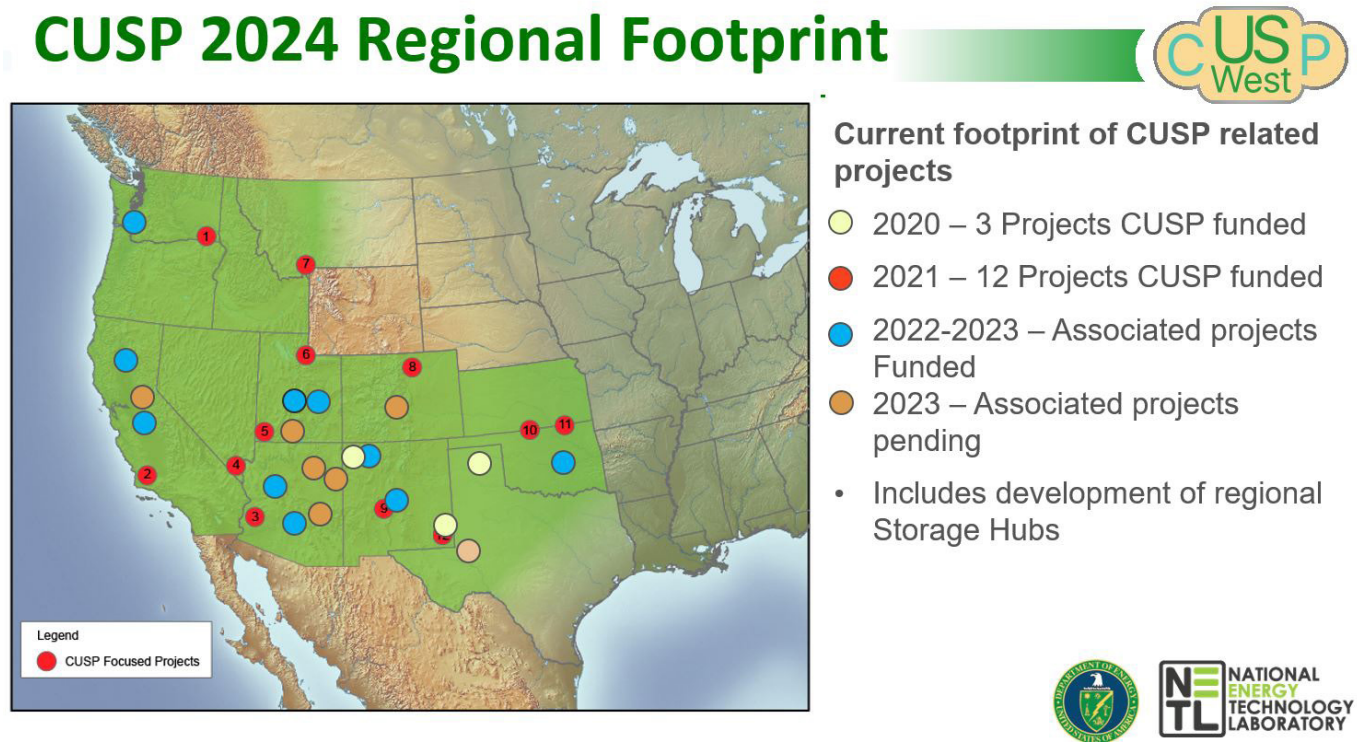
HGS CCS Luncheon Meeting

Robert Balch
Petroleum Recovery Research Center
New Mexico Tech

Impact of Regional Carbon Partnerships on Commercial CO_2 Storage Projects

The Carbon Utilization and Storage Partnership of the Western United States (CUSP) has a primary goal of providing support to commercial carbon storage projects in a 13 state region encompassing the Western and South-Western United States. The CUSP, with 16 founding organizations formed from Universities, Research Centers, State Geological Surveys, and US National labs, is tasked with creating opportunities for projects in the region by compiling and sharing regional and inter-regional data on potential geologic carbon storage sites and transportation pathways with industrial carbon sources and then to provide for regulatory considerations, community engagement, and technical support in application processes for Monitoring, Reporting, and Verification (MRV) plans and Class VI permits. These permits, required by the US Environmental Protection Agency (EPA), allow for optimal site selection, well design, and operation of carbon storage sites. MRV plans also enable access to 45Q tax credits and create a favorable environment for commercial storage, since the credits can effectively recover much of the initial capital costs of projects. With the expansion of section 45Q tax credits for CO_2 storage in recent US federal legislation, industry interest has grown significantly in deploying new storage projects at commercial scales, and in state governments to provide sound legal and regulatory support to administer these projects. An integral part of preparing for commercial storage is to provide information to communities and to ensure that Environmental Justice concerns are addressed both in project design, but also in direct community engagement. A primary task for the CUSP is to accelerate and assist in development of projects in the western US in a responsible and sustainable manner.

Between 2019 and 2024 the CUSP directly received $15 million in federal funds, generated an **CCS Luncheon** *continued on page 31*



HGS CCS Luncheon continued from page 30

extra $3 million in cost-share from partners, and CUSP members have generated new work totalling more than $100 Million and had a portfolio of 32 projects at the end of 2023. Another category of work that CUSP provides is direct industry support. These projects do not have direct federal funding but instead are supported by industries that are decarbonizing in the region. Currently CUSP members are directly engaged with industry on two hydrogen projects, eight midstream company projects, and an EOR conversion to storage project. Most of this work is focused on permitting storage wells and 45Q tax credit eligibility.

Since 2020 the CUSP has accumulated a diverse portfolio of projects including: Focus in conversion of midstream facilities from acid-gas disposal to regional carbon storage hub development; Conversion of an active CO2 EOR project to a storage focus; Development of storage for blue hydrogen power generation facilities; and in developing regional storage hubs in Arizona, California, New Mexico, Oklahoma, and Washington states. During the course of CUSP engagement in the western USA, it has become increasingly important to focus efforts on outreach, community engagement, and environmental justice as these are critical components to the acceptance and deployment of commercial storage projects. One strategy of the CUSP's regionally based partners is to directly engage in their own communities. Through August of 2023 the CUSP has performed at least 949 stakeholder interactions including: 69 workshops; 147 Abstracts, papers and posters; 203 Presentations and panel sessions; and 530 collaborative discussions with regional stakeholders. ■

EARTH SCIENCE WEEK EVENT

HGS is sponsoring an Earth Science Week event at the Houston Museum of Natural Science.

The event will be on Saturday, October 12, from 10:00 a.m. to 1:00 p.m. in the Paleo Hall Lobby. The theme this year is Geology is all around us.

For this, we will have geology experts at four stations that highlight different aspects of geology: Texas Geology and Fieldtrips, Everyday Uses of Common Rocks and Minerals, Petrified Wood, and Rocks, Minerals, and Fossils. Each station will have small giveaways for children, families, and teachers.

The event is free with admission to the museum. ■

EARTH SCIENCE WEEK

BIOGRAPHICAL SKETCH

Dr. Robert Balch is the Director of the Petroleum Recovery Research Center located on the campus of New Mexico Tech. As director, Robert has consistently grown the organization's research portfolio to include 29 active projects with a total active research portfolio of $227 million. The Center currently focuses on sustainability, carbon management, and hydrogen, as well as traditional oil and gas upstream and downstream projects, and it has worked with companies across the US and the world. Robert has served for 6 years on the ISO TC265 world standard for geologic storage of carbon oxides, as a representative for ANSI, serves on the Reservoir Advisory Board for the Society of Petroleum Engineers, and held an appointment as an Oil Conservation Commissioners for the State of New Mexico between June of 2011 and 2018 the commission serves as the top regulator for the oil and gas industry in New Mexico. Robert is active in Class VI and MRV permitting and is involved with multiple permits in this space, including early MRV approvals for Lucid Energy Group and Capture Point LLC. Dr. Balch holds a PhD in Geophysics from the New Mexico Institute of Mining and Technology.

Tuesday, October 15, 2024

Social Hour 5:30 pm

Dinner 6:30 pm, Presentation 7:15 pm

HGS Members/Emeritus/Honorary Life $65
Students $65 • Non-Members & Walkups $75
Norris Conference Center, Citycentre
816 Town and Country Blvd #210 • Houston, TX 77024
https://www.hgs.org/civicrm/event/info?id=2571
Event Contact: Catie Donoghue • catie_donohue@murphyoilcorp.com

Jeff Lund

Who Were the First Independents? The Origin of the Oil & Gas Industry

Jeff Lund has worked as a geologist, exploration manager and VP for nearly a dozen oil companies but the truly formative ones were Amoco, Clark Oil, Southland Royalty, Burlington Resources, Ashland and Kerr-McGee. At Ashland and Kerr-McGee he served as VP of Exploration and Production and as VP Worldwide Exploration, respectively. By 2009 he finally figuring out "going independent" was much more fun and lucrative and he formed a consultancy named Corridor Oil & Gas LP with Bill Crenshaw, an engineer colleague. Despite retiring, he still consults and has production in the Permian Basin, Eagle Ford and Gulf Coast Tertiary. He remains actively involved with HGS, AAPG and SIPES.

Marti and Jeff Lund moved to Houston in 1969 to start careers, respectively, as an operating room nurse in the Medical Center, and as a petroleum geologist at Pan American Petroleum. 55 years later, it looks like it was a good idea. The irony is that they both grew up in the place where the oil and gas industry literally started, but did not really come to appreciate it until much later. Jeff grew up in Jamestown, New York and Marti in Corry, Pennsylvania. Glacial drift and Devonian Shale outcrops defined their hometowns, located within a few dozen miles of Drake's oil well in Titusville, Pa. and even closer to the first natural gas well in Fredonia, New York. Who knew?

This presentation is also a personal journey of learning about the origin of petroleum geologist's profession and a passion in telling the fascinating tales few of us seem know. Jeff will discuss Colonel Drake's drilling venture, which changed the world, and the even earlier first commercial use of natural gas.

Along the way here are a few things you may find interesting to learn more about:

- How did the "First Independents" decide where to drill?
- Where does the term "wildcat" come from?
- Why do we measure oil volumes in terms of "barrels"?
- How does John Wilkes Booth enter the story?
- Why did Charles Lyell visit Fredonia, New York in 1841?
- How did our profession "save" the whales from extinction?
- How did John D. Rockefeller create one of the largest corporations in history? And then get in trouble? And thereby provide many of us our first jobs in the industry?
- Who first used surface casing to drill?
- When and how was the first "frac job" conducted?
- In short, how did the professions of petroleum geology and petroleum engineering begin? ■

BIOGRAPHICAL SKETCH

Jeff received his BS in Geology at Case Western Reserve University in Cleveland, Ohio and then, while working at Amoco and Clark Oil, attended U of H to earn an MS in Geophysics and an MBA in Finance.

He has been President and is an Honorary Member of HGS and GCAGS, Chair of the AAPG House of Delegates, Honorary Member of AAPG, and is currently a Trustee of the AAPG Foundation. He serves as a board member of SIPES Houston and chairs the HGS Calvert Memorial Scholarship Board.

Monday, November 11, 2024

5:30 – 9:00 p.m.

HGS Members/Emeritus/Honorary Life $65
Students $25 • Non-Members & Walkups $75
Norris Conference Center, Citycentre
816 Town and Country Blvd #210 • Houston, TX 77024
https://www.hgs.org/civicrm/event/info?id=2570
Event Contact: Catie Donohue

HGS General and North American Dinner Meeting

Dr. Lesli Wood
Robert J. Weimer Chair, Dept of Geology and Geological Engineering, Colorado School of Mines

The 26th Anniversary Lecture

The Robert E. Sheriff Lecture Series

Sponsored by the Department of Earth and Atmospheric Sciences at University of Houston and the U.H. Geoscience Alumni Association

Learn about University of Houston geoscience program with Dr. Tom Lapen, Department Chair, Dr. Robert Stewart and Dr. Paul Mann. As well as the departmental Outstanding Alumni Award. There will be a poster session early in the evening on current thesis and dissertation research of the U.H. students.

Join the meeting early to meet the next generation of geoscientists from the University of Houston!

The Robert E. Sheriff Lecture Series was initiated in 1999 by the University of Houston Geoscience Alumni Association to honor Dr. Sheriff as an educator, scholar, and proponent for the geosciences. The series has recently been co-sponsored by the Houston Geological Society.

The Sheriff Lecture mission is to

bring some of the best known geologists and geophysicists in the world to the Houston community to share ideas relevant to exploration geology and geophysics, and to showcase geoscience activity at the University of Houston.

A full list of the Student Posters will be available on the HGS Website.

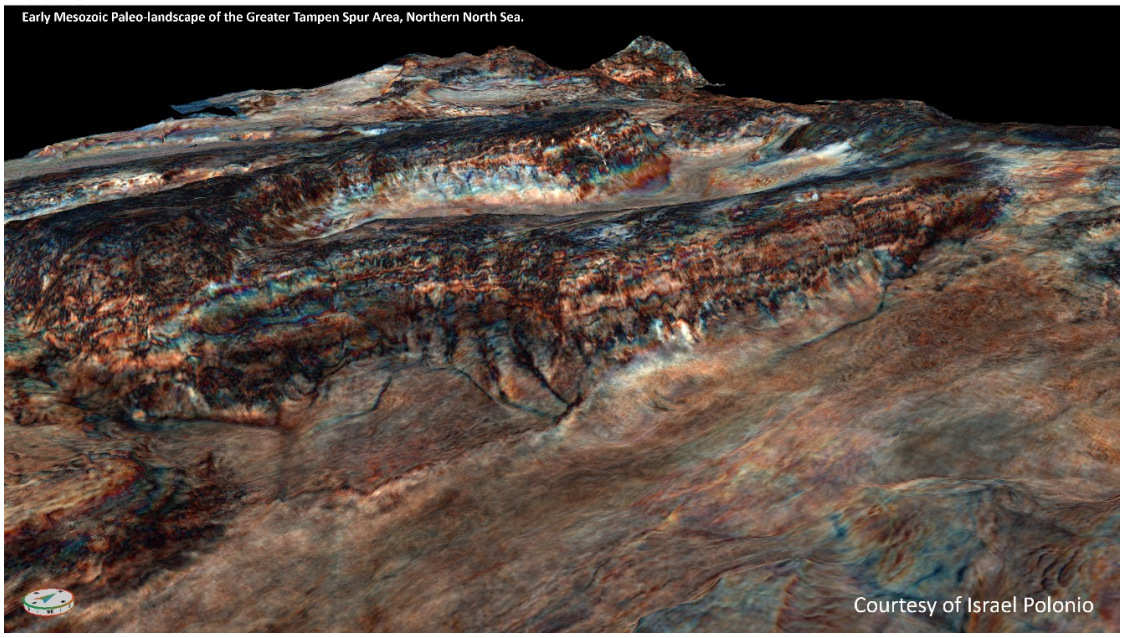
R.E. Sheriff Lecture

Seismic Geomorphology of Ancient Earthscapes — Strengthening our Perspectives of Deep Time and Clarifying Our Role in the World's Future

Fathoming deep time is arguably geology's single greatest contribution to humanity. …geology provides a lens through which we can witness time in a way that transcends the limits of our human experiences. This quote from Marcia Bjornerud's book *Timefulness* captures our role as geoscientists, to bring a knowledge of the deep-time past to bear on the present. If geology is the lens through which we witness, then seismic data is the muse under the scope. Advances in seismic imaging of ancient rocks and in our ability to display and render visual, past landscapes and seascapes provides a window through which to view the history of the Earth. These insights bring a responsibility to facilitate conversations on not just the geomorphology of the past, but on how those Earthscapes have been impacted by natural and

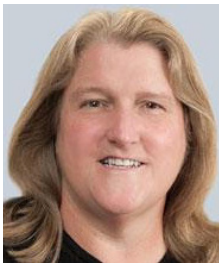
HGS Joint General and North American Dinner *continued on page 34*

HGS General and North American continued from page 33



anthropogenic forces. This talk will look at our amazing ability to see the ancient geomorphology of the Earth. We will examine ancient landscapes from the Mesozoic of Australia and the North Sea, Cretaceous canyons of northeastern South America, submarine mountains of mud and deep ocean canyons in offshore Trinidad and Tobago, carbonates systems of the West Texas Permian Basin, and paralic systems of the Guyana/Suriname regions. We will discuss how to integrate those seismic observations with learnings from modern systems study and modeling to quantify processes active in the past. This talk will also discuss the role of geoscientists in conversations of society's impact on the Earth and Earth's processes, and geoscientists' unique perspective on the role of human society in the evolution of the planet. ■

BIOGRAPHICAL SKETCH



BS, Geology, Arkansas Tech University, 1985
MS, Geology, University of Arkansas, 1988
PhD, Earth Resources, Colorado State University, 1992

RESEARCH INTERESTS

- Quantitative Seismic Geomorphology of clastic depositional systems
- Clastic reservoir characterization and modeling through research in outcrop and modern systems
- Tectonic and sedimentologic interaction in continental margins around the world
- Neogene development of the world's large deltas
- Martian deltas and shoreline processes
- Shale tectonics and mud volcanoes

TEACHING

- GEGN 204 Geologic Processes and Deposits
- GEGN 503/504 Integrated Exploration and Development
- GEGN 585 Seismic Geomorphology

SELECTED PUBLICATIONS

- Salazar, M., Moscardelli, L., and Wood, L., 2018, Reconstructing sediment infill and high-relief clinoform architectures using forward-modeling: A case study from the Taranaki Basin. AAPG Bulletin.
- Moscardelli, L. and Wood, L., 2015, Morphometry of mass transport deposits as a predictive tool. GSA Bulletin, June, j2015.
- Dunlap, D. B. and Wood, L., 2013, Seismic Geomorphology of Early North Atlantic Sediment Waves, Offshore North West Africa: Interpretation, v. 1, no. 1 (2013), SA75-SA91.
- Burton, D. and Wood, L., 2013, Quantitative shale bed characterization of the tidally-influenced Sego Sandstone, Petroleum Geology.
- Wood, L. J., Editor., 2011, Shale Tectonics: AAPG Memoir 93, p. 157.
- Moscardelli, Lorena, and Wood, L. J., 2006, Seismic geomorphology of mass transport deposits and controls on formation and character, eastern offshore Trinidad (abs.): American Association of Petroleum Geologists Annual Convention, v. 15, p. 76.
- Wood, L. J., 2006, Quantitative geomorphology of the Mars Eberswalde Delta: Geological Society of America Bulletin, v. 118, no. 5/6, p. 557–566.
- Wood, L. J., 2000, Chronostratigraphy and tectonostratigraphy of the Columbus Basin, eastern offshore Trinidad: American Association of Petroleum Geologists Bulletin, v. 84, no. 12, p. 1905–1921.

October 2024

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1	2	3	4	5 Make your reservations online at hgs.org
6	7	8	9 **HGS E&E Dinner Meeting** *TBD* *https://www.hgs.org/civicrm/event/info?id=2608*	10	11	12
13 **Earth Science Week** *https://www.hgs.org/civicrm/event/info?id=2590*	14	15 **HGS New Energies Luncheon Meeting** *Page 30* *https://www.hgs.org/civicrm/event/info?id=2596* **HGS General Dinner Meeting** *Page 32* *https://www.hgs.org/civicrm/event/info?id=2571*	16	17 **HGS NeoGeos Happy Hour Pickleball Tournament** *Page 11* *https://www.hgs.org/civicrm/event/info?id=2594*	18	19
20	21 **HGS Golf Tournament 2024** *https://www.hgs.org/civicrm/event/info?id=2591*	22	23	24 **HGS Short Course** *Practical Aspects of Core Analysis* *Page 19* *https://www.hgs.org/civicrm/event/info?id=2605*	25	26
27	28	29	30	31		

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).

Houston Geological Society President's Night Award Dinner 2024

The Houston Geological Society hosts Presidents Night once a year, typically at the end of our fiscal year. This event is by invitation only, and it is our way of honoring our many volunteers and corporate sponsors for all they have contributed to society over the years. The "passing of the Rock Hammer" is the traditional way of marking the transition from the previous Board President to the new President.

Corporate Star Award

Gold

Chevron
GCAGS
Houston Energy
Oxy
Shell
Thunder Exploration

Silver

Murphy Oil Company
Terrain Solutions, Inc.
Tri-Star Group

Bronze

Angela Hammond
Coterra Energy
Southwestern Energy

Rising Star Award

Kristen Briggs
Kurang Mehta

Outstanding Board Member Award

Caroline Wachtman

President's Award

Bruce Blake
Amanda Johnston
Jeff Lund
Troy Meinen
Michael Salazar
Andrew Sterns
Charles Sternbach
Linda Sternbach

Distinguished Service Award

Bryan Guzman

Honorary Life Award

Cheryl Desforges
Craig Dingler

Recognition of Departing Board

Paul Britt, President
Linda Sternbach, Vice President
Fang Lin, Treasurer
Kenneth Mohn, Secretary
Caroline Wachtman, Editor
Troy Meinen, Director
Bill DeMis, Director

Recognition of Incoming Board

Penny Patterson, President
Patty Walker, President-elect,
Catie Donohue, Vice President
Glenn Lowenstein, Treasurer
Angela Hammond, Treasurer-Elect
Ted Godo, Editor
Lucia Torrado, Editor-Elect
Sharma Dronamraju, Director 1
Catherine Cox Strong, Director 2
Lauren Seidman Robinson, Director 3
Judy Schulenberg, Director 4

HGS President's Night Award Dinner *continued on page 37*

President's Night Award Dinner continued from page 42

Terrain Solutions, Inc. – Silver
Glen Lowenstein accepting award

Tri-Star Group – Silver
Garrett Fletcher accepting award

Southwestern Energy Corp. – Bronze
Josh Novello accepting award

Coterra Energy – Bronze
Chris Spies accepting award

Rising Star Award
Kurang Mehta

Chairman's Award
Bryan Bottoms

Chairman's Award
Angel Callejon

Chairman's Award
Chuck Cauhey

Chairman's Award
Dorene West

HGS President's Night Award Dinner *continued on page 38*

President's Night Award Dinner continued from page 37

Outstanding Board Member Award
Caroline Wachtman

President's Award
Amanda Johnston

President's Award
Troy Meinen

President's Award
Mike Salazar (by Jeanette Salazar)

President's Award
Charles Sternbach

President's Award
Linda Sternbach

Distinguished Service Award
Bryan Guzman

Honorary Life Membership
Cheryl Desforges

Honorary Life Membership
Craig Dingler

H G S
GOLF
TOURNAMENT

October 21, 2024
Sterling Golf Club

REGISTER NOW!

Individual Golfer	$200
4 Man Team	$800

Register at www.hgs.org
or call 713.463.9476

Sponsorships available

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

Raffle Swag Prize Sponsorships
- Par Sponsor **$250**
- Birdie Sponsor **$500**
- Eagle Sponsor **$700**

Please submit company logo with form and payment. Payment by credit card or check.
Please make checks payable to *Houston Geological Society*. Email form to office@hgs.org.

Company Name: _____

Sponsorship Type: _____ Amount Enclosed: _____

Contact Name: _____

Billing Address: _____

Phone: _____ Email: _____

Card Number: _____Expiration Date: _____ CVC: _____

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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:_____

Billing Address: _____

Foursome Members	Company	Phone	Email
1. _____	_____	_____	_____
2. _____	_____	_____	_____
3. _____	_____	_____	_____
4. _____	_____	_____	_____

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

HGS
SPORTING CLAY SHOOT

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

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

Westside Sporting Grounds
10120 Pattison Rd., Katy, TX 77493

Registration & Sponsorship Info: www.hgs.org or call 713-463-9476

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: _____

Annual dues Active & Assoc. for the one year *(July 1st-June 30th)* **$36.00**_____

Student **$0.00**_____

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

Total remittance_____

Payment:

Check #_____

Credit card: V MC AE Discover

Credit Card#_____

CVV code (req'd): _____ Expiration: _____ (mm/yy)

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)* _____

School *(required)*_____

Major *(required)*_____ **Degree** *(required)*_____

Year Graduated _____

School *(optional)*_____

Major *(optional)*_____ **Degree** *(optional)*_____

Year Graduated _____

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.

AAPG Member Number _____ OR

HGS Sponsor's Name _____

Signature: _____ **Date:**_____

Professional Directory

Consulting, Evaluate Prospects:
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Victor H. Abadie III
Consulting Geologist

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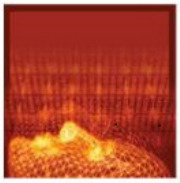

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Kevin Rigsby - President/Geologist

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