HGS Bulletin

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Houston Geological Society

DECEMBER 2023

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In Every Issue

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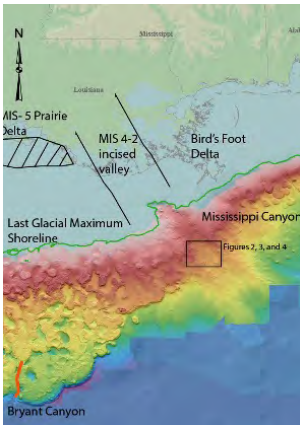
About the Cover: Chesapecten jeffersonius is an extinct scallop that is the state fossil of Virginia. This fossil is ~8 inches in diameter, is ~4 million years old, and was recovered from a creek at College of William and Mary.

Technical Meetings

Features



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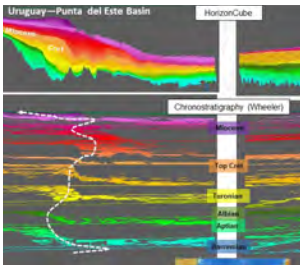

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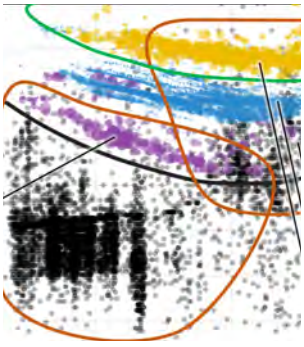

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Paul Britt
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The Shortcomings of a Digital Library

An associate called me a few weeks ago with a simple request. He was looking for an HGS publication, Typical Fields of Southeastern Texas Volume 1, that had a field write up in Victoria County that he needed, and wanted to know if I had the book. I did, but through several office moves and upheavals, I couldn't find it readily on my bookcases. Probably either in off-site storage, or loaned to someone years ago and forgotten. In any case, no problem. As an AAPG member, I subscribe to the Datapages Archives for a nominal subscription fee. The archives have publications from many affiliated society publications, including the HGS. A quick search yielded the results, the field I was looking for. As it was in an area I had worked many times over the years, I got curious and wanted to see what fields were in the publication surrounding this field. Normally a simple task, accomplished by a glance at the table of contents or index map, turned out to be not-so-simple. While the field descriptions are stored separately in the archives, the volume as a whole is not. A search for the entire volume, or at least the table of contents, yielded no resutlts. The archives do not allow for a search by society. So while most of the publications are preserved digitally, and can be specifically searched for by name, they are not preserved in a manner that allows for simple review.

I was researching the HGS Bulletins for an article recently, one that was published in the 1980's listing the various geological data libraries in Houston, an resource I found very useful at the time. Again, searching the Bulletin content should have been a simple matter, yet I was unable to search just HGS publications through Datapages. Repeated searches of the full archives yielded a large number of hits, but not the article that I was looking for. The alternative is to download all of the Bulletins and visually search them one at a time, a task that I have yet to complete.

The reality is that while a huge amount of content is being captured digitally, it may not be organized in a form that makes it easy to find. More importantly, there is still a vast amount of technical literature and geological data that may never be digitized. As we move away from physical libraries, that material that was acquired at great cost will likely be lost forever. I have in my personal collection volumes of logs, scout tickets and core analyses throughout the gulf coast that is not available digitally anywhere, as do many of our members across Houston. The private data libraries, awash in data contributions and diminishing memberships and funds, are turning away additional contributions due to their inability to handle the volume. The result is the loss of historic data that could provide the lead to a new prospect, or prevent the repeat of something that has already been tested.

The commercialization of data collection through the companies that are in that space has resulted in vast collections, but there are gaps in their data as well, and often the decision to capture a dataset is based on the ease of its capture and the number of customers that are expected to use it. That formula also leaves gaps, particularly in less active trends.

The purpose of this commentary is that the HGS should consider what it can do to assist in the preservation of geological literature and data. We offer printed copies of some of our publications through the Bureau of Economic Geology (https://store.beg.utexas.edu/42-hgs). Perhaps simply serving as a clearinghouse to identify sources of literature and geological data would be a sufficient beginning.

The past month showed an outstanding turnout for our events, an E&E ethics talk by TBPG appointed Board member Danny Kingham, also an HGS member. The 25th Anniversary of the Robert Sheriff Lecture was an outstanding success with over 130 in attendance and many student posters presented before the two talks given, one by HGS member Charles Sternbach. There was also a Saturday field trip down the Brazos River and Galvestion to illustrate Texas coastal processes. And, of course, the Thanksgiving Holiday. I hope all of our members have a terrific Thanksgiving.

This month is the second annual Holiday Party on Monday, December 4. The first one was the result of a last minute decision to use a credit at the Norris Center after an earlier general dinner was canceled. Turn out was good and well received, so we hope to maintain the tradition this year with the help of some generous sponsors. The following Monday is the International Explorationist Group's first dinner this year on "Stratigraphic Architecture Across Conjugate Margins of Uruguay, South America, and Namibia, Africa with Seismic Ties". Also the return of the annual Sporting Clays Shoot on Saturday, December 9. I will be at all of these and am looking forward to seeing many of you there. ■

Caroline Wachtman
editor@hgs.org

Are We Solving the Right Problem?

Since starting my term as *Bulletin* Editor in July, I have conducted one-on-one interviews with more than 20 HGS members to learn about their careers, their involvement in the HGS and their feedback on the Society. The most common statement I hear from members is, "We need to get more young people more involved in the HGS." This statement is then typically followed by explanation about why more students and early career people aren't involved, for example: Houston's traffic, busy work schedules, and young people don't know the value of networking. HGS members offer solutions, for example: the HGS needs to educate students and young people about the value of oil and gas, the HGS needs to provide mentorship, and the HGS needs to educate younger geologists about the value of professional societies.

offer wide-ranging content to attract students

ARE WE SOLVING THE RIGHT PROBLEM?

"Are you solving the right problems?" was published by *Harvard Business Review* in 2017 (Are You Solving the Right Problems? (hbr.org). The author, Thomas Wedell-Wedellsborg, describes an example where the residents of an apartment complex complain about slow elevators in the building. Upgrading the elevators is costly and impractical and building management is at a loss for what to do, until they decide to install mirrors in the elevator lobbies. The real problem was that residents were bored with the wait time. Boredom was solved by providing residents a way to pass the time—by looking at themselves. The elevator example highlights the need for companies—and societies—to thoroughly understand a problem before identifying solutions.

Based on interviews with the eight professors I interviewed for this month's article What's Hot and What's Not in Geoscience Education, students are generally not interested in learning about Oil and Gas. They want to hear about environmental geology, critical mineral mining, data science, planetary science, atmospheric science—anything but Oil and Gas! Based on this feedback, it is unlikely that HGS will be able to attract more students if Oil and Gas is the focus of the Society's content.

A second problem I've heard from the approximately 10 early-to-mid career geology professionals I've interviewed is the perception that younger people aren't permitted to serve in HGS leadership roles. The underlying problem (think back to the elevator example) is that early-career people want their demographic to be visibly and prominently represented.

Students and early career professionals are not asking to be educated on the value of in-person networking, or to be educated on the value of professional societies. They are not asking for more Oil and Gas technical content or more mentorship in how to be an oil-finder.

BUILD IT AND THEY WILL COME

I loved collecting rocks from the woods in rural Virginia where I grew up, but it never occurred to me that I could turn an interest in rocks into a profession. By chance, I signed up for a geology course in my first year of college and got hooked. The class visited a small creek on campus and plucked 4 million-year-old eight-inch diameter pectin fossils out of the creek's banks (Chesapecten jeffersonius, the state fossil of Virginia and cover of this month's *Bulletin*). I remember being amazed to think that the ocean had once covered that same spot. My journey to a career in Oil and Gas (now Carbon Sequestration) started by learning about the natural environment and Earth's processes. Many of the other geologists I've worked with share a similar origin story—we got into Oil and Gas by first being exposed to non-Oil and Gas topics.

Colleges and universities in the greater Houston area have figured out that the way to attract more geology students is by offering a range of introductory courses. They also report that once students are hooked on geology, they become more interested in Oil and Gas, and many MS and PhD students go on Oil and Gas careers. The lesson that colleges and universities have learned is relevant to the HGS: offer wide-ranging geology content to attract students and early-career geologists (Geo 101). Offer Oil and Gas content to keep them throughout their careers (Geo 202).

HEAR MORE FROM CURRENT AND PROSPECTIVE HGS MEMBERS

- Read about what colleges and universities are doing to attract and retain geology students in *What's Hot and What's Not in Geoscience Education*
- Learn about what members want from the HGS in *Do More, Do Less or Do the Same: Future of HGS*
- Hear from a geologist who has pivoted his skills in Oil and Gas to academia in *Pivot Profile*
- Consider the career perspectives from senior-career member Richard Howe and mid-career member Carlos Cabarcas in *We Are the HGS*
- Get inspired with geology legend, Bill Armstrong, by reading his interview with Charles Sternbach ■

We Are The HGS

Richard Howe, HGS member since 1979

Currently an engineering geologist, Richard Howe has spent most of his 47+ year career applying geologic and geomorphologic principles, soil and rock mechanics, and other related disciplines to characterizing the near-surface geology in Houston and surrounding areas. Now in his 70's, he continues to spend six or seven days each week mapping near-surface structural features for clients such as government entities, engineering firms, land developers, and others.

Although Howe returned to school to retrain in engineering geology and hydrogeology in the mid-1980s, he credits his professional success to a foundation in petroleum geology that began with a job at W.S. Wallace and Associates followed by a move to Houston with Columbia Gas Corporation in 1979. Howe says that although engineering geologists work on a smaller scale than petroleum geologists, it is imperative to know petroleum geology skills, such as how to correlate logs and drill wells.

Howe also credits his success to his long-standing involvement in the HGS, which helped him secure jobs, build life-long friendships, and most importantly to define the "profession" of geology. Howe says that involvement in professional societies is important because, "It lets you influence your science and your profession." For example, Howe says that he and other members of the HGS were influential in establishing the Professional Geologist licensure program in Texas to ensure that a high level of technical quality and safety practices are followed when geologists engage in the Public Practice of Geology.

You can always make time to do the things that are important to your profession

Because of his many years of dedication to HGS and other professional societies, Howe is disappointed in declining professional society memberships. "Too many younger people today aren't joiners; they aren't participants. They just want to go home at the end of a workday," says Howe. He takes a strong stance on junior geologists who don't want to devote time to evening and weekend events. "You can always make time to do the things that are important to your profession," says Howe.

Howe volunteered for many years on the HGS Field Trip Committee, organizing the second Big Bend field trip, among others. He has been a dedicated contributor to the HGS' Environmental and Engineering Group and organized multiple technical conferences, such as one focused on the Daisetta Sinkhole in 2008. Howe also served as a HGS Director where he encouraged the HGS Board to view the society not just a social or professional group, but "first and foremost as a business." For his service to HGS, Howe has received the Distinguished Service Award and the Honorary Life Award. ■

Carlos Cabarcas, HGS member since 2004

Adaptability and flexibility have been hallmarks of Carlos Cabarcas's career. Trained in Venezuela to become part of the National Oil Company work force and earning post-graduate degrees in France, Cabarcas looked forward to opportunities to work multi-nationally. However, Cabarcas built a career in the US onshore industry, working for Chesapeake and Hilcorp Energy. When visiting the US in 2001 for a professional convention in San Antonio, his trip unfortunately coincided with the September 11th attacks. Months-long travel restrictions followed, but Cabarcas made the best of the situation, using this time to visit a friend in Norman, Oklahoma. While there, he made connections that subsequently led to further education, opened doors to future job opportunities and allowed him to expand the relationship with his host-friend who eventually became his wife.

Adaptability and flexibility are needed when working on a wide range of projects as Cabarcas does on a day-to-day basis. These activities include, drilling conventional wells in Texas and Louisiana, proposing new seismic surveys in the Rockies, interpreting microseismic from Ohio and Pennsylvania, recommending investments in Alaska or helping on the development of Eagle Ford assets to support its divestiture. Working for a nimble operator you need to have the capacity to switch priorities dynamically and embrace change quickly.

Persistence and determination are also skills that Cabarcas fully embraced. For example, Cabarcas began his PhD research while employed at Chesapeake. However, he lost access to data when he moved to Houston and joined Chevron. Cabarcas designed a new dissertation project using data from Chevron, but that project was also suspended when he moved to Hilcorp. After two more project iterations, Cabarcas successfully defended his dissertation.

We Are The HGS *continued on page 8*

We Are The HGS continued from page 7

Cabarcas says that although he has been a HGS member for nearly 20 years, his involvement in the Society has been limited over the past decade due to work and family obligations. However, Cabarcas expects to re-engage with HGS and attend lunch meetings at the Petroleum Club. He says he values the opportunity that HGS provides to generate ideas for solving technical problems, learn about new opportunities, and connect (or sometimes commiserate) with like-minded people. Additionally, Cabarcas aspires to be "90 or 95 years old and still active in the HGS" he laughs.

Justifying the value of geophysical data v. conducting operational work is one of the key professional challenges Cabarcas says he has faced. It is difficult to justify large geophysical expenses when the return on the investment is uncertain. In addition, he really believes that we are currently experiencing a significant transition in the way we work. Assisted interpretation supported by machine learning and artificial intelligence is already here, but "it is extremely difficult to participate in this transition if most of your data is still within boxes and in paper records." He notes that professional societies like HGS can help showcase innovative technologies, but recommends not to underestimate simple workflows that could still have a very positive economic impact.

Persistence and determination are also skills that Cabarcas fully embraced

Cabarcas advises junior geologists to be persistent and offers this perspective from his own career, "I keep bringing forward ideas, big, crazy ideas. I keep trying them, because sometimes they pay out," he says. ■

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.

WELCOME TO NEW MEMBERS, EFFECTIVE NOVEMBER 2023

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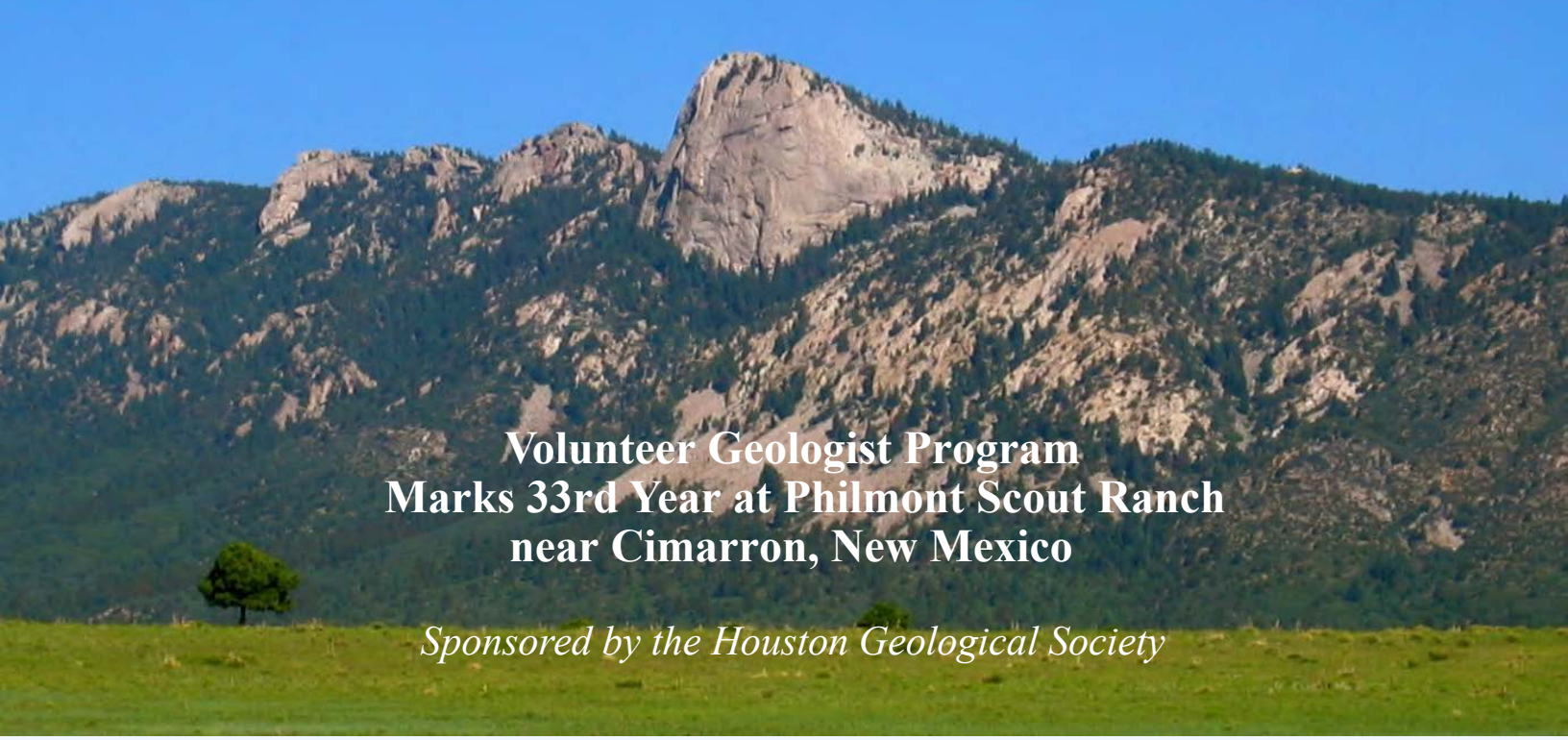
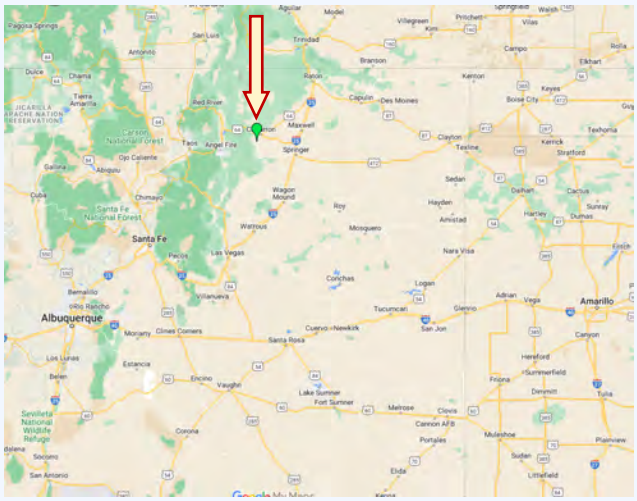


Volunteer Geologist Program Marks 33rd Year at Philmont Scout Ranch near Cimarron, New Mexico

Sponsored by the Houston Geological Society



Map of northeast New Mexico with Philmont Scout Ranch

Philmont Scout Ranch Map in northeast New Mexico

Philmont Scout Ranch is one of three national high-adventure bases owned and operated by the Boy Scouts of America. Located in the southern Sangre de Cristo Mountains of northern New Mexico, Philmont is a 140,000-acre ranch dedicated to outdoor activities. The twelve-, nine-, and seven-day backpacking experience serves more than 27,000 high-school-age boys and girls from all of the USA as well as several foreign countries. Learn more about the geology of the area at: https://pubs.er.usgs.gov/publication/pp505

Fifty-four volunteer positions are open each year, to be filled on a first-come, first-served basis. Volunteers will receive a sign-up packet with scout applications (you have to be register with BSA, at least for the summer!), medical forms, and brochures before summer (usually May). Students who would like to volunteer must show proof of enrollment in a graduate-level program. The 2024 season begins on Saturday, 10 June; the last week of the program begins on Saturday, 5 August.

For more information and to sign up, contact: Gordon Start, 5202 Caversham, Houston, Texas, 77096, USA (713.349.0542, cell: 832.725.8918), ggstart1020@yahoo.com. Alternate contact: David O'Neill, Philmont Scout Ranch, 17 Deer Run Road, Cimarron, New Mexico, 87714, (575.376.2281), david.oneill@scouting.org

Volunteer to Teach and Demonstrate Area Geology in Back-Country New Mexico the Summer!

Pivot Profile
Steve Kaczmarek on the Transition from Industry to Academia

By Caroline Wachtman

"It's not in my nature, and I've never looked back," says Steve Kaczmarek of his pivot from Oil and Gas to academia more than 10 years ago. Kaczmarek left Houston in 2011 to become Assistant Professor at Bridgewater State University in Massachusetts. In 2015, he returned to his home state of Michigan, where he is currently an Associate Professor and the Principal Investigator of the Carbonate Petrology & Characterization Laboratory at Western Michigan University. Although Kaczmarek fondly recalls his days in the Oil and Gas Industry where he worked large, integrated projects, had amazing travel experiences, and a significantly higher salary, often referred to as "golden handcuffs," he says that the location and atmosphere at Western Michigan are well worth the pivot.

Kaczmarek began his professional career at the ExxonMobil Upstream Research Company (EMURC) where he leveraged his skills in investigating dolomitization to help characterize carbonate reservoirs around the world. Kaczmarek says that his work at EMURC taught him how to integrate large and diverse datasets, such as data from petrophysics, geochemistry, and geophysics. Learning to integrate enabled him to "Take the blinders off and open up to the broader world of geology," he says. The experience of "connecting science to the broader geologic community" has been essential to his success in academia, especially to demonstrate the impact of his work to funding agencies. His Industry experience allows him to speak credibly about the usefulness and broader impacts of his research.

Persuasive communication is a key skill that Kaczmarek says he learned during his time in Oil and Gas. While at EMURC, Kaczmarek needed to convince management to fund research into understanding the role that microporosity plays in carbonate reservoirs. "I had to learn how to sell a large research project and convince someone it was important to the business," he says. Now, Kaczmarek coaches his students to be great scientists, but also effective communicators. "I mentor them to be better writers and after a couple years they get it; then they move on," he jokes. "It's wash, rinse, repeat around here," he says.

While Kaczmarek was well-prepared for most of the challenges that he has encountered in academia, he has surprisingly learned new skills as a small business owner, which is how he describes his role as Principal Investigator of the Carbonate Petrology & Characterization Lab. Managing staffing, payroll, contracts and other business services is essential to running his lab. Despite not having a background in management, Kaczmarek says that his lab is distinguished by the professionalism he brings to the job. "Some of my colleagues don't answer emails," laughs Kaczmarek. "To push the project forward even when you don't get your way, to communicate with your colleagues in an effective, timely, and respectful manner, to be a reliable team member, are all critically important in industry and in academia." he says.

Connect science to the broader geologic community

Kaczmarek advises geologists considering the move from Oil and Gas to academia, "Timing is everything, so don't wait until there is a layoff and the job market is flooded." He also emphasizes the importance of building and maintaining a publication record. Although some more industry-focused academic departments, such as Texas A&M, have Professor of Practice roles, most academic institutions "don't swap out a demonstrated publication record for years of industry experience." Finally, Kaczmarek notes that "although it's the best job in the world," geologists considering the pivot to academia should seriously consider the realities of a reduction in salary and benefits.

Although he left Houston behind over ten years ago, the industry network he built there continues to play a key component of Kaczmarek's academic life. He has worked on a number of collaborative projects with ExxonMobil Research Qatar, a partnership that has helped to fund PhD projects for his students. In the future, Kaczmarek expects to continue leveraging his connections to Industry and the lessons he learned during his time there. ■

Pivot Profile is an occasional series that highlights geoscientists who have utilized their geology skills to interesting career applications. Are you interested to learn more about unique geology-inspired careers or do you have a suggestion of someone to profile? Contact me at editor@hgs.org.

A Massive Submarine Canyon Formed in 60,000 Years or Less – Mississippi Canyon, Gulf of Mexico

By Michael L. Sweet, *The Institute for Geophysics, The University of Texas at Austin and*
Jacob Margoshes, *Department of Earth and Planetary Science, The University of Texas at Austin*

ABSTRACT

The Late Pleistocene Mississippi Canyon is a prominent bathymetric feature in the northern Gulf of Mexico. It is the most recent in a series of submarine canyons that have routed sediment from the Mississippi River to the Mississippi Submarine Fan throughout the Plio-Pleistocene. The Canyon began to form about 60,000 years ago during the Marine Isotope Stage 4 (MIS-4) low stand of sea level when the Mississippi River extended across the continental shelf initiating excavation of the canyon. This earlier canyon was narrower than the canyon observed at the sea floor. Seismic reflection data shows evidence of repeated episodes of erosion and deposition of sediment within the Canyon. There is also evidence of sediment collapse from canyon margins and from salt diapiric structures adjacent to the Canyon. The relative high stand of sea level at about 40,000 years before present (MIS-3) may have attenuated the connection of the Mississippi River with the canyon resulting in a partial infilling. This event is marked by seismic facies that are interpreted to represent finer grained sediment. During the most recent low stand of sea level (MIS-2) at about 20,000 years before present, the Mississippi River fed directly into the head of the Canyon. A core in the Canyon and cores cut by the Ocean Drilling Program in the upper reaches of Mississippi Fan encountered sand and gravel-size sediments suggesting, while much of the canyon-fill is muddy, it also has coarser grained component. The Canyon became inactive over that last 14,000 years as sea level rose during deglaciation.

INTRODUCTION

Submarine canyons are amongst the largest landforms on the planet. They may be over a kilometer deep and 10's of kilometers across. Because they are below the ocean, an understanding of their scale and significance has come more recently than terrestrial canyons, rivers or deltas. Pioneering work by Francis Shepard starting in the 1930's (Shepard, 1941) recognized their occurrence and geometry using bathymetric data off the California coast. Awareness of the erosive power of turbidity currents led to a better understanding of the sedimentary processes responsible for submarine canyon formation. Submarine canyons have been described on every continental margin and are seen throughout the sedimentary record (Harris and Whiteway, 2011; Fisher et al., 2021). It is now recognized that they play a key role in routing sediment, especially sand and organic carbon, from the shoreline to deep-water environments (Sweet and Blum, 2016). Submarine canyons were thought to have been largely inactive features in the current high stand of sea level. In the last decade, data from current and sediment monitors and repeat high-resolution bathymetric surveys have shown that many canyons are active sedimentary environments regardless of sea level conditions. These instruments have tracked the movement of turbidity currents within submarine canyons and quantified the velocity, density and volume of sediment transported by these flows (Talling et al. 2023).

Mississippi Canyon (**Figure 1**) is a large canyon off the coast of Louisiana. It has not been studied in detail since the work of Goodwin and Prior (1989). Our team in the Jackson School of Geosciences at The University of Texas, Austin is studying the Canyon in light of new concepts and newly released industry 3-D seismic reflection data made available by the United States Geological Survey (USGS). **Technical Article** *continued on page 12*

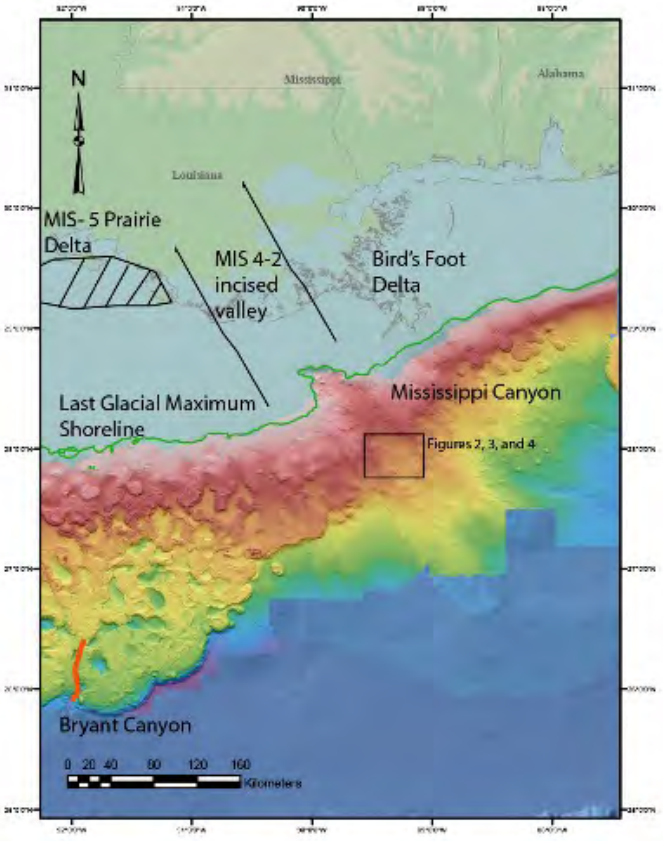


Figure 1. *Location map showing Pleistocene and Holocene geologic features of the study area – the MIS-5 Prairie Delta of the Mississippi River, the MIS-4 and MIS-2 incised valley of the Mississippi River and the Holocene Bird's Foot Delta of the Mississippi River. Bathymetry from the BOEM (https://catalog.data.gov/dataset/gulf-of-mexico-deepwater-bathymetry-with-hillshade) shows the location of Mississippi and Bryant submarine canyons. The box shows the location of the 3-D seismic reflection data used in Figures 2, 3, and 4.*

Technical Article continued from page 11

ORIGIN OF THE CANYON

There are limited data to directly determine the age of Mississippi Canyon. Carbon 14 (C14) ages from a core reported by Goodwin and Prior (1989) show the oldest canyon-fill deposits to be at least 30,000 years old. Mapping of the valley incised by the Mississippi River during the MIS-4 and MIS-2 low stands of sea level, at about 60,000 years ago and 20,000 years ago respectively, shows the river heading towards the head of the Canyon at this time (**Figure 1**). During the last interglacial, about 125,000 years ago, when sea level was within a meter or so of its present-day level, the Mississippi River deposited the Prairie Delta, west of the Canyon. During the previous glacial period of low sea level at about 135,000 years before present, Tripsanas et al. (2007) showed that the Mississippi River fed Bryant Submarine Canyon further to the West (**Figure 1**). The modern-day Bird's Foot Delta of the Mississippi River began to form about 7,000 years ago (Blum and Roberts, 2012). These studies suggest that subsurface Mississippi Canyon began to form about 60,000 years ago as the Mississippi River extended across the exposed continental shelf. When sea level rose about 40,000 years ago, the Canyon may have partially back-filled. Another sea level fall at 25,000 years ago brought the river again to the Canyon head and lead to a new round of canyon cutting. By about 7,000 years ago the Mississippi River avulsed East and began to form its modern-day delta, cutting the Canyon off from its supply of sediment.

SURFACE EXPRESSION OF THE CANYON

The Bureau of Ocean Energy Management (BOEM) made available high-resolution bathymetry of the northern Gulf of Mexico (https://catalog.data.gov/dataset/gulf-of-mexico-deepwater-bathymetry-with-hillshade). These data clearly show the seafloor expression of Mississippi Canyon (**Figure 1**). The Canyon penetrates the continental shelf for about 30 km and extends 175 km across the continental slope into the basin. It is up to 400 m deep and over 35 km wide. The Canyon is flat bottomed, unlike many submarine canyons that are V-shaped in cross-section (Fisher eta al., 2021). Prominent scallop-shaped slump scars appear on both NE and SW walls of the Canyon suggesting that it has widened by slumping of sediment off its margins. The Canyon is situated in a region of active salt tectonics with salt-cored structures clearly visible on the seafloor. The head of the Canyon is at the -120 m isobath. Sea level fell to this water depth during the Last Glacial Maximum (LGM) about 20,000 years ago (Miller et al., 2020). The Canyon does not have a bathymetric expression on the continental shelf.

SUBSURFACE EXPRESSION OF THE MISSISSIPPI CANYON

A 3D seismic reflection dataset made available by the USGS (https://walrus.wr.usgs.gov/namss/) that lies in the middle to lower continental slope was used to study the fill of Canyon (**Figures 1, 2** and **3**). Here, the Canyon truncates older mass-transport complexes that underlie it (Figure 2). The subsurface morphology follows a steers-head shape, with gently sloping walls towards the margins, steep walls around the axis, and a flat base. Many scallop-shaped scars cut into the canyon's axial walls. There are two large, well-defined scars, one on the West wall at the northern, up-dip edge of the survey and one further south on the East wall. These features **Technical Article** continued on page 13

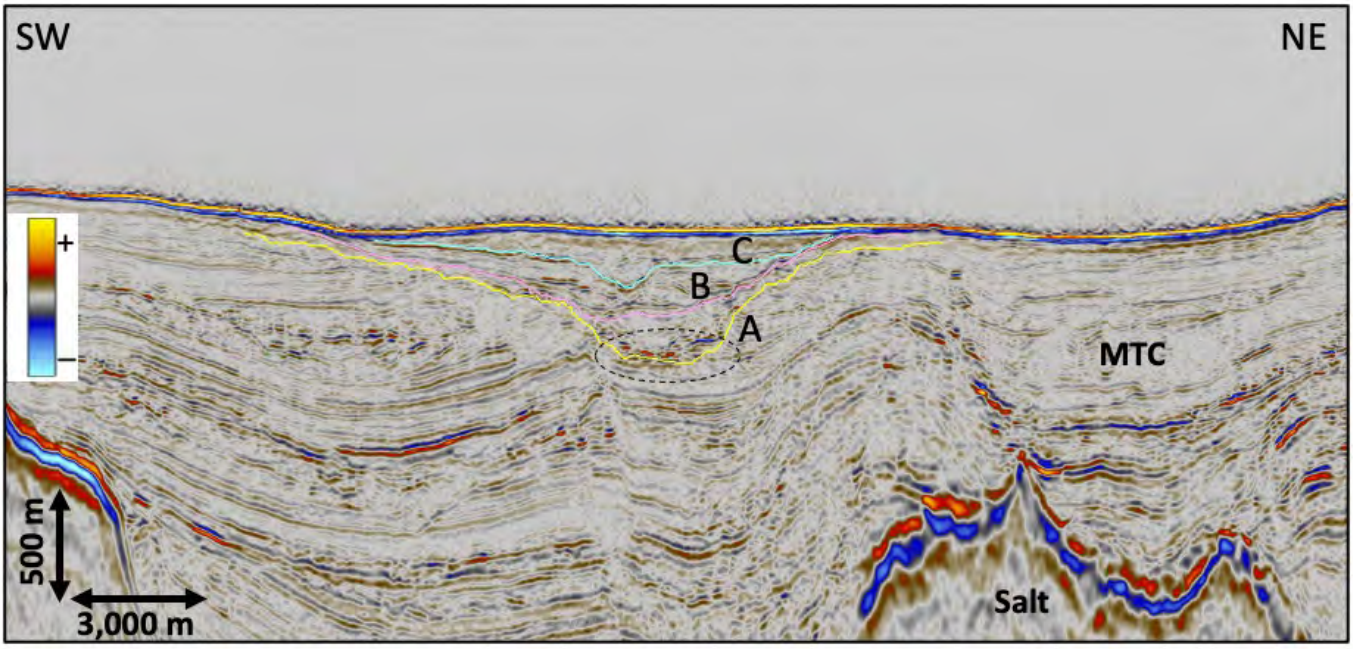


Figure 2. *West to east oriented seismic reflection line showing erosion and fill of the subsurface Mississippi Canyon. Erosion surfaces A (yellow), B (lavender) and C (light blue) and general facies between each are described in the text. Below the canyon is a prominent feature interpreted as a Mass Transport Complex (MTC). Faulting and deformation of the strata below the canyon are related to an underlying salt body.*

Technical Article continued from page 12

seen on seismic reflection data are very similar in shape and scale to those seen on the seafloor. They suggest widening of the canyon by slumping of its margins.

Within the Canyon fill, we have mapped three major erosional (**Figures 2** and **3**). Surface A is the base of the subsurface canyon (**Figures 2** and **3**). Overlying this surface are flat, high-amplitude reflectors. Depth slices reveal that these reflections have the shape of low-sinuosity channels in map view (**Figure 4a**). These high amplitude reflectors are notably absent in about a quarter of the mapped area, where an allochthonous salt body juxtaposes the base and East wall of the Canyon. This area also aligns with a structural high on the base canyon surface. Where the high amplitude channelized basal reflections are present, they are variably overlain by discontinuous, low amplitude, chaotic reflectors with little internal structure. We interpret these seismic facies as basal coarse-grained channelized deposits, followed by mass transport deposits generated by collapse of the Canyon's walls.

Surface B marks a change in the character of the Canyon's fill (**Figure 2**). Semi-continuous, moderate amplitude reflectors comprise the majority of this section. Sub-parallel reflectors progressively onlap the Canyon's steep axial walls, and chaotic reflectors comprise most of the fill along the Canyon's axis. Locally, reflectors onlap the Canyon walls and downlap onto the Canyon axis. The chaotic axial-fill aggrades conformably in some areas and truncates internally in others, often exhibiting both in a single section. Channel forms are visible on depth slices near the base of Surface B, but are lower amplitude than those at the base of Surface A. This section constitutes the majority of the fill, representing continued flow through the Canyon with simultaneous filling and widening by sediment coming off the walls, evidenced by the convergence of the subsurface walls of surfaces A and B.

Surface C truncates earlier fill, is generally more V-shaped than the other two surfaces, and onlaps the earlier surfaces (**Figure 2**). Above its axis, the fill is mostly chaotic with little internal structure. Overlying this is a moderately continuous low-amplitude reflectors that directly underly the seafloor. This surface likely represents the Canyon's late-stage configuration before being disconnected from the Mississippi River. We interpret these deposits as being mud-rich based on their low amplitude, draping seismic geometry.

The axis of the Canyon seen on each surface is almost identical, where it trends NNW-SSE in the northern two-thirds of the mapped area, and relatively abruptly shifts to trending N-S in the southern third (**Figure 4**). Structurally high allochthonous salt trends NNW-SSE adjacent to the Canyon's East wall in the middle third of the survey. This structure deepens and then rises again adjacent to the West wall, trending N-S, in the southern third of the area, routing the Canyon through the structural low and likely causing the change in the Canyon's trend. Paired with the absence of high amplitude channels at the base of the Canyon related to another salt high, it strongly suggests that the salt had a significant influence in both the routing of the Canyon and the character of its fill. Further work is needed to fully understand this influence, but its role in shaping the canyon is clear.

There are limited data to constrain the lithology and age of the canyon-fill deposits. Goodman and Prior (1989) reported lithology and 14C age dates from **Technical Article** continued on page 14

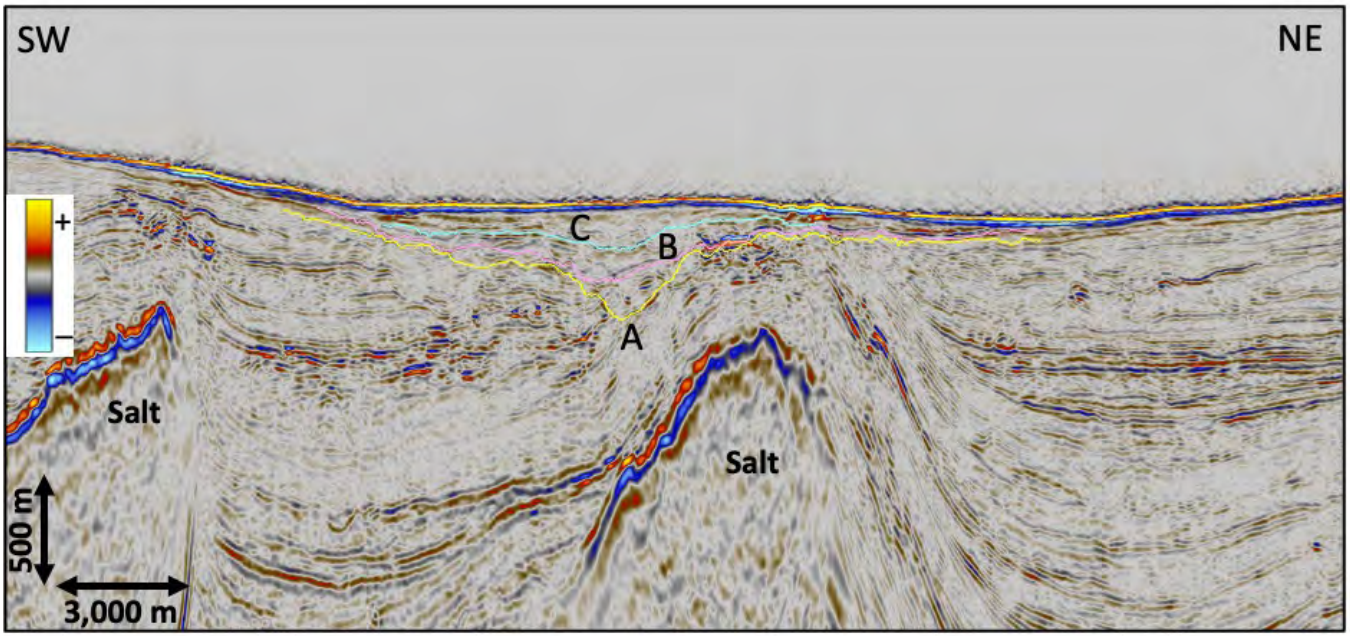


Figure 3. *West to east oriented seismic reflection line showing erosion and fill of the subsurface Mississippi Canyon. A large salt diapir is observed east of the canyon. Note the absence of flat, high amplitude reflectors at the base of the canyon.*

Technical Article continued from page 13

a research well drilled to a depth of 683 m below the mudline in the middle reaches of the canyon. The deepest unit penetrated by this well encountered a mixture of sand and mud with some gravel that was at least 30,000 years old. A significant unconformity separated these deposits from a unit of laminated mudstone that was dated to be 19,000 years old. Overlying this section were deformed mudstone that ranged in age from 12,000 to 7,000 years old. Sediments of a similar age were observed in Ocean Drilling Program cores from the upper reaches Mississippi Fan, downdip of Mississippi Canyon. These cores encountered abundant muds and lesser sand and gravel-size sediments (Bouma et al., 1985).

Bathymetric data that shows the head of the Canyon was at or near sea level during the LGM and the occurrence of gravel-sized clasts suggests that the Mississippi River flowed directly into the head of Mississippi Canyon during the LGM.

CONCLUSIONS

Mississippi Canyon is a large, shelf-penetrating, passive margin submarine canyon.

It has acted as a conduit for moving Mississippi River sediment, especially sand, to the Mississippi Fan for at least the last 30,000 years. Seismic reflection data and very limit core data suggests that the lower part of the canyon fill contains sand and gravel that was deposited during MIS-4. Younger sediments appear to be muddier and are comprised of channel-fill deposits and muddy slumped material from the canyon margins.

Mississippi Canyon is uniquely well exposed at the seafloor in a region of active salt deformation. It clearly acts as a conduit routing sand from the Mississippi River into deep water. By understanding how it formed we can improve our predictions of sand routing through salt the deeper section of the Gulf where the connection between deltas and submarine fans are obscured by deep burial and/or later salt deformation. Better understanding of the sand routing system can improve reservoir presence risking. Our group at The University of Texas Jackson School is just starting our research into the evolution of Mississippi Canyon and we are excited about what we will learn as our research progresses. ■

ACKNOWLEDGEMENTS

This work was supported by the Gulf Basin Depositional Synthesis Project (GBDS) at **Technical Article** *continued on page 15*

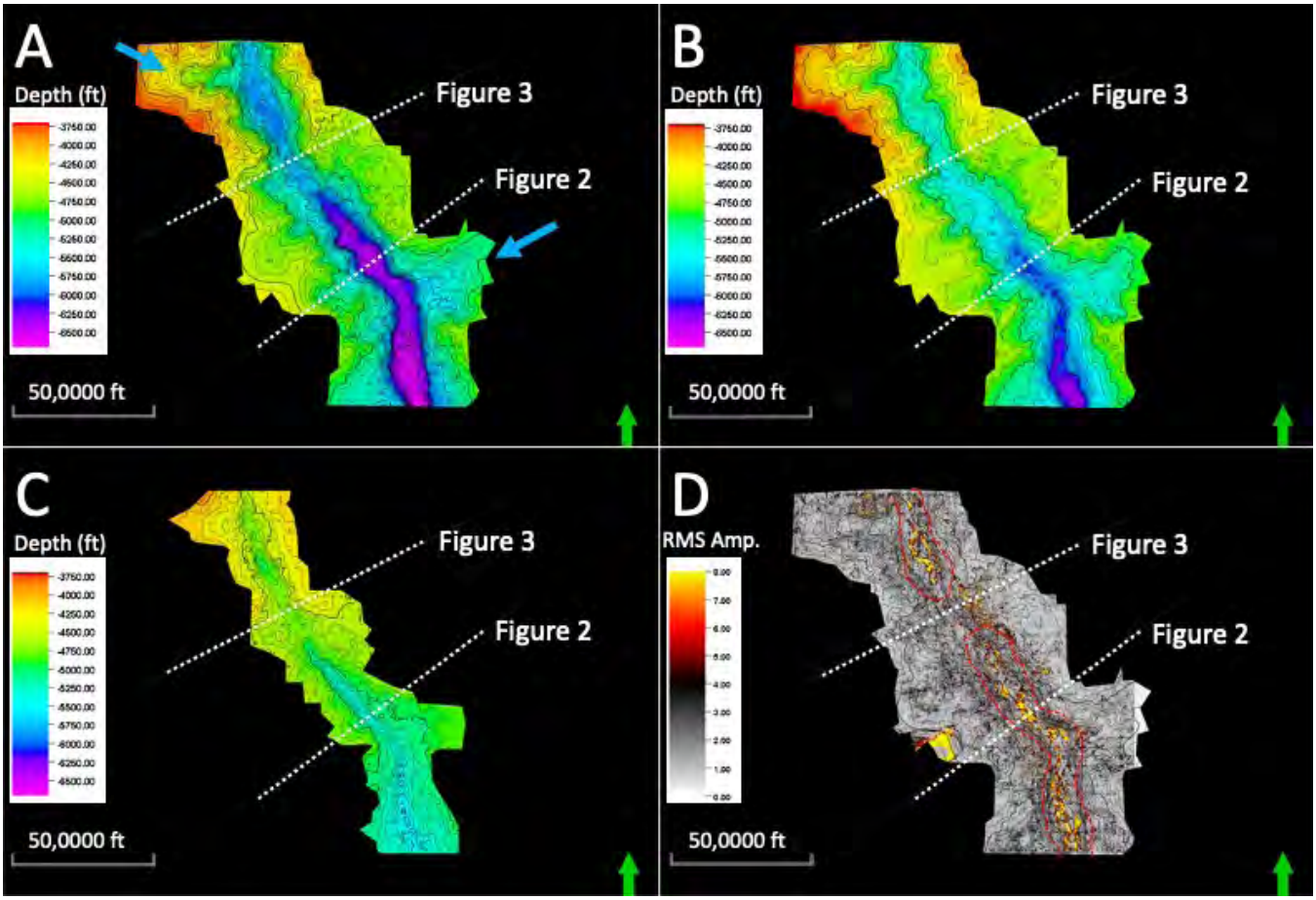


Figure 4. ***A)*** *Depth to Surface A map. Note prominent scallop-shaped features (blue arrows) described in the text, along with smaller scallops.* ***B)*** *Depth to Surface B map.* ***C)*** *Depth to surface C map.* ***D)*** *RMS amplitude extraction displayed on depth to Surface A contour map. Low sinuosity, high amplitude channels at the base (red dashed outline) are present in most of the canyon, but absent at structural high on Surface A.*

Technical Article continued from page 14

the Institute for Geophysics, The University of Texas at Austin. We acknowledge the funding companies for their support. Jacob Margoshes received additional support from the Department of Earth and Planetary Science at The University of Texas at Austin. Discussions with our colleagues Jake Covault and Juan Gutierrez contributed our understanding of Mississippi Canyon. John Snedden reviewed an earlier draft of this paper. Our thanks to HGS Editor Caroline Wachtman for her careful reading of our manuscript and her useful suggestions to improve its quality.

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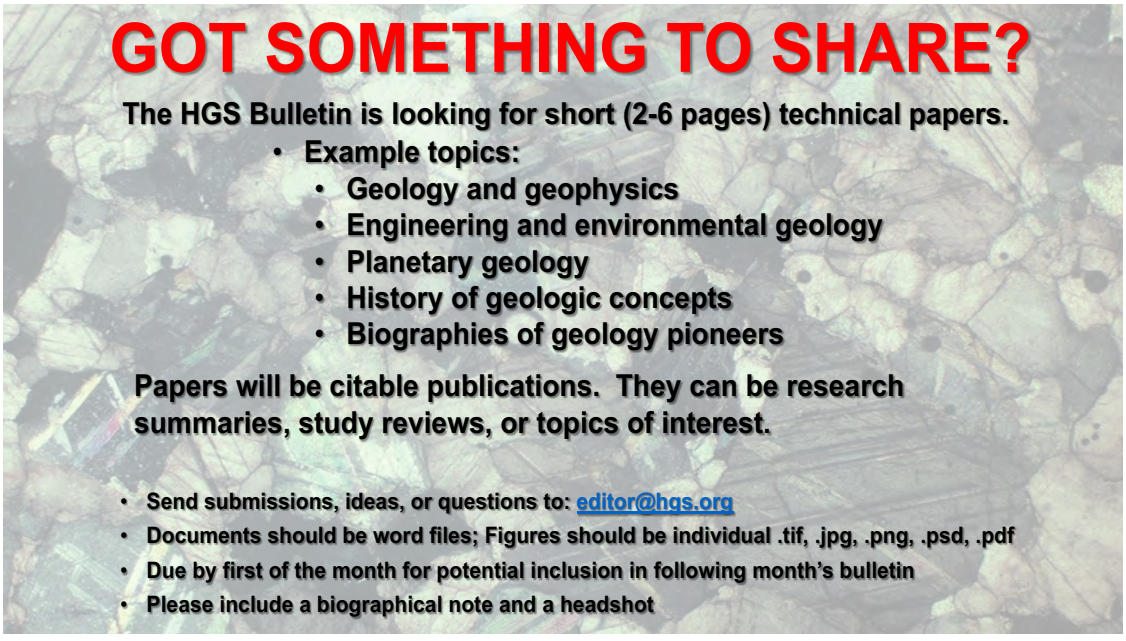


Deepwater Exploration Leads the 39th Annual GCSSEPM Foundation Perkins-Rosen Conference at Equinor US

By J. R. Rotzien

Join fellow HGS members at the 39th Annual Gulf Coast Section of the Society for Sedimentary Geology (GSSEPM) Foundation Perkins-Rosen Conference focused on Deepwater Exploration and Potential. This year's conference will be held at Equinor's office in Houston on December 4-6, 2023.

The Perkins-Rosen Conference started in 1980 as the Gulf Coast Section SEPM (GCSSEPM) Research Conference. The GCSSEPM Foundation was established in 1981 as a 501c3 tax-exempt corporation to organize and conduct the Research Conference, which acquired its present name sequentially in grateful recognition and appreciation of the major contributions of the first Executive Directors of the Foundation: Bob F. Perkins and Norman "Norm" C. Rosen.

The Perkins-Rosen Research Conference has created a rich legacy of exploring timely and important sedimentary geology topics, routinely featuring many of the most notable geoscientists in their respective fields – Chief Geologists, Presidents & Vice Presidents of Exploration, Professors, Wildcatters, Subject Matter Experts – making it one of the premier and most distinctive research conferences in the world. This year, over 30 presenters working across all oil-producing continents showcase the latest results of their deepwater exploration plays and research activities. Conference sponsors include Equinor (venue sponsor), Chevron, ExxonMobil, Petrostrat, RohmTek and ConocoPhillips. If interested in becoming a conference sponsor, contact John Suter, the current Executive Director of the GCSSEPM Foundation, at gcssepm1@gmail.com. Conference registration ends soon, so sign up today at https://sepm.org/2023-perkins-rosen-gcssepm-rc.

The conference focuses on themes that have matured over the last thirty years since the first deepwater-focused conference in 1994. That conference focused on submarine fans and their architecture, processes, and deposits. Some of the key aspects explored this year include:

- Deepwater exploration play types: what has worked and not worked
- New modeling techniques enabling better prediction of deepwater deposits
- Source-to-sink methods that have increased drilling success
- Plays in basins with mobile substrates including salt and mud
- Dogma-busting: where we were 30 years ago, and how we could be thinking about the value of deepwater systems over the next decades
- Deepwater mudrocks and their role as source, reservoir and seals

The conference technical committee is led by some of the most esteemed deepwater explorers from industry, academia and government agencies including Luke Walker, Vitor Abreu, Juan Fedele, Tao Sun, Jason Flaum, Lori Fremin, Daniel Minisini, Samuel Plitzuweit, Kevin Reece, Clara Rodriguez and John Snedden.

The conveners include the editors of the deepwater treatise published by Elsevier in 2022: Cindy Yeilding, Richard Sears and F. Javier Hernández-Molina. John Suter is sincerely thanked for his help in developing and executing this year's conference.

Highlights of the conference include two keynotes pertaining to exploration successes and giant fields by Fernando Sanchez Ferrer (Shell) and Mark Shann (Westlawn Americas Offshore). Bold themes introduced by Ferrer and Shann may not be well understood for another 10-20 years until more wildcats are drilled in frontier settings.

Monday sessions feature presentations by HGS members Daniel Minisini (Shell) and Paul Mann (University of Houston), Richard A. Sears (Gamechanger; retired, Shell), John Snedden (University of Texas), Dick Bishop (retired, ExxonMobil) and Neal Auchter (Shell). Other presenters include Samuel Plitzuweit (ExxonMobil),Thomas Heard (Shell) and Juan Fedele (ExxonMobil).

Summarizing the day will be a conversation with Cindy Yeilding and Richard Sears on themes in exploration potential and where deepwater exploration is headed.

Tuesday features presentations by David Mohrig (University of Texas), C. Robertson Handford (Consultant/ CSM), Paul Myrow (Colorado College), Kenn Ehman (Chevron), Ariana Osman (University of the West Indies), Michael Sweet (University of Texas), Kyle Straub (Tulane University), Kevin Reece (Tulane University), Tao Sun (Chevron), Elisabeth Gillbard (TGS) and HGS member Robert Pascoe (Dynamic Group).

Vitor Abreu, Juan Fedele, Tao Sun and Daniel Minisini will summarize the day. You won't want to miss their insightful analysis of deepwater exploration in the GOM and abroad.

Wednesday features presentations by HGS members Patricio Desjardins (Shell), Neal Auchter, and Peter Mullin (Werrus Aquamarine). Other presenters include Ofelia Silio (YPF), Tiago Alves (Cardiff University), Juan Gutiérrez (University of Texas) and Howard Feldman (Feldman Geosciences).

Concluding the presentations, Cindy Yeilding, Richard Sears and Tiago Alves will discuss the achievements of the conference and The Next 100 Years of Deepwater.

From 2:15pm – 4:30pm, Chevron's Tao Sun presents an interactive short course on deepwater sedimentary processes, products and modeling.

Houston Geological Society

Scholarship Night

FEBRUARY 12, 2024 | 5:30pm - 9:00pm

Norris Conference Center, Houston, TX

How Geological Field Work in the Guadalupe Mountains Helped Solve Oil Field Production Problems in the Permian Super Basin: Real Case Studies - Introducing the Houston Geological Society Guadalupe Mountain Field Trip.

Guest Speaker
Robert (Bob) Lindsay

Member $65.00
Non-Member/Walk ups $75.00

Online & pre-registration closes Monday, February 12, at 5:00 a.m.

CLICK HERE TO SIGN UP EARLY!

HGS NeoGeos 2023-2024 Happy Hour Schedule

*Locations may be subject to change as dates approach

~~Thursday, September 28th - Walking Stick Brewery~~

Wednesday, October 25th – Kirby Ice House (Memorial)**
Change of date due to Astros Game**

Thursday, November 30th – GeoTrivia @ Cottonwood

Thursday, January 19th – Walking Stick Brewery

Thursday, February 22nd – Kirby Ice House (Memorial)

Thursday, March 21st – GeoTrivia @ Cottonwood

Thursday, April 18th – Walking Stick Brewery

Thursday, May 23rd - Kirby Ice House (Memorial)

Sponsorship opportunities available:
Contact Bryan @ geobottoms@gmail.com

The Houston Geological Society Continuing Education Committee Presents

Fundamentals of Basin Modeling in Oil Exploration

Angel Callejon
Thursday, January 18, 2024
Zoom Class 8:00am – 12:00pm CST

COURSE DESCRIPTION

In this four-hour course, students will learn the fundamentals of basin modeling for oil and gas exploration, including data requirements and modeling workflows.

SUMMARY

This course aims to equip geoscientists with knowledge and skills in basin modeling workflows and the associated data requirements. The curriculum is designed to provide an introductory understanding of the fundamentals necessary for effective basin analysis. Participants will explore basin modeling topics such as petroleum systems, thermal history, hydrocarbon generation, migration, and preservation mechanisms.

PRICING

$200 for HGS Members
$100 Student/Emeritus/In-transition members
$300 *Non-Members.

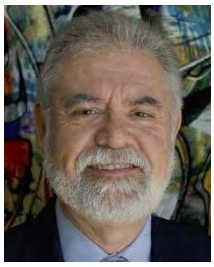
*Non-Members can submit an application and pay their dues before registering to get the member price. Please call the HGS office at 713-463-9476 to be registered only AFTER your application and dues are submitted.

KEY LEARNING OBJECTIVES

1. **Building a physical model:** Understand the geological processes shaping sedimentary basins and their implications for basin modeling and the petroleum system.
2. **Building a thermal model:** Learn the principles of thermal modeling to assess the history of temperature changes within the basin, crucial for understanding hydrocarbon maturation.
3. **Building a generative model:** Explore the mechanisms of hydrocarbon generation, migration, trapping and sealing that are essential for predicting potential reservoirs.

By the end of this course, participants will be able to apply basin modeling techniques to make informed decisions on the exploration of hydrocarbon resources. Whether you are a seasoned geoscientist or a junior professional seeking to enhance your skills, this course provides a solid foundation for effective basin analysis

ABOUT THE INSTRUCTOR



Petroleum Systems Assessment Specialist
MS Geochemistry at Universidad Central de Venezuela and
a BS Chemistry at Universidad Simón Bolívar
https://www.linkedin.com/in/callejon

Angel Callejon joined the Oil and Gas Industry in 1988 after teaching geology for more than five years at Universidad Central de Venezuela. Since then, he has applied his geochemistry and basin modeling expertise to hydrocarbon exploration at PDVSA, UH, PRA, ExxonMobil and Equinor. Most recently, he has used modeling and geochemistry to predict GOR and PVT properties in unconventional plays. Callejon also developed a chemo-stratigraphic framework for the Austin Chalk, Eagle Ford, and Buda Formations to characterize and drill sweet spots within the unconventional plays.

Since late 2015, Callejon has been an independent consultant in geochemistry and petroleum systems analysis for petroleum exploration and production. Recently, he has applied his skills to evaluate Carbon Capture and Storage projects.

Callejon has an extensive publication record; is a reviewer for the Journal of Marine and Petroleum Geology, Journal of Organic Geochemistry and AAPG Explorer; and has lectured on the topic of Petroleum Systems at the University of Houston for the past 15 years. Angel joined the Houston Geological Society's Continuing Education Committee early 2023 and is currently the Committee's Chair.

Thursday, January 18, 2024 • 8:00am – 12:00pm • Zoom Class
Please make your reservations on-line
https://www.hgs.org/civicrm/event/info?id=2537

For more information about this event, contact Angel Callejon, callejon@yet2find.com

The Houston Geological Society Continuing Education Committee Presents

Clastic Depositional Systems

Mike Sweet
Thursday, March 28, 2024
Core Lab, Building 2
6323 Windfern, Houston, TX 77040
8:00am – 5:00pm

COURSE OBJECTIVES

1. Understand how sediment is routed through clastic depositional systems from source to sink
2. Learn to identify clastic depositional environments using core, log and seismic data
3. Understand how the spatial organization of facies in each environment of deposition affects the subsurface flow of fluids.

COURSE OUTLINE

This course will cover the following topics:

- Source-to-Sink concepts
- The controls of grain size, sorting and diagenesis on porosity and permeability
- Eolian Depositional Environments
- Fluvial Depositional Environments
- Shoreface Depositional Environments
- Deltaic Depositional Environments
- Marine Shelf Depositional Environments
- Slope and Deep-Water Depositional Environments
- Final Exercise

PRICING

$475 for HGS Members
$225 Student/Emeritus
$600 *Non-Members.

Registration will close Wednesday, March 27, 2024 at 4 p.m.

Attendees will receive a Certificate of Continuing Education for 8 Professional Development Hours and digital course notes. Lunch is included. *Students should bring pencils, a ruler and their laptops.*

*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.

ABOUT THE INSTRUCTOR

Mike Sweet began his role as Co-director of the Gulf of Mexico Basin Depositional Synthesis Project (GBDS) at the University of Texas, Jackson School of Geosciences Institute for Geophysics since 2019. The GBDS is an industry-supported research project that assembles and synthesizes well, seismic, and other data to establish a basin-scale depositional history of the Gulf of Mexico. His work focuses on Cenozoic depositional systems, particularly on quantifying how sediment moves between shallow marine and deep-water environments.

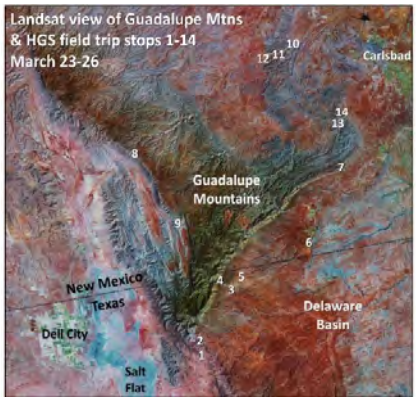
Previously, Sweet spent 18 years working as a stratigrapher for the ExxonMobil Research Company where he described kilometers of core and taught numerous field and classroom courses in clastic stratigraphy. He won the ExxonMobil Excellence in Instruction Award seven times. In addition to his experience in research, Sweet worked as the geoscience led for Angola Production and as a Geologic Advisor to the Caribbean exploration team. Before joining ExxonMobil, Sweet spent 10 years at BP Exploration as a sedimentologist working on clastic reservoir description projects in the North Sea, North Slope, Gulf of Mexico and Colombia. Throughout his career, Sweet has published extensively on deep-water clastic facies and reservoir geology.

Sweet received his PhD in Geology from The University of Texas-Austin in 1989. He is the current President of the Gulf Coast Section of SEPM, has served on the GeoGulf Technical Program Committee (2020-2021), and was Editor of the AAPG Bulletin from 2013-2016

Thursday, March 28, 2024 • 8:00am – 5:00pm
Core Lab, Building 2, 6323 Windfern, Houston, TX 77040
Registration will close Wednesday, March 27, 2024 at 4 p.m
Please make your reservations on-line
https://www.hgs.org/civicrm/event/info?id=2538

For more information about this event, contact Bill DeMis, billdemis@aol.com

GUADALUPE MOUNTAIN AND DELAWARE BASIN FIELD TRIP



When: March 21- 24, 2024

Where: Starts/ends in Midland, Texas and base camp is Carlsbad, New Mexico

Itinerary: Carbonates Galore – Debris flows, turbidites, shelf margins, basin floor deposition, and sponge-algal reef as presented by Dr. Robert Lindsay who will be giving a talk on the topic on February 12, 2024 during HGS Scholarship Night in the Magnolia Room Norris Conference Center. Dr. Lindsey has led dozens of field trips in this area in the past.

Cost: $1,400 (Deposit of $800 due with registration; Final balance due by March 7, 2024) includes local transportation to and from Midland airport, van transportation to the various geologic stops, van snacks and water, guidebook, welcome dinner, daily lunches, 3 nights lodging at the Stevens Inn. Cost does not include airfare/ transportation from home to Midland and back.

Registration Deadline: March 9, 2023

Please contact the HGS (713-463-9476) to reserve a spot early (Limited spaces left).


Drawing Middle Permian lithofacies onto 38 mile cross section – Guadalupe Mtns into Delaware Basin


Guadalupe Mountains: View of El Capitan with Guadalupe Peak, highest peak in Texas, in the background

Preview of HGS Legends Night, January 8, 2024
An Interview with Bill Armstrong

By Charles A. Sternbach, *Legends Moderator and originator of the HGS Legends Program*

Bill Armstrong, founder of Armstrong Oil & Gas, Inc. in 1985, will be our HGS Legends night speaker. Bill has made many discoveries over the years, but Armstrong's largest success has been on the North Slope of Alaska, where he and his team have found numerous 100+ million-barrel oil fields. His successes include the Horseshoe/Pikka Field, which experts say could develop into the third-largest conventional oil field in U.S. history, only behind Prudhoe Bay and East Texas fields. Bill is a geologist and an inspiring explorer!

How did you get started in Alaska?

My first interest in Alaska dates to 2001. Recall that the industry was abuzz about the happenings in the deepwater GOM around that time. Thunder Horse Field (originally called Crazy Horse, discovered in 1999) was being developed. I was blown away, and my geologic paradigm was shattered. No way good sands can be that far from the GOM shelf. At least, that was my paradigm.

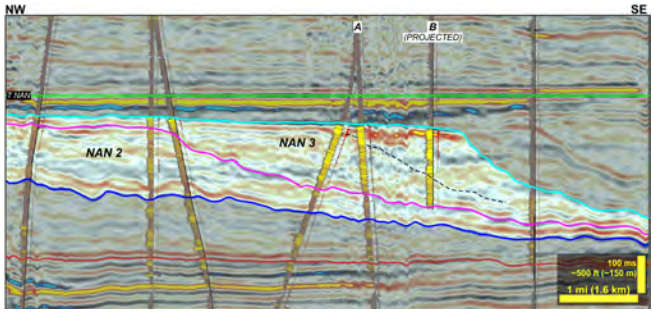
I hired an Exxon Geologist named Matt Furin, who understood the GOM. I told him I liked to look for new ideas with the big-time running room, like the deepwater GOM in those days. He then told me about a well that Exxon had drilled on the North Slope that was "close," but they had chosen not to follow up on. That had as much to do with the fallout from the Valdez oil spill as it did geology. My team and I tore into the North Slope and couldn't believe how under-explored it was. Plus, the oil flow through the TAPS pipeline was in steep decline, so there was plenty of room in the infrastructure for newcomers.

What were some of the milestones and challenges you had to overcome?

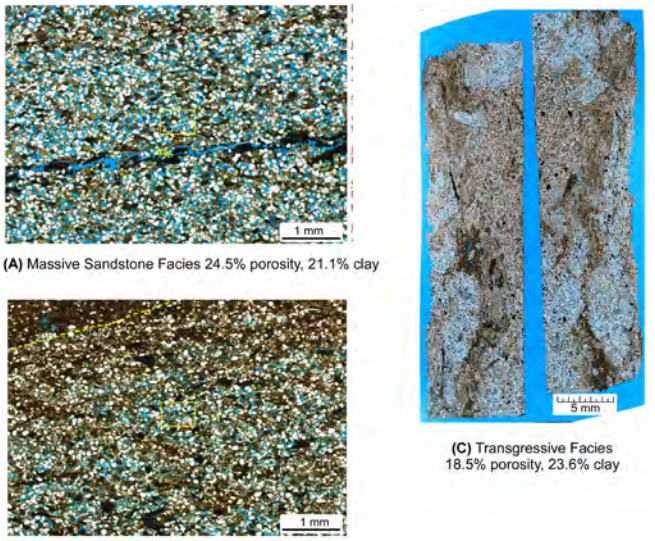
For the most part, the North Slope challenges are mostly above ground: cold weather, opposition from NGOs, legacy producers that discourage competition, Native groups, etc.

What were the critical insight(s) to the discovery?

We have had multiple big discoveries on the North Slope (ten separate 100+ MBO recoverable discoveries so far). With each discovery, we learn something new and important. The biggest surprise is the size and productivity of the shallow Nanushuk formation. A new idea, particularly an overlooked one, in an established "mature" oil province is rare. Since discovering Pikka, the industry is 31 out of 34 on wildcat/appraisal wells with a 94 percent success rate in the Nanushuk.



Seismic dip section



Reservoir quality photomicrographs

How big can it be?

We believe the Pikka field will be more than 3.5 billion barrels recoverable—the third largest field in U.S. history. Prudhoe Bay #1, East Texas #2, and Pikka #3. (Editorial Note: To fully appreciate these discoveries globally, they are the first onshore Super Giant(s) in North America since Cantarell, Mexico, in the 1980s and are an inspiring geopolitical game changer.)

Can you share a few personal stories?

These will take some time. I might be able to talk about some great war stories at the event. But every true Wildcatter knows the thrill of a big discovery.

What are the defining trap elements of Pikka?

The updip seal is the key to these Nanushuk stratigraphic traps. But reservoir quality also varies a bit; some subtle (sometimes) structural elements and variations in crude viscosities are present.

Bill Armstrong *continued on page 23*

Bill Armstrong continued from page 22

Are all the clinoforms prospective or only those with folded structural lateral seals?
Avoid any of the clinoforms at your peril. The subtle structural elements are not obvious initially due to a serious lack of structuration on the North Slope. It is crazy quiescent. Of course, not all clinoforms will work. But quite a few will.

(*Editorial Note:* In a fairway north of the Brooks Range and south of the Beaufort Sea, stretching from the National Petroleum Reserve Alaska in the west to the Arctic National Wildlife Refuge in the east, hundreds of clinoforms and subclinoforms are unexplored.)

The AVO in these reservoirs is extraordinary. How is that possible?
This phenomenon is extraordinary and something that we have been able to ascertain as we learn more and more and "dial in" our geology and geophysics. AVO anomalies must be firmly rooted in solid geologic understanding, or they will be misused. Due to permafrost, surface issues, and shallow coals, the seismic data quality on the North Slope is quite a bit worse than the pristine offshore seismic data most companies are used to working with. But, on the positive side, most source rocks on the Slope are oil-mature with little gas in the system. The direct detection of oil is "the holy grail" for explorationists.

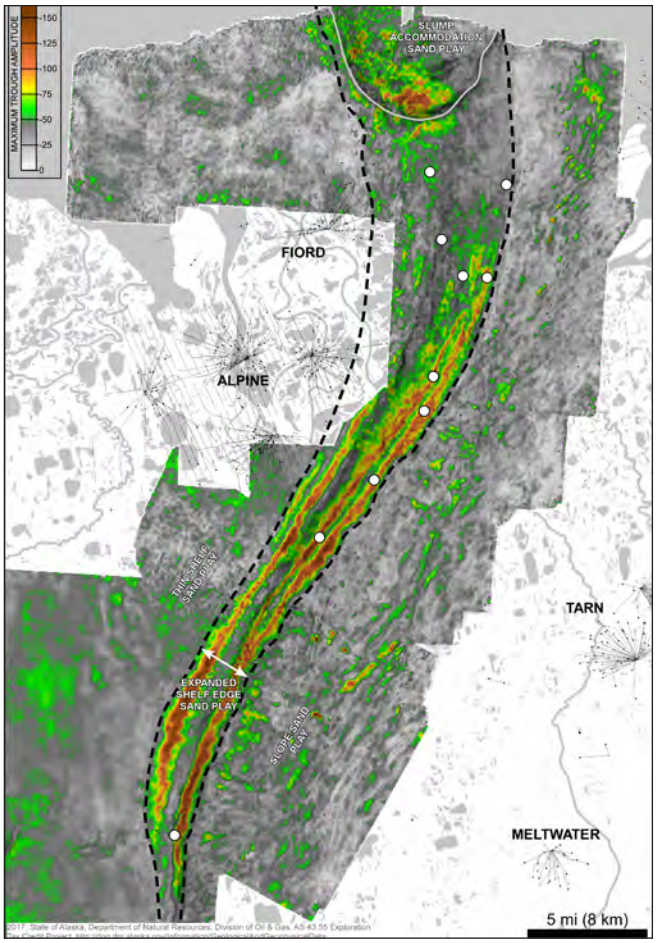
What are you working on now, and how might that expand the productive fairway?
We want to expand our discoveries to the West and East. There is a lot of big-time running room left on the North Slope.

Who were your heroes and mentors?
This list is long and colorful: Boone Pickens, Jim Wallace, my dad (Jerry Armstrong), Tom Jordan, Michel Halbouty, Don Evans, RO Anderson, Tom Brown, Arnold Palmer (my first-ever boss), Bill Saxon—so many great role models. I think we all need heroes in our lives.

Can you tell us what being a wildcatter means to you?
I need always to be looking for what is new and what might be possible. I know many people don't have the stomach for wildcatting, and I get that. But don't underestimate the leverage potential of a successful wildcat.

Thank You, Bill. HGS has had Michel Halbouty and Boone Pickens (some of your mentors) speak at previous HGS Legends programs. Halbouty famously said 2003, "I can't live without wildcatting." Thank you for being a keeper of the wildcatter flame.

We look forward to seeing you at the HGS Legends Night on Monday, January 8, 2024, at the Norris Conference Center, Houston. From 1999, 25 years ago, the HGS Legends program has been about role models. Thank you for continuing the HGS Legends tradition.



Amplitude map

Bill Armstrong was a featured speaker at the Discovery Thinking Forum at the AAPG/SEG IMAGE meeting on August 30, 2023, in Houston. The Forum was highly attended, and Bill's talk packed the house to standing room only in a room capable of seating 500.

Bill's team also published a well-illustrated account of the Pikka discovery in 2021. Several illustrations were featured on the Cover of AAPG Memoir 125 and included on the HGS *Bulletin* cover.

REFERENCE

J.V. Sommer, Dorrington, K., VanDenberg, C., Bonelli, J.R., Algeibez Alonso, J.L., 2021. "Pikka Field and the Opening of the Nununshuk Play, North Slope, Alaska," pages 301-338, in the AAPG Memoir 125 Giant Fields of the Decade 2010-2020, Edited by Sternbach, C.A., Merrill, R.K., Dolson, 455 pp.

BIO FROM THE WESTERN ENERGY ALLIANCE WEBPAGE

Bill founded Armstrong Oil & Gas, Inc. in 1985 in the attic office above his 100-year-old barn. Today, the privately held independent oil and natural gas exploration company is headquartered in downtown Denver and employs some of the most innovative thinkers in our industry. Armstrong chased deals in Kansas and independent-friendly regions like the Denver-Julesburg Basin and the Permian Basin in the early **Bill Armstrong** continued on page 24

Bill Armstrong continued from page 23

years. Later, he shifted focus by seeking top geologic, geophysical, land, and engineering talent, pursuing big "wildcat" opportunities in the United States and worldwide.

Armstrong's largest success has been on the North Slope of Alaska, where he and his team have found numerous 100+ million-barrel oil fields. His successes include the Horseshoe/Pikka Field, which experts say could develop into the third-largest conventional oil field in U.S. history, only behind Prudhoe Bay and East Texas fields. Over the last 36 years, Armstrong has been part of the discovery of over 20 oil and natural gas fields in the Williston Basin, Powder River Basin, Wyoming/Utah Overthrust Belt, Green River Basin, Michigan Basin, Cook Inlet, Gulf of Mexico, and San Joaquin Valley, among others. In 2019, Armstrong was profiled in The Wall Street Journal as "One of the Last Wildcatters."

Equally impressive is Armstrong's leadership in the community. He and Liz manage The Armstrong Foundation, primarily focusing on education and arts philanthropy. Their generosity includes funding the Denver Art Museum, Central City Opera, Armstrong Center of Dance at the Colorado Ballet, Residential Commons Complex, the Armstrong Field House at Southern Methodist University (SMU), Alaska Pacific University educational endowment, and Armstrong Dining Hall at Westminster School. Armstrong is a former Denver Art Museum board member and

Charles Sternbach, Bill Armstrong, and Susan Morrice celebrate Bill being inducted as the Western Energy Alliance Wildcatter of the Year in Denver on November 6, 2021.

trustee emeritus at the Colorado Ballet. He currently serves on the boards of Tourmaline Oil Corp. (Calgary) and Southern Methodist University (Dallas), where in 2021, both he and Liz received SMU's Distinguished Alumni Award.

In 2004, the couple founded Epoch Estate Wines, a premium vineyard and winery in Paso Robles, Calif. Armstrong is a member and past chairman of the All-American Wildcatters and sits on the National Petroleum Council. He graduated in 1982 from SMU with a Bachelor of Science in geology.

73rd Annual GCAGS Meeting
AND

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Do More, Do Less or Do the Same: Future of HGS

By Caroline Wachtman

SURVEY OVERVIEW

The HGS *Bulletin* conducted a survey to better understand the views of members. The survey was opened on 1 September 2023 and responses were recorded through 8 November 2023. A total of 90 responses were recorded, which is approximately equivalent to a 95% confidence level with ±10% error for the surveyed population. See **Figure 1** for demographic information. Survey results were dominated (nearly 80%) by people with more than 25 years of work experience. 50% of respondents are retired or self-employed, and 56% of respondents identify as technical contributors (**Figures 2** and **3**). This population of respondents dominated the survey results. Because less than 5% of responses came from early career people or students, the responses from this population are not within an acceptable confidence interval and margin of error.

In addition to the anonymous survey answers and written responses, nine HGS survey respondents volunteered to provide additional information: Dare Adeniyi, Lyle Baie, Meredith Faber, Joel Gervitz, Pete Lehle, Don Walker, Kurang Mehta, Richie Miller, and Haider Rizui. The discussion below highlights the feedback of survey respondents and those interviewed.

MOST INTERESTING TOPICS

Survey respondents say that onshore and offshore domestic oil and gas are the topics they most want to learn about through the HGS (**Figure 4**). The population is almost evenly divided on the question of whether they are interested in international oil and gas, planetary geology and mining. More respondents indicated they were not interested in local geology of Houston; Carbon Capture, Utilization and Storage (CCUS); or Environmental and Engineering topics. Based on the small number of student and early career respondents, it is not possible to determine whether their responses would be similar or different to the large number of senior career respondents.

HGS needs to rebrand to attract a younger generation

Despite the survey results indicating relatively low levels of interest in geothermal, CCUS, or Environmental Geology, written and verbal feedback from members provides a different perspective. Bill Dickson says, "Broaden the focus of HGS to think about CCUS and how we can use geotechnical expertise for siting solar and wind farms." Haider Rizui notes that "HGS has been oil and gas centric, but HGS needs to rebrand to attract younger generations." A similar view was shared by Richie Miller who wants to see HGS cover a broader range of geology topics to better respond to the changing industry.

VALUE OF HGS

Survey respondents were asked to describe the value that they receive from their membership in HGS (**Figure 5**). The majority of respondents cite that networking and technical training/knowledge sharing is what they value most from HGS. Lyle Baie explains that technical training is highly valuable, and could be more impactful to early career members by focusing on fundamental problem-solving methodologies. Because many of the Oil and Gas

HGS Survey Results *continued on page 28*

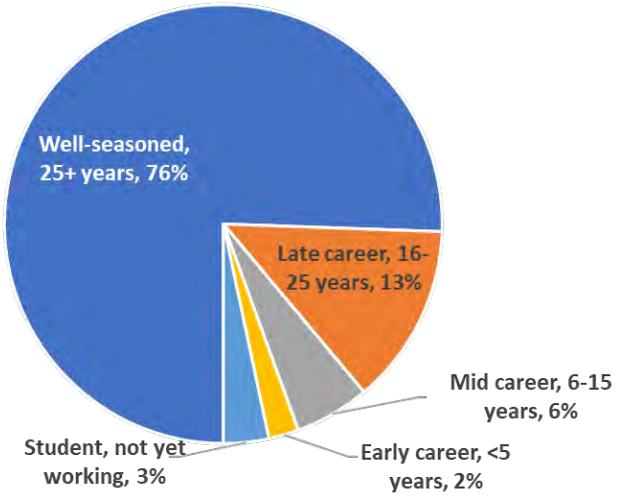


Figure 1. *Nearly 80% (68 people) of respondents identify as "well-seasoned with 25+ years of work experience." Of the remaining respondents, 13% (12 people) identify as being late career with 16-25 years of experience; 6% (5 people) identified as being mid-career with 6-15 years of experience, and 3% (2 people) identified as being early career with <5 years of experience. Three people self-identified as students. Because 90% of respondents have more than 16 years of experience, the survey responses are dominated by their views.*

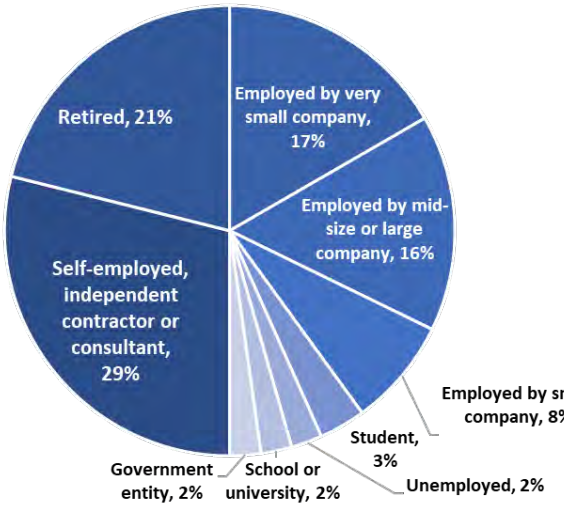


Figure 2. *50% of the respondents are either self-employed or retired. 40% are employed by companies and the remaining 10% are students, work for government entities or are unemployed.*

HGS Survey Results continued from page 27

field in the US are discovered, Baie recommends the HGS focus its training on workflows to discover bypassed pay or near field wildcats. He says that the methodology of being an oil-finder starts with understanding the history of a field and historical economics, rather than with a brand-new 3D seismic survey.

Leadership opportunities, such as opportunities for committee work were valuable to less than 30% of the respondents. This survey result is in sharp contrast to the feedback from HGS member Charles Sternbach, who says, "To all HGS members, if you want to derive more from your membership volunteer to serve HGS. In nearly 40 years as a member, I have learned a simple equation. The more you give the more you benefit." Multiple members expressed concern and frustration that younger members are not selected for leadership opportunities. Meredith Faber says, "Please don't recycle old leaders when you've got young professionals ready and willing to serve. Make volunteer opportunities known." Faber proposes that HGS should either make an open call for Board nominations, or specifically allocate some seats for early career professionals. Similarly, Kurang Mehta suggest that the HGS should provide younger volunteers with more committee leadership opportunities.

We need more advocacy that what we do is good for humanity

DO MORE, DO LESS, OR STAY THE SAME?

Consistent with the feedback from respondents that technical training and knowledge sharing is of high value to them, 56% respondents want HGS to do more of this (Figure 6). Based on feedback from survey-takers, HGS members want to see more virtual and recorded talks. Don Walker says, "Not all of the HGS membership lives in Houston. Please provide virtual attendance opportunities at talks so that those of us who want to remain engaged with HGS but are not currently in Houston can maximize value for money from the dues we pay. Every meeting of the Austin Geological Society has a virtual option for remote attendees, and this is common practice with SPE. My home is Houston, but I'm currently posted outside the U.S. for my job. I want to remain engaged with HGS. Please make that easier for me." An anonymous survey respondent says, "Would appreciate hybrid talks, a more inclusive price range, talks on different days (Wed/Thurs), and shorter events when they're held at night."

While only 30% of respondents say that HGS should offer more social opportunities, Bill Dickson wants to see the HGS pair social activities with technical activities. He says, "When you walk into a pub, you think party, but when you walk into a conference room it's a different attitude even if the topic is the same." Dickson advocates that Craft Republic (where the E&E Committee hold their monthly meetings), is a venue where people can experience both the social and technical value of HGS membership. Joel Gervitz offers that not all members of the HGS want to socialize through crawfish boils and golfing. He suggests starting a "jam session" group to attract musicians.

Approximately 40% of respondents say that education and outreach is of high value to them, and approximately the same percentage of respondents want HGS to do more of this. Multiple members expressed the view that HGS should do more education and outreach. Haider Rizui wants to see HGS take a much more active role in HGS Survey Results continued on page 29

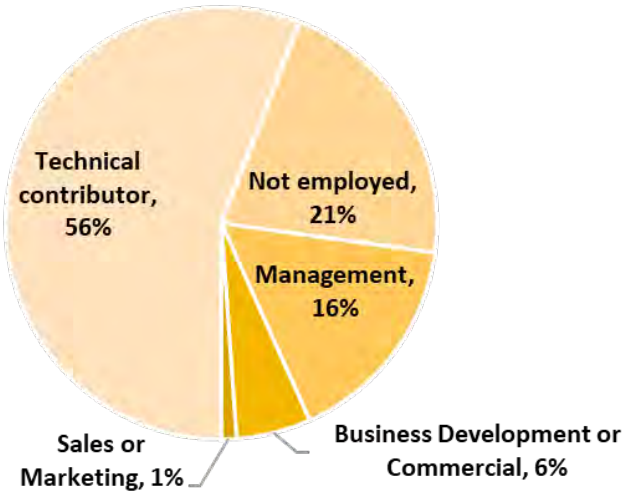


Figure 3. *The majority of respondents, 56% self-identify as technical contributors, and 16% identify as management. Over 20% are not employed. Of the remaining respondents, 6% are primarily involved in business development or commercial activities and 1% are involved in sales or marketing activities.*

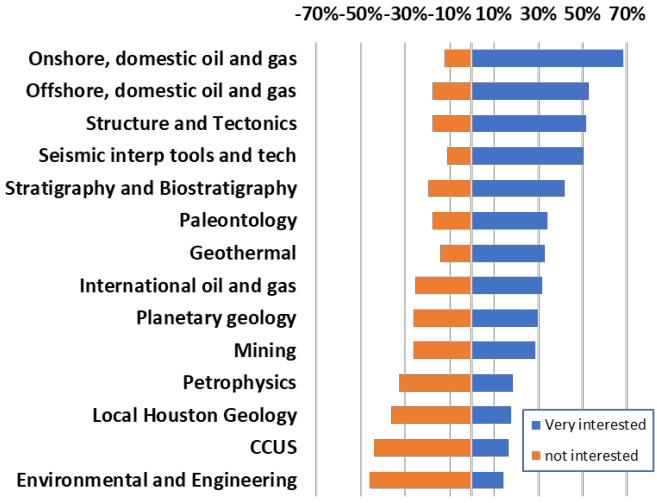


Figure 4. *68% of respondents indicated they were interested in learning more about onshore domestic oil and gas and 53% indicated they were interested in learning more about offshore domestic oil and gas. However, only 32% indicated they were interested in international oil and gas, which is approximately the same percentage who are interested in learning more about geothermal. 44% of respondents were not interested in learning about CCUS and 46% were not interested in learning about Environmental and Engineering Geology topics.*

HGS Survey Results continued from page 28

exposing high school students to geology, particularly those from underrepresented backgrounds. Pete Lehle also expressed strong encouragement for HGS to spend more time in schools. Lehle couples the need to get into schools with a message that the HGS should be a stronger advocate for the Oil and Gas Industry. He says, "Be a better advocate for the truth. We need more advocacy that what we do is good for humanity."

READING BETWEEN THE LINES

Three additional key themes emerged from the written and verbal feedback from survey respondents. First, members want the HGS to do more for workers in transition. Joel Gervitz says, "The Society needs to pay attention to what happens to us geologists; it needs to support people who are out of work." Gervitz suggests that HGS can support transitional geologists by offering business training courses, seminars on setting up LLCs, and resources for entrepreneurs. Similarly, the feedback from one anonymous respondent is that "HGS should do more on employment opportunities, networking with other professional societies in greater Houston and in Texas."

Second, multiple respondents indicated a desire to see more family-friendly events. For example, one anonymous respondent says the HGS needs "more family related events where children/guests can learn about our profession/science." Another anonymous respondent says, "Bring back more family related activities, YMCA camp, fall festival, museum night."

Although the data from survey respondents suggest uniformity of member viewpoints, verbal interviews reveal diversity of opinions. While some members want HGS be strictly focused on Oil and Gas and believe that the HGS should be an advocate for more Oil and Gas exploration (i.e., advocate against other forms of energy), other members think HGS should be advocating for a wide range of energy sources and expose its members to a wide range of geology topics. There is a vocal contingent of members who believe that younger people need to "earn a seat at the table," and there is a group of members who want to see HGS allocate leadership seats for early career people and students. While some members want all events to be in person at the Norris Center so that things can "get back to normal," many members embrace virtual events, lunchtime events and diverse venues. Furthermore, although some members believe the Society is welcoming to younger members, a quote from one mid-career member describes his experience this way, "Everyone is 20-30 years older than me. Same faces, same people all the time; it's like a clique. It's a turnoff." ■

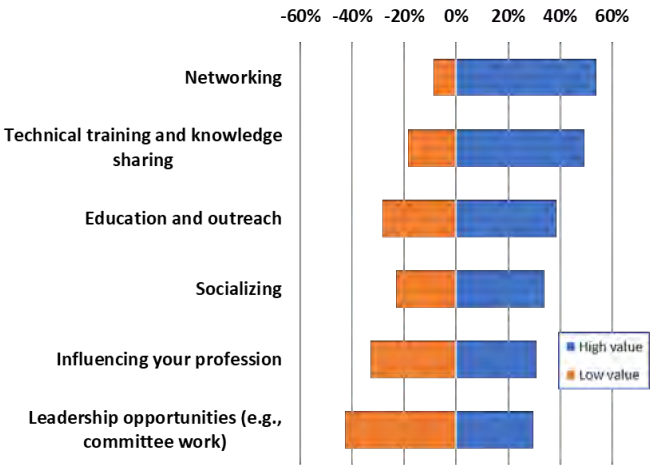


Figure 5. *54% of respondents say that networking through HGS is of high value and 49% say that technical training and knowledge sharing are of high value. Opportunities for education and outreach are high-value to 38% of respondents and socializing is high-value to 34% of respondents. Approximately the same number of respondents say that influencing their profession is of high value as those who say it is of low value. More respondents, 43%, say that committee work is of low value.*

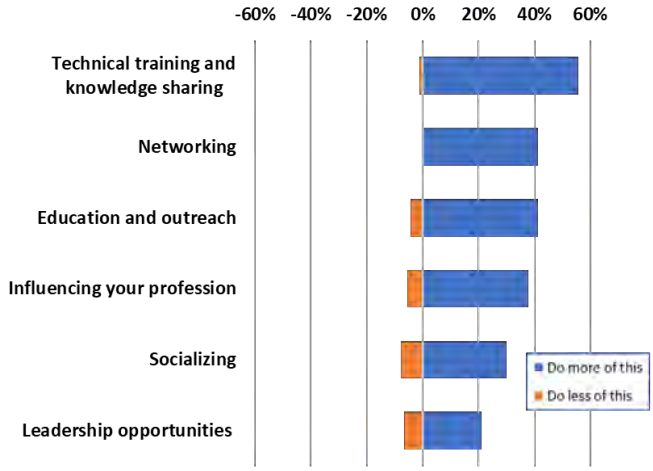


Figure 6. *56% of respondents think that HGS should offer more technical training and knowledge sharing, whereas only 1% say that HGS should offer less. 41% of respondents say that HGS should offer more networking opportunities, and no respondents indicated that HGS should do fewer networking opportunities. 41% of respondents indicated that HGS should offer more education and outreach opportunities and 38% indicated that HGS should do more to influence their profession. 30% want to see more socializing whereas 8% want to see less socializing. 21% want more leadership opportunities and 7% want less leadership opportunities.*

What's Hot and What's Not in Geoscience Education

By Caroline Wachtman

INTRODUCTION

"We need more young people in the HGS" is a common refrain from HGS members. The challenge of attracting and retaining a younger generation of geologists into professional organizations starts with attracting students at colleges and universities. Professors from geoscience departments at University of Houston (UH), University of Houston-Downtown (UHD), Rice University (Rice), Sam Houston State University (SHSU), Stephen F. Austin University (SFASU), and Lone Star College University Park (LSC) report that students are increasingly focused on pursuing Environmental Science, Planetary Geology, Atmospheric Sciences. Many of these departments have seen sharp drops in overall enrollment and steep declines in students interested in pursuing Oil and Gas.

To attract students, departments are shifting focus to offer more courses in Environmental Science, Artificial Intelligence, Machine Learning, Data Science, Planetary, Geothermal and others. While departments say they continue to focus on core geoscience skill sets, the coursework is tailored to better resonate with the interests of today's students. Furthermore, SHSU, SFASU and Rice have even changed the names of their departments to better attract students.

Many of these departments have seen sharp drops in overall enrollment and steep declines in students interested in pursuing Oil and Gas.

Graduated students are finding employment in a range of geoscience disciplines. Workers entering the workforce with an undergraduate degree are finding employment in environmental consulting or government regulatory agencies. Oil and Gas continues to be a significant source of employment for MS and PhD students, but an increasing number are finding employment with companies and agencies that focus on planetary science and data analytics.

STUDENTS SAY ENVIRONMENTAL SCIENCE IS MORE ATTRACTIVE THAN OIL AND GAS

The environment, sustainability and water resources are the topics that most interest current students, explains Kenneth Johnson, Associate Professor in the Department of Natural Sciences at UHD. This sentiment is echoed by Julia Wellner, Associate Professor in the Department of Earth and Atmospheric Sciences at UH. Wellner says that more undergraduates are choosing to major in Environmental Science rather than Geology or Geophysics. Bryn Benford, Professor at LSC says that her students want to "focus on the health of the planet." Benford says, "Despite being in Houston, they don't want to talk about Oil and Gas."

"Students just want to make a difference in whatever they are doing. They want to know how they can help communities," says Julie Bloxson, Assistant Professor at SFASU Department of Earth Sciences and Geologic Resources. Bloxson says that most of the undergraduates studying geosciences at SFASU believe they can help make a difference by focusing on environmental science issues. Despite Texas' energy-rich economy and widespread Oil and Gas Industry employment, it can be difficult for students to overcome a stigma attached to Oil and Gas. However, Bloxson, who teaches a mandatory senior-level course on Economic Geology, says that when students are exposed to Petroleum Geology they generally find it interesting.

GEOLOGY DEPARTMENTS ARE LOSING ENROLLMENT

David Moss, Assistant Professor of Geology at SHSU Department of Environmental and Geosciences, is the principal researcher on a recent study funded by the National Science Foundation (NSF) that focused on understanding high school students' perceptions of Geology and introducing students and teachers to Geology. Moss says that over 400 students from over 20 Texas high schools were surveyed. Although analysis is ongoing, students ranked a career in Geology as their lowest choice. Moss says that students equate a career in Geology with a career in Oil and Gas, and both careers are at the bottom of the students' lists. One of the reasons for the lack of interest in Geology may be a result of many high schools not offering Geology or Earth Science courses. "More concerning," says Moss, "is that if a Geology or Earth Science course is offered, it may be part of a non-college-bound track."

Johnson says that the UHD Department of Natural Sciences has seen a "steady decrease in number of students enrolled" over the past decade. He says that his department had approximately 140 students enrolled before 2014, but that number dropped to about 70 students enrolled this fall. Pat Harris, Associate Professor in the Department of Environmental and Geosciences at SHSU shares a similar decrease in enrollment numbers. Over his 12 years at SHSU, Harris has seen enrollment in the Geology major drop from approximately 120 to approximately 60 students. Meanwhile, SHSU's Environmental Science Major has increased to approximately 75 enrolled students.

Tom Lapen, Professor and Chair of Earth and Atmospheric Sciences at UH, says that his department has also experienced a decrease in undergraduate students. Lapen recalls having 200

Geoscience Education Trends *continued on page 31*

students in a mineralogy course in 2013. That number dropped to just over 20 students in recent years. Data from UH supports a continuing decrease in the number of PhD students in Geology or Geophysics. While PhDs in Geology decreased 27% and Geophysics decreased 81% year-over-year, the number of PhD students in Atmospheric Sciences increased 60%.

Both Johnson and Lapen explain that the numbers of enrolled students in their departments tend to follow oil price. The recent oil price downturn in 2020-21 is partly to blame for reduced enrollment. Bloxson at SFASU says that her department saw a significant decrease in students during the COVID-19 pandemic, consistent with decrease in college and university enrollment nationwide.

WHAT ARE DEPARTMENTS DOING TO REVERSE ENROLLMENT TRENDS?

Colleges and universities are developing creative ways to recruit and retain new Geology and Geophysics students. Some departments are focusing on re-branding to shift focus to earth science or environmental science. Last year, SFASU rebranded their geoscience department to the Department of Earth Sciences and Geologic Resources. SHSU recently rebranded to the Department of Environmental and Geosciences. Despite the name changes at SFASU and SHSU, the course offerings have not substantively changed.

Rice University has changed their name three times over the past 15 years, starting with Geology and Geophysics Department, then re-branding to Earth Science, and then re-branding approximately five years ago to be the Department of Earth, Environment and Planetary Sciences (EEPS). In addition to name changes, Rice has also expanded the number of entry-level geoscience courses they offer. Julia Morgan, Professor and Chair of the EEPS department at Rice University, says her department realized that Physical Geology may not be attractive to all students, so they now offer introductory courses on natural disasters, planetary science, climate science, a field-based earth science course, and a course called "Earth, Environment and Society." Morgan says that Energy Transition, Environmental Science, and Planetary Science are significant draws for Rice students, so the department plans to expand their faculty in these areas over the next few years. Like Rice, other departments are broadening the entry point to Geology to attract more students. Benford says, "Students try Environmental Science, and they get pulled into more traditional Geology courses."

Lapen says that UH has re-focused their department to include offerings in machine learning, artificial intelligence and Python programming. In addition, existing courses are being re-tooled to focus on future energy challenges related to energy security, clean energy, and environmental science. Lapen says that the Geophysics courses at UH are focused on developing transferrable skills that can be applied to a wide range of Geology disciplines, including critical minerals, planetary science, environmental science, and others. Johnson echoes that a similar shift has occurred at UHD, where they now offer new courses in data analytics and Geographic Information Systems.

WHERE ARE STUDENTS GOING AFTER GRADUATION?

Despite the reluctance of students to pursue traditional Geology or Geophysics study paths, oil and gas continues to be a primary source of employment opportunities for students who graduate with a degree in Geology or Geophysics.

Geoscience Education Trends *continued on page 32*

OPTIONS FOR GEOSCIENCE DEGREES IN HOUSTON AND SURROUNDING COMMUNITIES

Lone Star College
Associate of Science

Rice University
BS in Environmental Earth Sciences, Geosciences or Planetary Sciences
Environmental Science BS or BA with concentration in Evolutionary Ecology and Biology or Earth Science
MS and PhD programs in Geology;
Professional Master of Science in Subsurface Geology or Environmental Analysis and Decision Making

Stephen F. Austin State University
BS in Geology
MS in Geology or Natural Science

Sam Houston State University
BS in Geology, Geography or Environmental Science
MS in Geoscience in Applied GIS

University of Houston
BS in Geology, Geophysics, Environmental or Atmospheric Sciences
BA in Earth Science
MS and PhD in Geology, Geophysics; or Atmospheric Sciences;
Professional MS programs in Geology or Geophysics

University of Houston-Downtown
BS in Geosciences with concentration in Environmental Geology, Geochemistry or Petroleum
MS in Data Science

Geoscience Education Trends continued from page 31

Of the schools interviewed for this article, only UH systematically tracks employment for graduated MS and PhD students. For academic year 2022, UH reports 82% of the students earning a MS and 100% of the students earning a PhD in Geology or Geophysics (37 total) are currently employed. Nearly 30 of those graduated students found employment in the Energy Industry, primarily in Oil and Gas. The remaining employed students continued in academia; one student became a data scientist for Walmart. Among the five students who graduated with a degree in Atmospheric Science, four continued on in academia in post-doctoral programs at national labs and one became an air quality specialist for a consulting company.

Although UH did not provide quantitative data on students who find employment with an undergraduate degree, Wellner describes that many undergraduates proceed to work for state or federal agencies such as the Texas Commission on Environmental Quality (TCEQ), Army Corps of Engineers, United States Department of Agriculture, United States Geologic Survey or the Bureau of Ocean and Energy Management. Other undergraduates find employment with environmental consulting companies.

The qualitative insights from other Houston-area colleges and universities are similar to the quantitative data from UH. Graduates of Rice are "taking full advantage of what Houston has to offer," says Morgan. Recent Rice graduates have taken positions at local environmental consulting companies, several have research positions with NASA or other planetary institutes, and others are working in Oil and Gas. Many Rice PhD graduates seek research, postdoctoral, or academic positions elsewhere. Johnson says that in addition to finding employment with independent Oil and Gas companies, many UHD graduates go to work for TCEQ or for environmental consulting firms. Bloxson says that of her five most recent graduated students, two found employment in mining, one is employed in environmental consulting, one is employed in Oil and Gas, and one left Geology.

WHAT CAN HGS DO TO ATTRACT STUDENTS?

Bloxson and Harris both say that the scholarship opportunities that HGS currently provides are vital for their students. Furthermore, Bloxson says that increased scholarships for travel would be a great addition. SFASU allocates a total of only $600 in annual travel conference expenses, which is insufficient to support more than one student traveling to a conference. Wellner agrees that scholarships are important to UH students and wants to see scholarship criteria expanded to include environmental science, to reflect the changing interests of their student population.

Harris and Mills says that networking and career path discussions are helpful for their students at SHSU. Harris recently helped a group of students to attend a HGS dinner meeting and believes that students found value in hearing from more senior professionals. Mills says that providing examples of Geology and Geophysics career paths is another important way to retain students. ■

Salt Party

By Janet Combes

The HGS held a "Salt Party" on my driveway on October 23 to break up about 400 pounds of rock salt donated by United Salt's Hockley Salt Mine. Volunteers this year included Chuck Caughey, Phil Caggiano, Paul Riegler, Sue Pritchett, Janet Combes, Marsha Bourque, Dianna Phu and her daughter Mandolin (earning volunteer credit for her high school). While several of the geologists used their rock hammers and chisels to break up the rock, others put the smaller pieces into baggies with labels. These samples are given out at various outreach programs in which the HGS participates. Volunteers prepared enough samples for give-aways at the Houston Museum of Natural Science GEMS event on November 4, and at the annual Houston Gem and Mineral Show November 10-12 (see separate reports on these events in the *Bulletin*). This party broke up less than half of the donated salt. There will be another Salt Party in early 2024 to prepare the rest of the specimens. *Contact Janet Combes at jmcombes@msn.com if you would like to participate* ■

Bags of salt from Hockley

Monday December 11, 2023

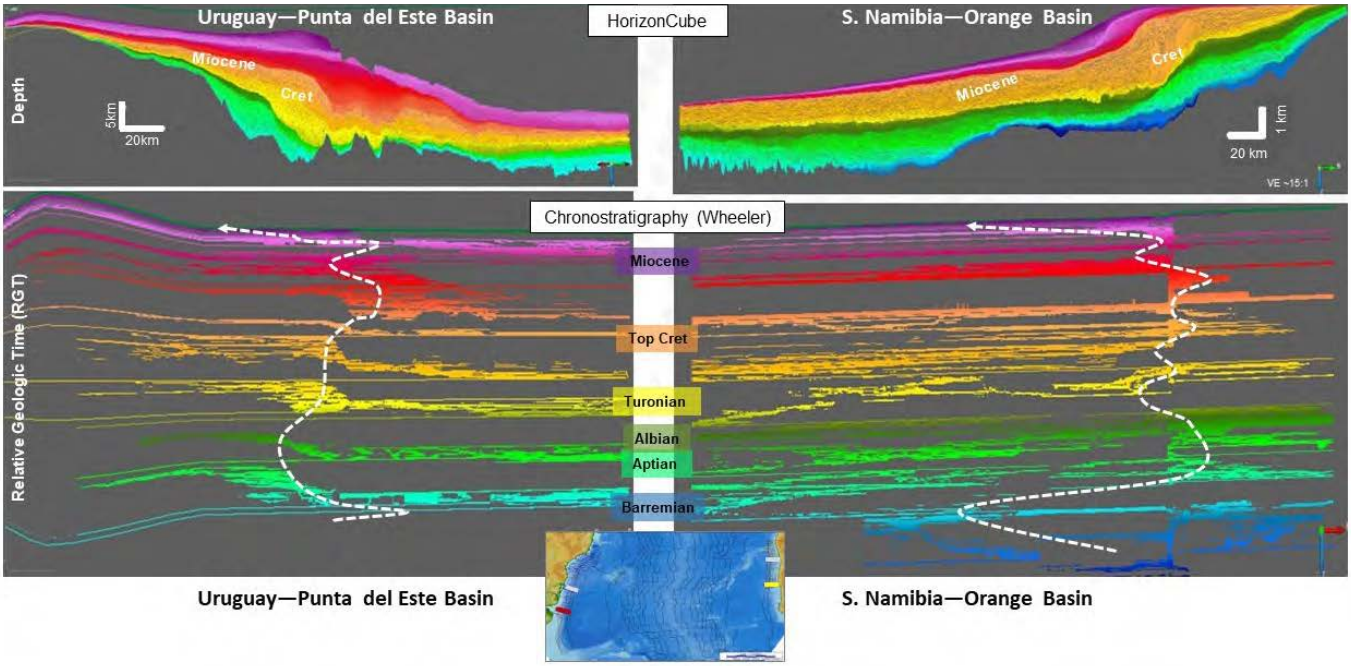
5:30 p.m. – 9:00 p.m.

Norris Conference Center, Citycentre
816 Town and Country Blvd #210 • Houston, TX 77024
Member/Emeritus/Honorary Life $65.00
Non-Member/ WALKUPS $75.00 • Student $25.00
https://www.hgs.org/civicrm/event/info?id=2478
Event Contact: Linda Sternbach • linda.sternbach@gmail.com

HGS International Explorationists Dinner Meeting

Brian W. Horn
Consultant

Comparison of Stratigraphic Architecture Across Conjugate Margins - Identifying Reservoir Presence and Architecture Uruguay, South America, and Namibia, Africa



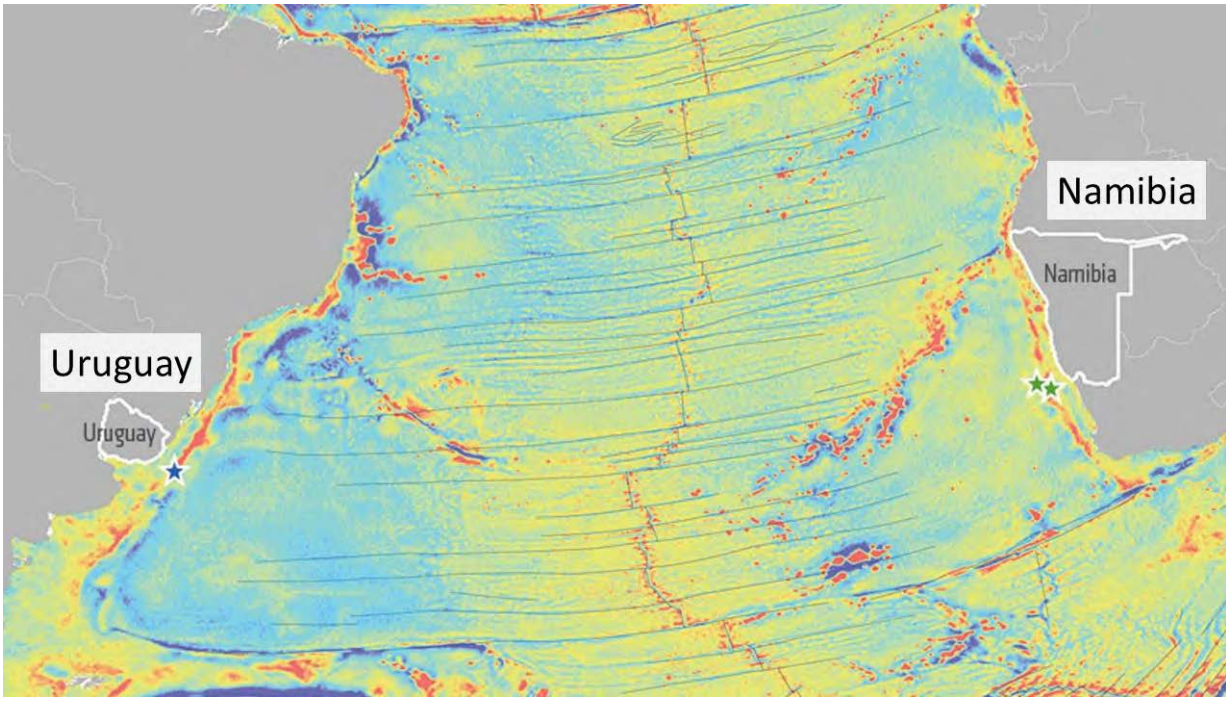
Extensive offshore areas of the South Atlantic and East African continental margins remain underexplored, despite recent hydrocarbon discoveries. Giant discoveries on these margins attest to functioning petroleum systems with both shallow marine and deep-water siliciclastic reservoirs. Exploration wells have identified the presence of Early and Late Cretaceous petroleum systems. Source-reservoir couplets on both margins provide insight into petroleum habitats of the conjugate margin in addition to large deep-water fan systems. This presentation reviews the stratigraphic evolution of conjugate continental margins in the South Atlantic and the potential for predicting reservoir presence and geometry using 2D seismic data. This technique also demonstrates the potential for identifying the temporal and spatial distribution of deep-water fans, their geometries, and architecture in the Rovuma basin.

Detailed chronostratigraphic interpretations (HorizonCubes) in dGB OpendTect across four seismic profiles offshore Brazil, Uruguay, and the conjugate margin of northern and southern Namibia are shown. HorizonCubes depict high-resolution stratal architecture and the evolution of the post-rift sequences as the South Atlantic margins drifted apart. This analysis highlights similarities and differences of the margins demonstrating variation in petroleum systems and identifies other potential hydrocarbon fairways. The variation and stratigraphic architecture across conjugate margins and the divergence of evolution of depositional systems with increasing separation of the continents and changes in sediment supply is highlighted.

On the Uruguayan margin, two-phase shelf margin aggradation in the Turonian gave rise to shelf reservoir buildups and slope-failure-related deep-water reservoirs, with intervening condensed source rocks. The contemporaneous Namibian margin experienced similar two-phase aggradation with steeper shelf profiles giving rise to more persistent lowstand development in deep water.

International Explorationists Dinner Meeting *continued on page 34*

International Explorationists Dinner Meeting continued from page 33



Map of Atlantic Ocean

The synchronous low stand at the K-T boundary suggests a simultaneous large-scale (global) regression across both margins. With increasing cycle diachroneity, high-resolution T-R cycles on the lower-gradient Namibian shelf demonstrate the influence of tectonism and sediment supply on individual continental margins.

With the depositional framework outlined it is possible to analyze and predict the geometries and presence of deepwater channel and fan systems. Examples from offshore Tanzania demonstrate the identification of depositional fairways and geometries by placing their evolution in a time-space framework. This approach can be used in exploration access to identify high-graded areas for reservoir presence. These comparisons reveal that variation in stratigraphic architecture enables the prediction of reservoir/trap configurations. Using this technique and an understanding of the stratigraphic framework creates a conjugate margin-scale interpretation of depositional history and petroleum systems. ■

BIOGRAPHICAL SKETCH

Brian Horn was most recently Technical Head of Exploration Portfolio and Assurance at Cairn Oil and Gas in Delhi, India. Prior to joining Cairn, he was the Senior Vice President and Chief Geologist of ION E&P Advisors. He received his Ph.D. in Geology and Geological Engineering from the Colorado School of Mines and his MSc and BA degrees in Geology from the University of Colorado, Boulder. Brian has worked in oil and gas exploration and production for over 25 years. Brian served as HGS Bulletin Editor and is a long-time member of the HGS.

His experience includes technical and commercial advisory, regional exploration, basin and play fairway analysis, petroleum systems, regional stratigraphic and seismic correlations as well as resource assessments globally. He has directed New Ventures exploration teams conducting new opportunity evaluations, regional portfolio development, and technical and commercial analysis, delivering projects that identify uncertainty and are focused on returning value.

WORD BRECCIA – A GEOLOGY WORD JUMBLE

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

GANHEC	_ _ ○ ○ _ _
YUSERV	_ _ ○ ○ ○ _
TLEANP	_ _ _ ○ ○ ○
OGISUNI	○ _ _ _ ○ _ _
RENALMI	○ _ ○ _ _ _ ○

Today's students are interested in this science

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Wednesday, December 13, 2023

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

Pre-registered HGS Members $35
Emeritus/Honorary Life $35
HGS Students Members $15
Non-Members & ALL Walkups $40
Craft Republic Houston • 11470 Westheimer Rd.
https://www.hgs.org/civicrm/event/info?id=2511
Event Contact: Matthew Cowan • mrcowan1@hal-pc.org

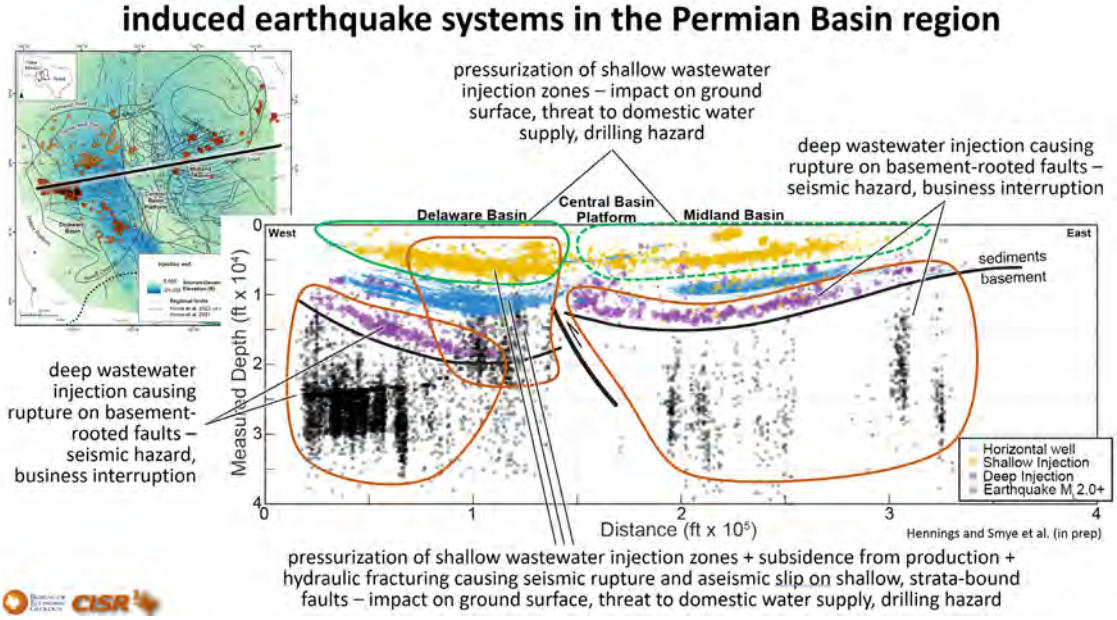
Peter Hennings
Research Professor, Principal Investigator – Center for Injection and Seismicity Research (CISR)
Jackson School of Geosciences Bureau of Economic Geology
The University of Texas at Austin

Injection-Induced Earthquakes – Understanding the Cases in Texas as Studied by the Center for Injection and Seismicity Research (CISR)

From 2010 through 2023 there were over 1,300 M3.0+ earthquakes of presumed induced origin in Texas and southeast New Mexico. The TexNet Earthquake Monitoring Network and its partner seismic networks have been providing detailed information on seismicity in the region since 2017. CISR has integrated this data and comprehensive geological, geophysical and geomechanical interpretations in five regional geologic systems to understand the subsurface conditions and injection practices that promote fault rupture and earthquakes. Three of these systems are the injection-induced ruptures of basement-rooted faults in the Fort Worth Basin, which sits under urban populations of more than 9 million people, the northern Delaware Basin, and the central Midland Basin. The inducement mechanism for these systems is an increase in pore pressure, and therefore stress, from injection into strata above basement. Because basement faults host these ruptures, the local magnitudes can be relatively large, with events of ML5.0+ recorded. For earthquakes associated with basement ruptures, we find pore pressure increases of up to 450 psi proximal to large-scale injection and strongly variable temporal variations in injection rate. In contrast, some ruptures are associated with pore pressure increases of ~10 psi for cases where the area perturbed is large, the distance between injection wells and ruptured faults is up to 30 km, and the most sensitive faults have been triggered. The most active sets of ruptures in this system are within the Culberson-Mentone zone in the Delaware Basin, which sits distally from areas of large-scale injection, and where changes in pore pressure are on the order of 0-75 psi. This implies that poroelastic stressing must play a role, acting at greater distances than pore pressure change alone. This mix of proximal and distal inducement in the northern Delaware Basin and the Midland Basin is like that observed for inducement in northern Oklahoma, Kansas, and in the Fort Worth Basin of Texas.

The fourth induced seismicity system is within Permian-age shales and shallower strata in the southcentral Delaware Basin and is caused by rupture of strata-bound faults that do not extend into basement. This geomechanically complex inducement is caused by injection into the Delaware Mountain Group (DMG), hydraulic fracturing (HF) of the underlying shales,

E&E Dinner Meeting *continued on page 36*



continued from page 35

and variable depletion and compaction of the shales associated with production. Host formation lithology and the strata-bound nature of these fault ruptures reduces the observed maximum magnitude to ≤ML3.5, with rare exceptions. Many of these seismogenic faults have been made neotectonically active and deform the ground surface due to both injection and production. Some of these shallow faults have tips that extend downward into underlying shale formations where HF rupture can be facilitated by natural overpressure conditions. In this system there has been a transition from seismogenic rupture to aseismogenic slip as HF-inducement gives way to faulting due to differential subsidence of the deeper shales and pore pressure increase of the shallow strata by injection.

In the Delaware Basin, petroleum operations are causing accelerating subsidence and uplift, and their implications must be understood to protect surface environment and the sustainability of energy production. We use Sentinel-1 satellite radar data to analyze the widespread deformation patterns we observe across the entire basin spanning 2015-2022. Through an integrated analysis of the observed deformation patterns with comprehensive subsurface data, we show that the rapidly accelerated deformation rates since 2018 dynamically relate to massive increases in production, injection, and activation of faults that deflect the ground surface, coseismic deformation, and induced earthquakes. Understanding these changes is a pressing concern for safeguarding the surface environment in the basin and its tens of thousands of old petroleum wellbores.

Not included in the presentation is the fifth system studied which is the unconventional Eagle Ford play region in south Texas where earthquake inducement has been linked exclusively to hydraulic fracturing operations. ■

BIOGRAPHICAL SKETCH

Dr. Peter Hennings is a Research Professor at The University of Texas Jackson School of Geosciences. Peter is the Principal Investigator for the Center for Injection and Seismicity Research at the Jackson School's Bureau of Economic Geology and he Teaches in the Department of Earth and Planetary Sciences. Prior to joining UT, Peter spent 25 years in the petroleum industry where he worked as a research scientist (Mobil Oil and Phillips Petroleum) and research manager (ConocoPhillips). Peter received BS and MS degrees from Texas A&M University and his PhD from The University of Texas. Peter's research specialty includes induced seismicity, structural geology, seismic structural analysis, reservoir geomechanics, and geology of West Texas and the Rocky Mountains. Peter has taught over 100 classroom and field courses at the professional, university undergrad, and graduate level on seismic structural analysis, fractured reservoirs, geomechanics, petroleum systems, induced seismicity, and field methods.

Remembrance

John Glenn, Chief Geologist

John Glenn passed away peacefully 11/6/2023. He founded Teal Energy in 2002, where he served as Chief Geologist and President. He focused on exploration and production in South Texas, where his team found three oil and gas fields. He held a MS in Geology from the University of Arkansas.

Glenn evaluated the geology of projects in over 20 countries worldwide and worked as a resident of six. His international experience began with 10 years at Phillips Petroleum in Singapore, Indonesia and the Philippines. He was also district geologist for Sohio-BP and Forest Oil in South Texas.

After moving to Denver with Forest Oil, he was asked to join the first joint oil and gas venture between Russia and the United States in Siberia, which was chronicled in the movie "The Prize." Glenn had 10 years of experience in Russia and other FSU countries and was Chief geologist for the White Knights project in Western Siberia, and for the Tenge project In Kazakhstan. Working for LUKOIL AIK he managed two 500-well field development projects including waterflooding and new drilling. He evaluated and secured approval for a 3D survey of a field that now has five Russian rigs drilling 24/7. EUR is 100 MMBO.

Glenn had made many friends from all over the world. He was a very well-respected geologist and a true gentleman. He was a member of HGS, SIPES, and Houston Chief Geologists. He will be missed by many. ■

HGS Supports Girls Engaged in Math and Science

By Janet Combes

Houston Museum of Natural Science hosted the Girls Engaged in Math and Science (GEMS) event on November 4. The event was sponsored by CITGO Petroleum Corporation and had a turnout of over 2,100 visitors. HGS and other professional groups interacted with visitors and answered questions about careers in science, technology, engineering, and math. HGS hosted a booth promoting the geology and geology careers. In addition, HGS handed out about 150 samples of rock salt from the United Salt Corp's Hockley Mine, along with info sheets courtesy of Shawn Wright at Hess. HGS volunteers Steve Johansen and Kristen Briggs set up the display and staffed it the first two hours; Sue Pritchett and Janet Combes handled the second shift and took it down when the event ended. ■

Sheriff Lecture Focuses on Technology and Networking with the Next Generation of Geoscientists from the University of Houston

By Linda Sternbach

The 25th annual Sheriff Lecture was held on Monday, November 13 at the Norris Center. This year's event exceeded expectations for student participation and faculty support. It attracted approximately 150 attendees, the largest number of attendees in years.

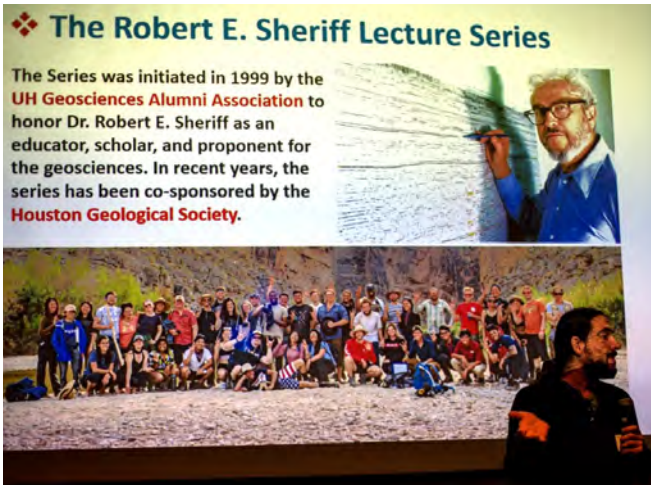
The Sheriff Lecture is a joint venture between HGS and the University of Houston (UH) Earth and Atmospheric Sciences Department (EAS). The Lecture was created in 1999 by the UH Geosciences Alumni Association. The partnership with HGS was initiated by UH Alumni and HGS then Board Member David Meaux in 1999. This year's event commemorated the 50th anniversary of Dr. Robert E. Sheriff's 1973 landmark book: *Encyclopedic Dictionary of Applied Geophysics*.

Planning for the 2023 Lecture started this past summer and involved contributors from UH EAS department and volunteers of the HGS. Dr. Robert Stewart, Dr. Paul Mann, and Dr. Jia Sun motivated students at the MS and PhD levels to submit abstracts for posters, resulting in 45 poster proposals.

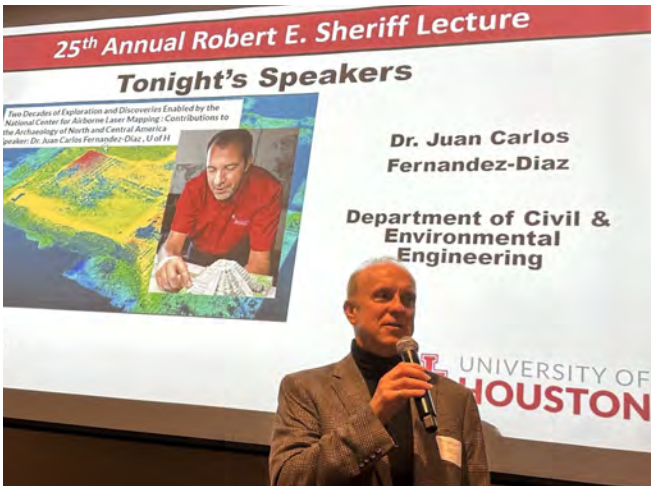
The HGS provided two Judging Co-Chairs: Sandy Rushworth and David Risch, who are long time HGS and GeoGulf volunteers. Thirty-four professional and academic judges volunteered to assess and rank the student posters. Judges awarded first, second, and third place in three categories (Geology, Geophysics and Atmospheric Science) and at three experience levels. Mann, who is the Robert E Sheriff Endowed Chair at UH, announced the winning students at the end of the night. Videos are online on the HGS GeoEducation YouTube Channel.

Stewart did a great job as master of ceremonies. He introduced Dr. Tom Lapen, UH EAS Associate Chair and Professor of Geology, who reported on the number of graduates from UH. Lapen highlighted that EAS currently has 186 undergraduates and 155 graduate students. There are five undergraduate degree options and eight MS and PHD degree options. Recent UH graduates from the department have found employment at NASA, Shell, ExxonMobil, MIT, BP, and Stanford University among others. Lapen noted that most

Sheriff Lecture *continued on page 39*



Dr Tom Lapen, Department Earth Sciences Chair



Dr Robert Stewart announced speakers at Sheriff lecture

Dr William Sager's Geology Students, attending Sheriff Lecture

Follow the EAS department news at: https://uh.edu/nsm/earth-atmospheric/

Sheriff Lecture continued from page 38

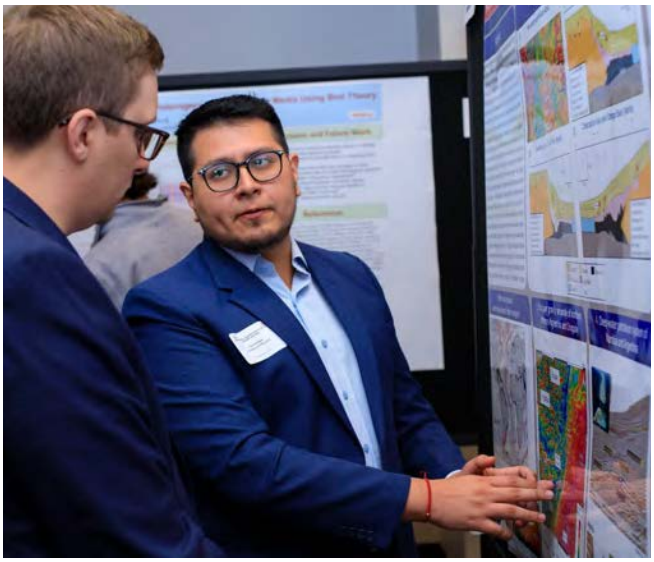
Geology and Geophysics PhD students are hired in the energy industry or academia. Atmospheric PhD and MS graduates are teaching or employed by government agencies.

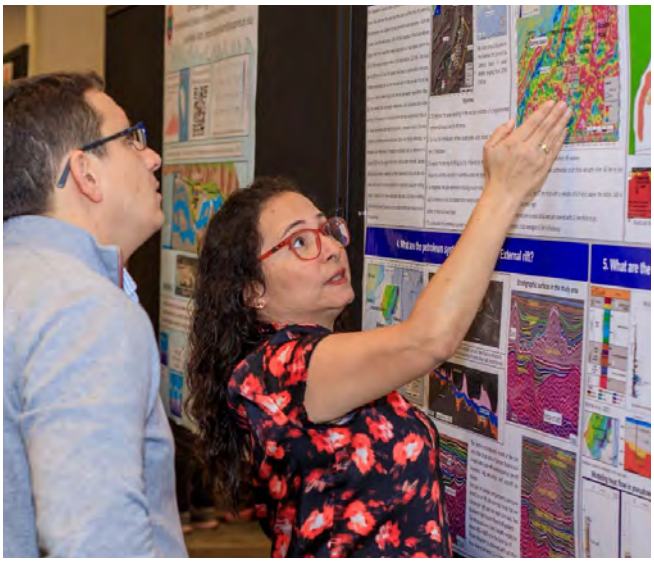
Dr. Juan Carlos Fernandez-Diaz, of the UH Engineering Department, spoke about the University's contribution to Airborne Laser Mapping (LIDAR) Technology, including over twenty years of mapping in Central and South America. LIDAR has enabled discovery of Mayan structures in the jungles of Central America hidden since 800 AD. His team has acquired 20,000 km^2 of LIDAR data in Mexico, Guatemala, Belize, and Honduras and discovered 60 Mayan cities and ceremonial sites.

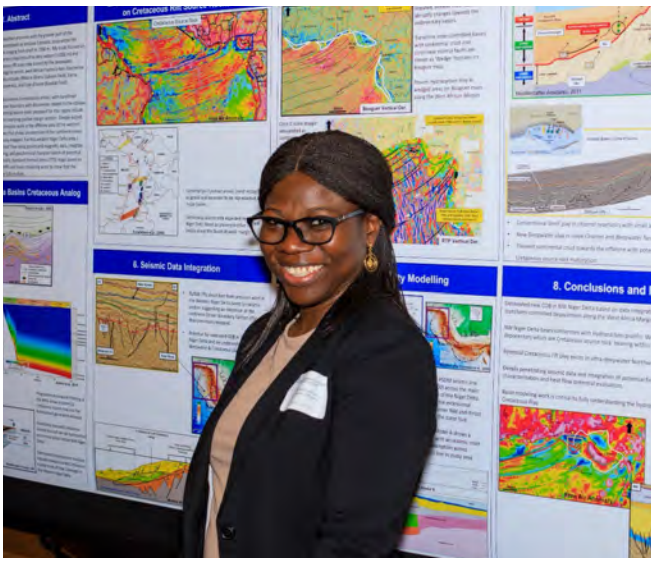
Dr. Charles Sternbach, adjunct professor at UH, described how to find Giant Oil Fields in the Gulf of Mexico by looking at their unique characteristics and tectonic/structural/source rock setting. He showed where Super Giant fields are located, based on research and databases created by John Dolson and Richard S. Bishop that were published in AAPG Memoir 125, *Giant Fields of the Decade 2010-2020*. Sternbach concluded that giant field are limited by trap elements, that most are Cretaceous and Miocene in age, and are often found on basement uplifts. Seismic imaging improvement over the last 25 years has resulted in the discovery of new Giant Oil fields.

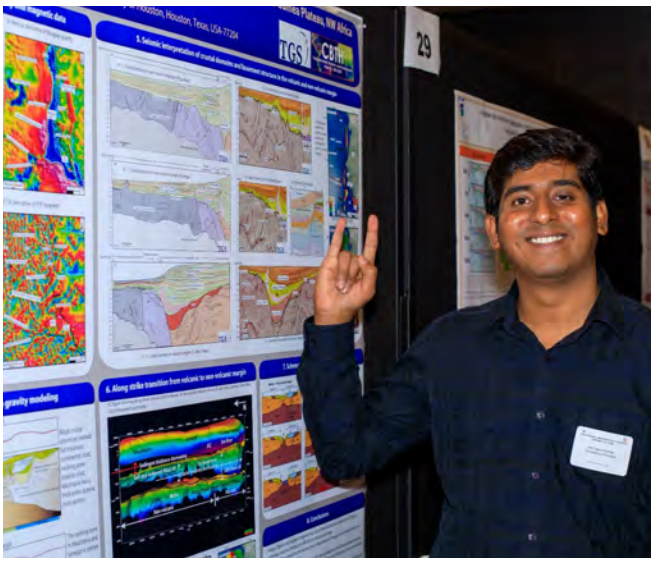
Linda Sternbach, HGS Vice President, and Andrea Peoples, HGS Office Manager, coordinated the advertising and on-site logistics of the event at the Norris Center. Thanks also to UH secretary Sarai Hernandez, the UH Alumni Association, and Julian Chenin, for expanding the advertising. Lapen said after the event, "This was one of the best Sheriff lectures in years!"

People are already asking about Sheriff Lecture 2024, scheduled for next November!









Sheriff Lecture Student Winners, November 13 University of Houston, Earth and Atmospheric Science Department

GROUP 1: ADVANCED SECOND YEAR PHD IN ATMOSPHERIC SCIENCE

1st Place Deveshwar Singh and Dr Tom Lapen, Department Chair

1st Place **Deveshwar Singh**
Deep-BCSI: A Deep Learning-Based Framework for Bias Correction and Spatial Imputation of PM2.5 Concentrations in South Korea
2nd Place **Mahsa Payami**
A 1D CNN-based Digital Twin of CMAQ: Predicting NO2 concentration over the most populated urban regions in Texas
3rd Place **Thishan Dharshana Karandana Gamalathge**
Influences of California Wildfires on CO_2, CO, and CH_4

GROUP 2: ADVANCED SECOND YEAR PHD IN GEOLOGY

1st Place Juan Pablo Ramos Vargas and Dr Tom Lapen, Department Chair

1st Place ***Juan Pablo Ramos Vargas***
How oceanic and oceanic plateau crustal structure controls deep water, hydrocarbon plays in the Colombian Basin, Caribbean Sea
2nd Place ***Olajumoke Akinpelu***
Proposed Cretaceous hydrocarbon play based on syn-rift Cretaceous source rocks, deepwater area of the western Niger Delta, Nigeria
3rd Place ***Md Upal Shahriar***
Along-strike crustal transition from the rifted volcanic margin of the Guinea Plateau in Senegal to the non-volcanic rifted margin of Mauritania, Northwestern Africa

GROUP 3: ADVANCED SECOND YEAR PHD IN GEOPHYSICS

1st Place Jennifer Welch and Dr Tom Lapen, Department Chair

1st Place ***Jennifer Welch***
Unveiling the Hidden Threat: Drought-Induced Inelastic Subsidence in Expansive Soils
2nd Place ***Yin-Kai Wang***
Processing and interpretation of elastic waves from a 3D fiber-optic VSP in the Permian Basin, West Texas
3rd Place ***Boming Wu***
Convolutional Neural Network-Assisted Least-Squares Migration

Sheriff Lecture Student Winners *continued on page 41*

Follow the EAS department news at: https://uh.edu/nsm/earth-atmospheric/

Sheriff Lecture Student Winners continued from page 40

GROUP 4: MS/1ST YEAR PHD IN GEOLOGY/GEOPHYSICS

1st Place **Samantha Baker**
Temporary Sediment Storage in Proglacial Lakes Near Kangerlussuaq, Greenland
2nd Place **Joseph McNease**
Modeling Pore Pressure Amplification in Heterogeneous Poroelastic Media using Biot Theory
3rd Place **Gabriel Lopez**
Calibration of Stalagmite δ18O for Paleoclimatic Interpretations in Cueva Ensueño, Hatillo, Puerto Rico

Student Award winners Sheriff lecture group photo

Judging Co Chairs: Sandy Rushworth and David Risch (Center) with Robert Stewart and Paul Mann

HGS at the 2023 Houston Gem and Mineral Society Show

By Sarah Heinlein

The annual Houston Gem and Mineral Society (HGMS) Show was held at the Humble Civic Center on November 10-12, 2023. The event attracted more than 4300 people over three days. The HGS hosted an outreach booth, as it has for many years. On Friday, students were required to stop at the HGS booth. On Saturday, 50 Scouts worked on Geology badges with the HGS.

We did not have 3D maps with 3D glasses this year, but we plan to return this fun and positive learning tool next year. We did share hand lenses, which were a big hit with children and young people as they perused the rock samples displayed along with the geology posters. All booth visitors walked away happy with salt rock samples to take home.

Sarah Heinlein (UHD Assistant Professor in the Geosciences Program) chaired this year's HGS participation. HGS volunteers included Ken Williams, Paul Riegler, Steven Johansen, Janet Combes, and Huw James, who was also a photographer. Thanks to these volunteers who participated all three days! We hope to see you next year if you could not volunteer this year. We can always use the help.

University of Houston-Downtown (UHD) students also volunteered at this year's HGS booth: Anthony Galarza (Friday and Saturday afternoons), Rose Campos, Estefani Ruiz, Eric Stinemetz, Anahi Reyes, Chelsea Torres, Molly Peplau, Victor Martinez, and Justin Petter. This event provided UHD Geosciences Program students an excellent opportunity to develop presentation and public speaking skills. This invaluable experience also helps to fulfil HGS' education non-profit, tax-exempt status.

The HGS booth shared an area with the Houston Museum of Natural Science volunteers. Multiple comments from HMNS volunteers and some senior HGS folks mentioned appreciation for how flexible and helpful UHD students were.

HGS at HGMS Show *continued on page 43*

HGS booth on Friday. From left to right, Anthony Galarza (UHD student), Ken Williams (HGS), and Victor Martinez (UHD student). Photo taken by James Huw.

HGS at HGMS Show continued from page 42

HGS booth Friday. From left to right, UHD geo student Molly Peplae shares her love of geology with a young visitor looking at the rock display. Photo taken by James Huw.

Saturday, UHD Geosciences Program volunteers (from left to right - Estefani Ruiz, Anahi Reyes, Rose Campos, and Anthony Galarza) at the HGS booth, and Vaneusa Paulo (orange vest) who volunteered for security for the HGMS.

December 2023

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
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.**					1	2 Make your reservations online at hgs.org
3	4 **HGS 2nd Annual Holiday Party** *https://www.hgs.org/civicrm/event/info?id=2536*	5 **GCSSEPM Perkins-Rosen Conference** *Page 16* *https://www.hgs.org/civicrm/event/info?id=2525*	6	7	8	9
10	11 **HGS International Dinner Meeting** *Comparison of Stratigraphic Architecture Across Conjugate Margins* *Page 33* *https://www.hgs.org/civicrm/event/info?id=2478*	12	13 **HGS E&E Dinner Meeting** *Injection-Induced Earthquakes* *Page 35* *https://www.hgs.org/civicrm/event/info?id=2511*	14	15 **GeoGulf 2024 Call for Papers Deadline** *Page 24* *https://www.hgs.org/civicrm/event/info?id=2519*	16
17	18	19 **HGS Office Closed for Winter Holiday**	20	21	22	23
24 31	25	26 **HGS Office Closed for Winter Holiday**	27	28	29	30

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).

FIRST ANNUAL HGS SPORTING CLAYS SHOOT

HGS 100TH YEAR ANNIVERSARY

SATURDAY DECEMBER 09, 2023
WESTSIDE SPORTING GROUNDS
10120 PATTISON RD., KATY, TX 77493

$800/4 person Team
$200 / Individual
Includes 4-man cart, 12 & 20ga ammo
Gun Rentals are available from the venue

Gun Raffels, Door Prizes, Lunch,
Drinks & MULLIGANS for purchase

Sponsorship Opportunities Available!

Register
your team now!

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

First Annual HGS Sporting Clays SHOOT
HGS 100 YEAR ANNIVERSARY

Saturday, December 9, 2023
Westside Sporting Grounds
10120 Pattison Rd., Katy, TX 77493

Individual and Team Entry Form

This is a 100-target event, a 4-man cart per team and ammo are provided, **participants must provide eye and ear protection.** Westside Sporting Grounds and National Sporting Clay Association safety rules will be in effect. Door prizes and raffle tickets will be awarded by blind drawing after the conclusion of shooting. You must purchase tickets for the drawing, and you must be present at the time of the drawing to win. Breakfast 7:30am to 9:00am Lunch will be provided from 11:30 until 1:30. Refreshments will be available throughout the day. **Non-shooting guests are welcome to enjoy lunch and refreshments at a cost of $25 per guest.**

We are limited to 120 shooters on 1 course. Entry fee is $200.00 per shooter for registrations received by MONDAY, DECEMBER 1st. After 12/1/23 REGISTRATION IS CLOSED. Individual shooters will be squadded with a team ***Register early it will fill up fast!!***

Team $800.00, Individual $200.00, Mulligans $25.00 each or $100.00 each team.

For more information, contact: Andrea Peoples at (713) 463-9476 or office@hgs.org
For directions to the club, visit www.wsgclays.com
****

ONLINE REGISTRATION INFORMATION AT: https://www.hgs.org/civicrm/event/info?id=2492

To pay by check, mail this form with a check made out to HGS to:
Houston Geological Society, 14811 St. Mary's Lane, Ste. 250, Houston, TX 77079

To pay by credit card, please call the HGS office: (713) 463-9476.

Name: _____ Company: _____

Email: _____ Phone: _____

CC#: _____ Exp:_____ CVC: _____

Ammo: (circle one) 12 gauge 20 gauge

Entry Fees: $ _____ + Guest Fees: $_____ + Mulligans Fee $_____Sponsor Contribution: $ _____
Total: $_____

If you wish to register as a squad, please return forms for all squad members together.

ALL SHOOTERS WILL BE REQUIRED TO SIGN A WAIVER OF RESPONSIBILTY BEFORE THEY WILL BE ALLOWED TO SHOOT!

Team Member Name	Email Address	Phone	Ammo Guage

First Annual HGS Sporting Clays SHOOT

HGS 100 YEAR ANNIVERSARY

1._____ _____ _____ _____
2._____ _____ _____ _____
3._____ _____ _____ _____
4._____ _____ _____ _____

Corporate Sponsor - $2,500

This will include one 4-man shooting team with team mulligans, cart and ammo. Your company logo will be recognized as a corporate sponsor and be displayed on the website, printed banner, sponsor board and promotional items.

Ammo Bag Sponsor - $2,250 SOLD

This will include 2 shooter registrations, cart and ammo. Your company logo will be recognized as the Ammo Bag sponsor and be displayed on the Bag, website, printed banner, sponsor board. **(Need logo by Nov. 10th, 2023 for this sponsorship)**

Lunch Sponsor - $2,000 SOLD

This will include 2 shooter registrations, cart and ammo. Your company logo will be recognized as a Lunch sponsor and be displayed on the website, printed banner.

Breakfast Sponsor - $1,000

This will include one team member registration with ammo. Pay for three more team registrations and get the cart with your package. Your company logo will be recognized as a breakfast sponsor and will be displayed on the website, printed banner.

First Annual HGS Sporting Clays SHOOT
HGS 100 YEAR ANNIVERSARY

Beverage Sponsor - $750

Your company logo will be recognized as a beverage sponsor and will be displayed on the website, printed banner.

Station Sponsor - $500

Company Logo will be displayed at assigned station, website and printed banner.
You will be allowed to set up a tent (max size 10'x10') at your sponsored station(s).
You can either cook or provide snacks and non-alcoholic drinks to the participants.

Door Prize / Raffle Sponsor - $500

Company Logo will be displayed on website and printed banner.

Individual Sponsor - $250

Company Logo will be displayed on website and printed banner.

To pay by credit card, please complete the form and return to office@hgs.org or call 713-463-9476
To pay by check, mail this form with a check made out to HGS to:
Houston Geological Society, 14811 St. Mary's Lane, Ste. 250, Houston, TX 77079

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**

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Consulting Geologist

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