HGS Bulletin

Volume 66, Number 10

Houston Geological Society

JUNE 2024

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Houston Geological Society

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In Every Issue

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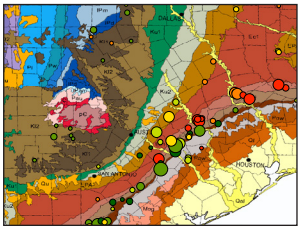

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About the Cover: HGS Art Contest submission by Jeff Lund: While on a cruise to Antarctica in February 2019 (on the Seabourn Quest) we approached a huge iceberg designated A57a. Icebergs are tracked by international agencies and NOAA as potential hazards.
The setting sun behind us caused very dramatic lighting of the 200-foot tall "cliff" of ice with dark sky above and dark water below. It looked like a Rothko painting!
We could approach the ice closely as the ship had sonar indicating a vertical ice face of almost 1000 feet with 80% below water. (The Titanic did not have sonar!). The captain interrupted dinner, and everyone went to the port side of the ship to see the brief phenomena just as the sun set.
I took this picture with my iPhone 10. There is another picture with the ship's shadow, but the color is not as spectacular.

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Paul Britt
pbritt@texplore.com

A Year to Remember

It has been a true pleasure to serve as your President during our Society's 100th Year Anniversary. Since its inception in 1923 coincident with the Gulf Coast oil boom, the Society has expanded to serve the many aspects of the Houston area and its geological needs. While still focused on petroleum, it serves member's needs in the environmental industry; salt, sulfur and uranium mining; oil and natural gas underground storage; geothermal; and carbon capture and storage, a logical extension of water and CO2 floods used in enhanced recovery of oil and gas. The Society is poised for future expansion into geological fields not yet envisioned.

I had hoped to talk about lofty ideas in my monthly letter. Instead, it seems I spoke mostly about the business of HGS. Operating the HGS is very much like running any small business. It has office expenses, phone systems, payroll, bookkeeping, tax filings, legal contracts, leases, event contracts, insurance, managing investments, website management and more. The office manages complex event schedules and various committee needs and supplies. The Board Members are engaged in many of these functions, and the President and President-Elect are engaged in all of them.

The Society is poised for future expansion into geological fields not yet envisioned.

The fiscal year (July 1-June 30) starts with preparing a budget. Using the prior year's actual expenses and each committee chair's estimate of the coming year, a budget is constructed. The importance of committee participation in this is crucial. Dues make up about ten percent of our total revenue. Many committees have no opportunity for revenue as they perform community services, such as Educational Outreach, the Science and Engineering Fair of Houston, Earth Science Week and others. Some committees have little cost or are revenue neutral, such as the technical dinners. That leaves most of the operating revenue to be generated by events; social, continuing education, symposiums, field trips and others. The remainder is made up by sponsorships. Corporate sponsors and individual Member sponsors all help to keep the Society operating. This year, we offered Member sponsorship opportunities beginning at $100, starting with the Past President's Luncheon in August, where we had nearly 100 percent participation. Since then, we have seen a very high level of Member sponsors, and we have recognized them on the monthly Sponsor page in the Bulletin. I would like to thank all of the Sponsors, from the largest corporate to the smallest Member levels that supported us this year. Thank you for your support!

We had some outstanding events this year, starting with the successful Student Expo in September chaired by Amanda Johnston. There was the 100th Anniversary Gala in October and the Bulletin Special Edition commemorating the 100th Anniversary. Thanks to Charles and Linda Sternbach, Craig Dingler and Jeff Lund among others for making this happen. The Golf Tournament was the usual great success, chaired by Jimmy Bagley. In November, we held a field trip to Galveston that was also chaired by Charles and Linda Sternbach. December was host to the Second Annual HGS Holiday Party, and we transformed the Skeet Shoot into the First Annual Sporting Clays event, chaired by David Perez. February was the Scholarship Night Dinner chaired by Fang Lin with the support of Sponsor Chair, Jeff Lund. March was punctuated by the HGS office move, transparent to most members as the suite number (250) moved with us. March also included a very successful short course, Clastic Depositional Systems, taught by Mike Sweet and hosted by the Continuing Education Committee's new Chair Angel Callejon. April saw the Annual Shrimp Peel chaired by Michael Salazar. Of course, each month saw technical dinners or luncheons in a robust and successful program such as the November Sheriff Lecture and the January Legends Night managed by Vice President Linda Sternbach. The Environmental and Engineering Group dinners were chaired by Matt Cowan and Troy Meinen. The newest technical group, the Carbon Capture, Utilization and Storage (CCUS) interest group hosted lunches chaired by Bryan Guzman.

There are many more activities too numerous to mention, and many active committees that make the HGS what it is. To all of those committee chairs and volunteers, named and unnamed in this column, I express my sincerest thanks and appreciation! My thanks also go to the committee volunteers that run the social media and communications committees. And to Bulletin Editor Caroline Wachtman, my special and express thanks. She has done a terrific job bringing interesting content to you, the Members, on a timely basis, while putting up **From the President** *continued on page 9*

Meet the 2024–2025 HGS Executive Board

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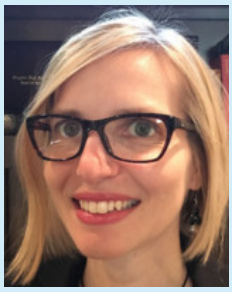

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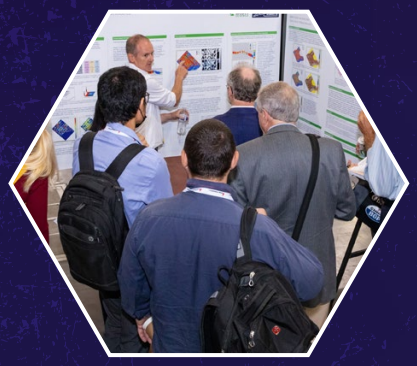

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What's Your Motivation?

This is my final Letter from the Editor for the 2023-24 HGS Board term. I'm happy to welcome Ted Godo into the Editor's role starting in July. I'm confident that Ted will put his own unique spin on the job. Thanks to Lisa Krueger for her creative and consistent graphic design of the *Bulletin*. She and Ted will make an awesome team. Thanks also to HGS members for your help in enhancing the *Bulletin*'s content this year—keep your submissions and ideas coming.

Special recognition goes to my husband, Rick, and my girls, Lucy and Annie, who allowed me to devote every night and weekend for the past 10 months to the HGS community. Rick created bespoke Word Breccia puzzles for the *Bulletin* and managed the kids while I worked. The HGS community of volunteers extends well beyond its paying members. This organization would not function without the dedicated support of volunteers and their families.

MY MOTIVATION

As I write my last Letter from the Editor, I'm reflecting on what motivated me to accept the role, what I gained from the experience, and what lessons are applicable to others. I built my own network by interviewing more than 80 geoscientists for Bulletin articles. These interviews allowed me to practice active listening skills. People were eager to share their stories, and it was up to me to hear the messages behind and between their words. I unequivocally became a better writer over the course of the year and feel certain that I would continue to improve with more practice.

I didn't accept the Editor's role with the intention of becoming a better listener or a better writer. Instead, I was motivated to learn from others because mentoring and networking offer tangible and intangible benefits that are essential to a career in geology. I love organizing things—teams, projects, words, and stories. I was motivated by the satisfaction that comes from taking a complex, nuanced story of someone's career and organizing it into key themes and lessons. Finally, I was motivated to amplify the voices of early and mid-career geologists. This population is critical to the long-term existence of HGS, but they make up less than 20% of the current membership. I hoped that by sharing the diversity of their experiences, the HGS would further embrace the talents and understand the challenges of the current geoscience workforce.

I was motivated by the satisfaction that comes from taking a complex, nuanced story of someone's career and organizing it into key themes and lessons.

COMMON THEMES

I found common themes among the stories of the 80+ geologists I interviewed. Geologists' careers are shaped by similar forces. How each geologist reacts to those forces is unique.

Be introspective if you want to control your own legacy. I found that very few geologists had previously been asked to reflect on the forces that shaped their careers. It is understandably difficult to distill a career of wins and losses into discrete lessons. However, an impactful legacy is built on more than a collection of anecdotes. The people who have devoted the time and hard work to reflect on their deliberate choices and lucky opportunities are those whose stories can be most impactful to others.

Risk-taking is an integral part of being a geologist, particularly a geologist in the Oil and Gas industry. I am consistently awed by geologists who have left corporate jobs to start their own exploration and development companies. I'm humbled by the geologists who have tenaciously pursued their ideas, sometimes not seeing the fruits of their labor until decades later. I'm also intrigued by the geologists who took a risk to say "no" to an opportunity. It takes courage and confidence, and careful introspection, to accept the possibility of missing out.

Business skills are equally essential as technical skills. Unlike engineering programs, many geologists are not exposed to business metrics and commercial decision-making in school. These skills are commonly learned on the job or with supplemental education from an MBA program. The most impactful geologists put their technical ideas into a compelling business context.

Find mentors who will advocate for you. Nearly all of the geologists I interviewed shared stories of being coached and supported by other geologists. **From the Editor** *continued on page 9*

From the President continued from page 6

with any delays to publication because the President is running late with his Letter; thank you Caroline. It has definitely been quite a year!

That brings us to the coming year. One of the first things you will notice is that we increased dues to $40 from $36. I appointed a special committee to review the dues situation including things like switching to a calendar year, different ways of billing, and of course, the increase. It has been two years since the last increase, a limit set by the bylaws. The maximum increase we could consider was to $43.20. The committee recommended a $4 increase to $40, which the Board agreed and approved. The cost of your membership is $3.33 per month, less than most of your streaming TV services.

Even though it is not July, next year is already moving ahead, and I am sure President Penny Patterson will embrace it with all the enthusiasm it demands. Already in motion are the Grand Canyon River Trip next spring, the Student Expo, the joint HGS/GESGB Africa Conference and the annual Golf Tournament and Second Annual Sporting Clays. Watch for them as some have deadlines coming, but I am going to let President Patterson tell you more about them in her monthly Letters.

It has been an honor to have served as your President, and I look forward to seeing all of you at the many upcoming events!

Cheers.

From the Editor continued from page 8

Those who reached senior corporate levels all had mentors who advocated on their behalf, bringing them opportunities to grow skills and grow in name recognition. Finding mentors and mentor-advocates is partly based on luck, but many geologists actively cultivate mentoring relationships.

Geoscience skills are transferable to other disciplines and industries. It is tough to survive an entire career in the Oil and Gas industry. Many geologists are forced, or choose, to pivot to other industries. However, the skills developed as a geologist, such as effective communication, multi-disciplinary integration, problem-solving, project management and business acumen are transferable to other geoscience disciplines like geothermal and CCUS, as well as adjacent industries, such as information technology, academia, entrepreneurship.

CONTINUE THE CONVERSATION ON MOTIVATION AND LEGACY:

- This edition of the *Bulletin* features conversations with long-time HGS volunteer, Linda Sternbach. Read more about her reflections on a career in geology and her motivations for volunteering.
- Read about Rob Pascoe's motivations that shaped his career and legacy.
- Hear about what motivates Galen Treadgold to handle logistics for 30 tons of rocks.
- See Scott Singleton's technical article that demonstrates his motivation to pursue a decades-long study of fossil wood on the Gulf Coast.
- Read about a motivated group of volunteers studying the geology of Buffalo Bayou.

WELCOME TO NEW MEMBERS, EFFECTIVE MAY 2024

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We Are The HGS

Babatunde Aderibigbe, HGS member since August 2023

"In Nigeria, where I grew up, every kid wants to be a doctor or to work in Oil and Gas," says Babatunde Aderibigbe. "I don't like blood," he laughs, "So it was petroleum engineering or geology for me." Aderibigbe says that he first learned about being a geologist when career counselors spoke to his high school class. He was attracted to the idea of climbing mountains and "talking to rocks" like the visiting counselors described.

In 2018, Aderibigbe earned a Bachelor of Science in Geology from Obafemi Awolowo University in Nigeria and then worked for nearly three years as a hydrogeologist with a Nigerian drilling company. He realized that he needed a graduate degree to advance in his career and chose the United States because of the research opportunities, academic excellence, and global networking opportunities. Now in his second year as a Master's student at the University of Tulsa, Aderibigbe says he is looking for geophysicist jobs where he can apply computational and geoscience skills. Aderibigbe says he loves to travel around the US to explore the geology. When he is not traveling or studying, Aderibigbe enjoys playing ping pong and asserts he is the best among his colleagues.

Aderibigbe explains that he joined HGS to learn about career opportunities and build his network of industry professionals

Aderibigbe explains that he joined HGS to learn about career opportunities and build his network of industry professionals. He also aims to give back to the HGS by volunteering. Aderibigbe notes that he took on leadership roles in the Africa region of AAPG and is currently an active participant in the National Association of Black Geologists and in other professional societies.

Aderibigbe says he likes trying new things and taking on new challenges. He is looking forward to participating in HGS virtual events from Tulsa and interested in attending future in-person conferences. ■

Sophie Broun, HGS member since November 2023

"I love the quote 'the person who sees the most rocks wins,'" says Sophie Broun, an independent geologist who most recently worked for Chevron. Taking this mantra to heart, Broun joined the HGS to "see more rocks" and build her network of industry professionals in Houston. Broun says the quality and topics of recent HGS talks appeal to her. She is looking forward to connecting in-person with the Houston geoscience community, because geoscience is "a people and relationships business," says Broun.

Broun joined the HGS to "see more rocks" and build her network of industry professionals in Houston.

Broun started her professional career as a Drilling Engineer for Chevron on the Northwest Shelf of Australia. She soon became intrigued in learning more about the rocks she was drilling through. "I developed a passion for geology and how to find pay," she says. After nearly six years in Drilling, she went back to school and earned a Master's degree in Petroleum Geoscience from Royal Holloway College at the University of London.

Broun took her new skills as a geologist back to Chevron in Australia where she progressed exploration investigations from the Perth office before moving to Houston in 2019. In the past four years, Broun has worked on deepwater GOM discoveries, including Tahiti and Ballymore, and is now a global advisor for Chevron's Joint Venture assets. In May 2023, Broun earned an MBA from Wharton. She is applying those business skills to her new role and intends to bring a more entrepreneurial mindset to future assignments. ■

WORD BRECCIA – A GEOLOGY WORD JUMBLE

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

CLICTEA _ _ _ ○ _ _ _

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TIBOTIE _ _ _ _ ○ _ _

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Thanks to _ _ _ _ _ _ _ _ for serving the HGS as Editor. Best wishes to Ted.

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.

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Conference Overview

The city of Houston will once again host the HGS-GESGB Africa Conference, now in its 23rd year, in September 2024. Taking place at the Norris Center in Houston, Texas, this two-day conference is scheduled for September 24-25. The HGS-GESGB Africa Conference is a prestigious event organized by two prominent member-led international professional organizations, namely the Houston Geologic Society (HGS) and the Geoscience Energy Society of Great Britain (GESGB), bridging the gap across the Atlantic Ocean.

The theme of this year's conference is Africa 2024: The Future in Energy, Skills, and Diversity. Its thematic focus on Africa's pivotal role in the global energy landscape is indeed timely and essential. With its wealth of natural resources and development potential, Africa will be central to shaping the future of energy. The conference theme, "The Future in Energy, Skills, and Diversity," underscores the multifaceted nature of Africa's energy sector and the need to address various challenges and opportunities. It is crucial to focus on harnessing Africa's plentiful energy sources while considering energy transition and sustainable solutions in the current socio-political environment.

Conference Objectives

The conference will cover key facets of Africa's energy landscape. Delving into the conference sub-themes noted on page 1, we will illuminate a nuanced understanding of complexities in harnessing Africa's energy potential while navigating sustainability alongside a gradual energy transition. We offer a platform for stakeholders from diverse backgrounds - industry experts, researchers, policymakers, and practitioners - to exchange insights, share best practices, and forge collaborations aimed at driving positive change.

A Word From the Chair

We intend that this year's conference participants will share diverse perspectives and experiences to enrich discussions and collaborations. Our significant effort towards soliciting more participants from Africa is evidence of that direction. Overall, the conference serves as a catalyst for advancing dialogue, innovation, and action towards a more sustainable and inclusive energy future, with Africa playing a central role in shaping this trajectory.

For potential sponsors, this conference presents a valuable opportunity to support and showcase your involvement in the energy sector, particularly in relation to Africa. The range of sponsorship options and associated benefits will prove advantageous to organizations and individuals looking to enhance their visibility and engagement within the industry. Please consider becoming a sponsor of this year's Africa Conference.

Gbenga Olumurewa
CHAIR, 2024 Africa Committee

AFRICA CONFERENCE

SEPTEMBER 24-25, 2024

NORRIS CONFERENCE CENTER, HOUSTON, TX

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Rob Pascoe: Make Your Luck

By Caroline Wachtman

"The first couple of years were amazingly disappointing," says Rob Pascoe of the geology curriculum at Imperial College of London. He was not motivated by identifying and drawing fossils and minerals which comprised much of the foundational courses at the time. His interest in geology changed when he took a class with Jeremy Leggett, a professor who had recently worked on his PhD on the Ocean Drilling Program. Leggett introduced Pascoe to plate tectonics and modern concepts in stratigraphy. "It changed everything for me," says Pascoe who continued his geology courses and earned a Master's degree in Marine Geophysics.

Pascoe joined Conoco to work the North Sea in 1982 at a time when many other geologists had recently joined the Oil and Gas industry. Peer mentors were a strong influence on his early career, and Pascoe says he learned from others who had recently faced the same technical challenges. Pascoe notes he was fortunate to have supervisors early in his career who taught him the commercial aspects of the industry.

"Passion, purpose, and play," says Pascoe, have shaped his career.

Throughout his 40+ year geoscience career, Pascoe says that he has been lucky to be in the right place at the right time, but has also worked hard to make his own luck. "Passion, purpose, and play," says Pascoe, have shaped his career. He lived this mantra, rising to senior management in Conoco and BHP, and in his current role as Managing Director of the Dynamic Group.

MAKE THE OPPORTUNITY

After working the North Sea for six years, Pascoe was looking for more adventure. He transferred to Luanda, Angola in 1988 to be part of a team exploring pre-salt plays, and then transferred to Houston into the Global Basin Studies group in 1990. During this period, Pascoe says he became interested in the new concept of sequence stratigraphy as a way of better integrating geology and geophysics. He successfully convinced his Conoco management that he should intern with Peter Vail, a pioneer in seismic stratigraphy at Rice University. Pascoe says that he could sense that sequence stratigraphy was going to be a key part in industry's continued move into deep-water and he had to be a part of it.

Pascoe continued to position himself to be in the right place at the right time by moving to BHP in 1999 to work the ultra-deepwater in the GOM. He says he recognized the potential of the ultra-deepwater and wanted to work with a company who had acreage in the region. Pascoe was Chief Geologist during the exploration and appraisal of the giant discoveries of Atlantis, Mad Dog, Shenzi, Cascade, and others. "It's important to be at the right place at the right time, but also to make the opportunity," says Pascoe.

SAVE ROOM FOR CREATIVITY

"Play," in the context of the Oil and Gas industry, "Is the ability to try new things," says Pascoe. He explains there isn't room for creativity when time is too short and performance goals are too rigid. During his career, Pascoe says that he has seen a shift towards a greater business focus on performance and accountability across the industry, which has been a necessary and positive evolution, but potentially at the expense of creativity. "When I started, the industry was much more forgiving of the space needed for new exploration ideas," he says. "The balance between creativity, and discipline, performance, and accountability is a polarity where both values have to be optimized," he continues.

Pascoe says he is passionate about his work, immersing himself in seismic interpretation and occasionally losing track of time, in a "state of flow." His passion stems from the view that "the industry is constantly reinventing itself, and explorers are the fundamental engine," he says. Furthermore, Pascoe has maintained his passion by immersing himself among top geoscience minds and going to conferences.

BUSINESS SUCCESS REQUIRES AN EXPLORER'S MINDSET AND BUSINESS ACUMEN

After leaving BHP in 2011, Pascoe joined the Dynamic Group (DG), a small, independent prospect generation and seismic licensing company. At age 50, after more than a decade in management, he returned to seismic interpretation work. Pascoe says he maintained a technical focus throughout his career, so it was an easy transition. Furthermore, his management experience allows him to contextualize opportunities in a way that is attractive to companies across the spectrum from super-majors to small independents and private investors.

Over the last decade, Pascoe has studied the complete basin history of the GOM, which was made possible by DG's basin wide SuperCache dataset and release of seismic data by the Bureau of Ocean Energy Management (BOEM) in 2016. Based on these data, DG realized that the middle and lower Miocene deposits of the GOM beneath the modern-day shelf were highly underexplored.

Pascoe and the DG team have

Rob Pascoe *continued on page 17*

 continued from page 16

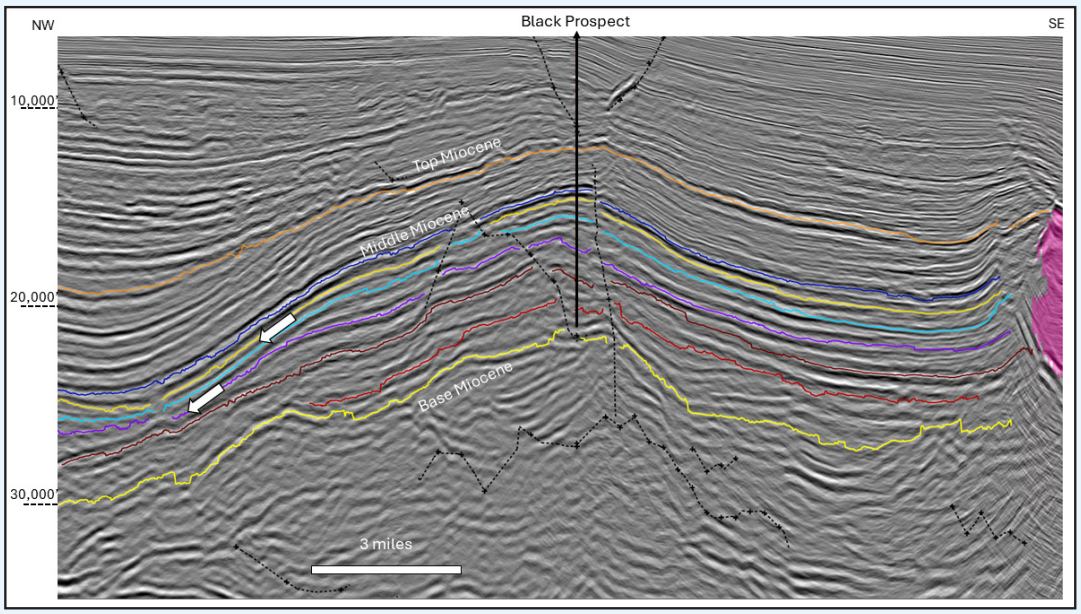
identified 23 structures interpreted to be inverted mini-basins that were formed on the paleo slope during the Miocene. These structures have the potential to be supergiant oil fields with an expected mean resource totaling more than 3 Billion Barrels of Oil (BBO). The structures are expected to be liquids-rich because of the preponderance of a type II source, and depth position that is below the biogenic gas window but above the oil-to-gas cracking window.

GOING FORWARD

After more than 40 years exploring, Pascoe continues to find passion, purpose, and play on the GOM shelf. He shows no signs of slowing down technical or business work and continues to be an active participant at conferences, such as the recent Perkins-Rosen GCSSEPM and GeoGulf2024. He hopes to look for new insights into the GOM basin by being creative and putting himself in the right place at the right time. ■

THE DEEP MIOCENE POTENTIAL OF THE OUTER WEST LOUISIANA SHELF: AN UNDEREXPLORED PLAY

By Robert Pascoe



"Black" prospect proposed location, TD at 21,300 ft. Middle and Lower Miocene minibasin inversion. 51,000 acres of closure and 3,500 ft of relief from the crest to the spill point. Vertical exaggeration 2:1. 3D Seismic courtesy of Fairfield Geotechnologies.

For the last 75 years, exploration and exploitation on the Louisiana shelf have been focused on a single play: Upper Miocene and Plio-Pleistocene deltaic sandstones trapped against growth faults and salt diapirs. The last giant field was discovered in 1974 and 95% of the ultimate resources had been discovered by 1983. During the mid-80s exploration drilling on the shelf peaked at over 500 wells per year and then declined to less than 250 wells per year in the early 2000, and for the last decade has been less than 10 wells per year. The first regionally extensive 3D seismic data did not become available until the late 90s. The underlying Lower and Middle Miocene sedimentary intervals remain largely unexplored despite being located between two prolific, coeval petroleum systems: shelf-margin deltas onshore and on the modern inner shelf and basin-floor fans in modern deep-water.

Mapping of the Lower and Middle Miocene slope systems using regionally merged 3D seismic surveys, has revealed extensive, linked, salt withdrawal minibasins within an 11,000 square mile focus area. The minibasins first occur 30-50 miles downslope from their coeval shelf margins. Multiple linked minibasins, up to 15 miles wide, extend over 100 miles downdip beyond the modern shelf edge. These minibasins represent the fill-and-spill transport pathways between the coeval shelf margins and basin floor fans. The sedimentary fill is interpreted as having significant sandstone reservoir potential, based on the seismo-stratigraphic signature and on analogs of younger Gulf of Mexico deep-water depositional systems. Many of the minibasins have been inverted by younger, lateral salt withdrawal, resulting in large, untested structural traps with closures of up to 50,000 acres and prospective intervals of 4,000-9,000 feet thick.

A portfolio of 21 prospects has been developed with a total mean recoverable resource of 3 billion barrels of oil. Target reservoirs are within a depth interval of 14,000-23,000 feet TVDSS. Cycle time from discovery to first production, with new infra-structure, is expected to be less than four years.

Linda Sternbach: Commitment to the Science and Profession of Geology

By Caroline Wachtman

"A lot of girls went into biology, but I wanted to be different," says Linda Sternbach, Vice President of Star Creek Enterprises and the 2023-2024 Vice President of the Houston Geological Society. Sternbach started her college career at Syracuse University (SU) as a journalism major, but soon realized that she wasn't interested in writing about politics or social issues. Instead, she was interested in writing about science. She discovered geology and liked that it was a "blend of all other sciences."

Sternbach knew that she wanted to go into petroleum geology because it was an opportunity to travel and had the best job prospects in the early 80s. SU professors encouraged Sternbach to apply for graduate school, and she was accepted to Rensselaer Polytechnic Institute (RPI), near Albany, NY to study Paleozoic carbonates with Gerald M. Friedman. "[Friedman] could get me tuition assistance and a Teaching Assistant job; and, the RPI offer was good enough to support myself, if I didn't eat much," says Sternbach. Upon arrival at RPI in 1981, Sternbach met Charles, a Ph.D student working with Friedman. "We got along very well from the day we met," says Sternbach. Their initial compatibility has resulted in a 40+ year commitment to geology, to volunteering, and to each other.

Commitment, dedication, and perseverance are hallmarks of Sternbach's career and life. She has served as Editor of the HGS *Bulletin*, is a past President of HGS, and currently is the Vice President of HGS. In addition, she has held volunteer leadership roles at AAPG, GCAGS and SIPES. Sternbach's dedication to volunteering stems from her love of geology, and because volunteering allowed her to develop leadership skills. After four decades of practice, Sternbach says she feels confident in her leadership style and confident that she will continue to work as a geologist with her husband, Charles, for many years to come.

Linda and Charles in Canada

COMMITMENT TO GEOLOGY

Sternbach started her career at ARCO working onshore South Texas fields before moving to offshore GOM lease sale exploration. Sternbach says that she never had serious concerns as a female geologist, even when visiting offshore rigs. "Robbie Gries [pioneering female geologist] broke the 1970s glass ceiling, and women of my era had a clearer path; you just had to be willing to work hard," says Sternbach. "My male co-workers have been very supportive of women's careers, both at ARCO and other companies."

Linda on an offshore rig

In the early 1990s, industry downturns forced many petroleum geologists into other roles. Instead of leaving the oil and gas business after getting laid off, Sternbach doubled down on developing her skill set as a workstation seismic interpreter and founded a consulting company, 3D Advantage. She consulted with Pennzoil to interpret GOM data for upcoming lease sales and took the opportunity to learn Landmark software by interpreting during the day and staying after hours to read the software manual. She further developed her workstation skills by taking classes sponsored by HGS and working as a seismic interpreter. She credits Steve Getz, and HGS Past Presidents Deborah Sacrey, John Jordan, and Jeff Lund as professional mentors.

The two-monitor workstation of the early 2000s had a whopping (for the day) 30 Gigabytes of hard drive space and Windows 95 software.

In the mid-2000s, company consolidation incentivized Sternbach to pursue a new job. She found that it was a "real struggle" to find a corporate role at age 48, despite having interpretation experience in the United States, West Africa, Australia, Middle East, and South America and having worked for Globex, Kerr McGee and Oxy. "Ageism is real," says Sternbach, who explains she found out she was "old" when her bosses were five years younger. "If you're in a technical role, even though you have 30 years of exploration experience, you're going to find **Linda Sternbach** *continued on page 19*

Linda Sternbach continued from page 18

that large oil companies are uninterested in interviewing people in their late 40s and 50s for corporate jobs," she says. "Large companies prefer to hire people with five to twenty years of experience."

After leaving the corporate world, Sternbach joined Charles' company, Star Creek Energy in 2006. For the past 18 years, she has worked as a geophysicist exploring for resources and developing assets throughout the mid continent and internationally.

COMMITMENT TO VOLUNTEERISM

Sternbach began her professional volunteerism by organizing weekly department seminars as a graduate student at RPI. She loved learning from prominent geologists. "We just thought the greatest thing in the world was to hear all these great speakers," she says. A love of learning keeps her volunteering 40 years later. "We just get a lot of satisfaction out of organizing talks because we benefit professionally, and we also like seeing colleagues benefit from good geological presentations," Sternbach says of Charles and herself.

We just get a lot of satisfaction out of organizing talks because we benefit professionally, and we also like seeing colleagues benefit from good geological presentations.

Upon taking the HGS VP role, Sternbach says she wanted to rekindle and revitalize HGS traditions like the "Legends in Wildcatting" talks and Sheriff lecture. She also wanted to increase dinner meeting attendance and expand attendance options to include Zoom Luncheon meetings. Sternbach believes that she accomplished her goals, citing approximately 150 attendees at several of the dinner meetings this year.

In addition to learning, Sternbach explains that volunteering with HGS offers her a venue to develop her leadership skills. She admits her natural mindset is "to debate everybody and set direction." Sternbach says, "It took me into my early 40s before I could handle criticism and group planning." She continues, "I had to learn that you have to work a little more collaboratively with people—it took me a couple years to really understand that, and the volunteer work helped a lot," smiles Sternbach.

Linda and Charles at Rensselaer Polytechnic Institute as graduate students (circa 1981)

Linda is an Honorary Member of many geological societies, including HGS, GCAGS, and AAPG. She also received the Gerald A. Cooley Award, HGS's highest honor.

COMMITMENT TO EACH OTHER

Since meeting in the basement of the Geology Department at RPI over 40 years ago, the Sternbachs have been partners in science, business, volunteering, and in life. They have held complimentary volunteer roles and commonly share responsibilities, such as cooperatively organizing the AAPG Gulf Coast Section GeoGulf conferences in Houston 2015-2023. Additionally, they co-mentor junior geologists. "We're more than happy to pull out the so-called Rolodex; sometimes all [job seekers] need to do is get connected with other people and get a better sense of what they want," says Sternbach.

The Sternbachs combined their geology skills into Star Creek Energy. They discovered new oil in the Oakdale Field, a Paleozoic carbonate play, in Illinois in 2021. "We believed enough in this prospect to buy a 3D with our company funds." Together, they have explored throughout the mid continent and internationally. Quick to compliment one another, Sternbach says, "Charles Sternbach is a very tenacious prospect generator. He does not give up on his ideas."

GOING FORWARD

Sternbach explains that some of her friends retired from the industry after 35 years and are "totally done," preferring to spend their time on crafts or grandkids. She doesn't intend to take that pathway, choosing to stay engaged with professional work, saying "I'm more on a journey of personal interests." She is currently exploring in the GOM through a partnership with a new company called Magnetar and plans to drill offset wells in the Oakdale field.

Sternbach says that she'll stay involved in professional societies, but in the short term she plans to focus her attention on personal interests like investigating geologically interesting locations. "The oldest rock I have seen is 3.78 billion years old and located in Minnesota," she says. "I like to try to figure out what the world was like when this rock was deposited," she continues. The Sternbachs have an upcoming trip planned to see billion-year-old rocks in Scotland and other locations. "I like to collect old rocks, because like geologists, they have great stories to tell," she laughs. ■

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Galen Treadgold's GeoInteriors is a Labor of Love

By Caroline Wachtman

"If you can open the door the whole way, then you have more room for rocks," smiles Galen Treadgold, the owner of GeoInteriors, a company focused on rock and mineral sales with a mission to support charities located in Houston, Dallas, and international locations. Treadgold's business began with a love of rock and mineral collecting and has grown over the past 20 years, reaching a peak of 38 metric tons (~84,000 pounds) of rock in a single sale in 2012.

Treadgold manages GeoInteriors in addition to working as a full-time geophysicist. With nearly 40 years of experience in oil and gas exploration, Treadgold is currently the Managing Director at AMNI International Petroleum Resources in Spring, Texas. Although Treadgold says that the majority of skills he uses as a geophysicist are distinct from those he utilizes as a small business owner, he provides a model for how a successful geoscience career can co-exist with entrepreneurship.

LABOR OF LOVE

"It's a labor of love," says Treadgold of his role as owner of GeoInteriors. Treadgold started the 'labor' in 1999 while he was working for ARCO on a joint venture with Petrobras. Treadgold visited a rock shop outside Rio de Janeiro on his first business trip to Brazil and says he was amazed by the large and beautiful pieces of amethyst, quartz and tourmaline. He shipped back several thousand pounds of decorative stone to his home in Dallas. Thrilled with his first purchase, Treadgold started bringing back 8,000 – 10,000 pounds of rocks and minerals every four to six months. He has continued to grow his business and now sources material from rock and mineral shows, primarily the Tucson show.

Treadgold with an amethyst cathedral from Uruguay

The "love" part of the company—requiring a donation to a charity with each purchase—started in the mid-2000s. Treadgold realized that charities could benefit from his work, so he began to require customers to add an additional 10% on their purchase price as a charitable donation. "I was uncomfortable making money on friends, but someone needed to benefit from the amount of work involved," says Treadgold. Customers can choose which charitable organization to support, and they are required to make a separate payment to their chosen organization at checkout. The geophysical and geological societies of Dallas and Houston are longtime beneficiaries of the GeoInteroirs sales. Recently, Treadgold has added non-profits that are of special interest to his volunteers: the Alzheimer's Association, Epiphany Community Health Outreach Services, and Trinity Ablaze that supports vision health in Kenya. GeoInteriors has raised over $430,000 in charitable donations since inception.

Fancy trilobite from Morocco

I'm always looking for new ways to sneak rocks into the house

BUILDING A BUSINESS, STEP-BY-STEP

Treadgold says that he is not an avid risk-taker. He grew the business by making incrementally larger purchases. Treadgold's largest purchase was 38 metric tons (~84,000 pounds) of rock, but he has since scaled back operations. "Even 20 tons is a big job," says Treadgold. "I'm moving to a smaller scale that doesn't require forklifts or giant warehouses," he says.

Ammonite from Canada

The business has evolved over the past 20 years to focus more on usable rocks, such as lamps, table tops and bowls. "I'm always looking for new ways to sneak rocks into the house," laughs Treadgold. He says that he relies on input from customers and volunteers to guide procurement decisions. For example, he recently started to source meteorites and fancy trilobites.

Galen Treadgold *continued on page 22*

Galen Treadgold continued from page 21

GeoInteriors has no routine overhead, instead sourcing trucks and warehouses as-needed to support sales in Houston and Dallas. Treadgold also relies on volunteer labor for purchasing trips and to manage the logistics of transportation and customer sales. "Our goal is to always be cheaper than any rock shop and our pricing is usually 50-75% less than the brick-and-mortar folks. The catch is — we're only open a few weekends a year so it's a bit of a feeding frenzy when we have a sale."

LOVE FOR LOGISTICS

The skills Treadgold uses for GeoInteriors are different from those he uses as a geophysicist. "It's a nice change of pace to put one thing down and then do logistics," he says. Treadgold explains that he enjoys solving logistical problems, such as how to aggregate and transport purchases made across the 23 separate venues that comprise the Tucson Gem, Mineral and Fossil showcase. "I really enjoy it when I have a quarter million dollars of delicate fossils and minerals arriving in a truck, and I don't have any way to unload it," he laughs.

Treadgold says he also enjoys the "thrill of the chase" involved in negotiating with suppliers. He explains that most customers at rock and mineral shows can negotiate for 50% off a marked price, but he can get a 70-80% discount based on the volume of merchandise and the long-standing relationships he has developed. "When you spend $60,000 with one dealer, you have their complete attention when you show up the next year," he adds.

Volunteer Steve Sinclair with petrified wood slab from Turkey

GOING FORWARD

Treadgold says he plans to focus on smaller, under 10,000-pound purchases for future sales. He anticipates hosting a sale in Dallas in October 2024, but doesn't have a time frame in mind for future Houston shows. He also anticipates delegating more responsibilities to volunteers, as he plans to spend more time on a new G&G focus – Golf and Granddaughter! ■

Occurrence of Fossil Woods in Texas, Specifically the Gulf Coast Cretaceous And Tertiary

By Scott Singelton

INTRODUCTION

I began a research project in 2000 to add to the body of scientific knowledge about fossil woods in the Central Texas Cretaceous and Gulf Coast Tertiary periods. Plant megafossils are important because they are relatively common in certain formations and can be used along with palynology and depositional stratigraphy to reconstruct terrigenous environments. The first portion of this project entailed a lot of field work for specimen collection that ended up lasting about a decade and a half (it was that much fun!). I collaborated on this study with the Houston Gem and Mineral Society (www.hgms.org), specifically the Paleo Section of that organization due to the immense amount of expertise they have.

In 2017, I summarized my results to date in a paper for Gulf Coast Association of Geological Societies (GCAGS) for which I won the best paper of that year (Singleton, 2017). By that time, my database had grown into an absolute beast, and it has continued to grow since then. It now consists of 353 fossil wood samples, each of which are represented by three orthogonally oriented thin sections (transverse, radial, and tangential). These samples come from 115 localities throughout Texas (**Figure 1**). In this paper for the HGS *Bulletin* I would like to summarize the key findings of my work.

Climate Overview: One of my key takeaways (which is intuitive to most experienced geologists) is that there has been significant climate variation in the Tertiary, including a gradual cool-down starting in the early Eocene at 51 Ma (Graham, 1999) (**Figure 2**). The terrestrial plant assemblage has steadily morphed because of climate shifts. For example, a Late Cretaceous tropical tree assemblage that exhibited large vessels and thick rays is present through the wet early Eocene thermal maximum. This assemblage changed distinctly by the mid-Eocene to a more modern tropical flora that persisted through the end of the Eocene. The Oligocene cool-down ushers in

Fossil Woods in Texas *continued on page 24*

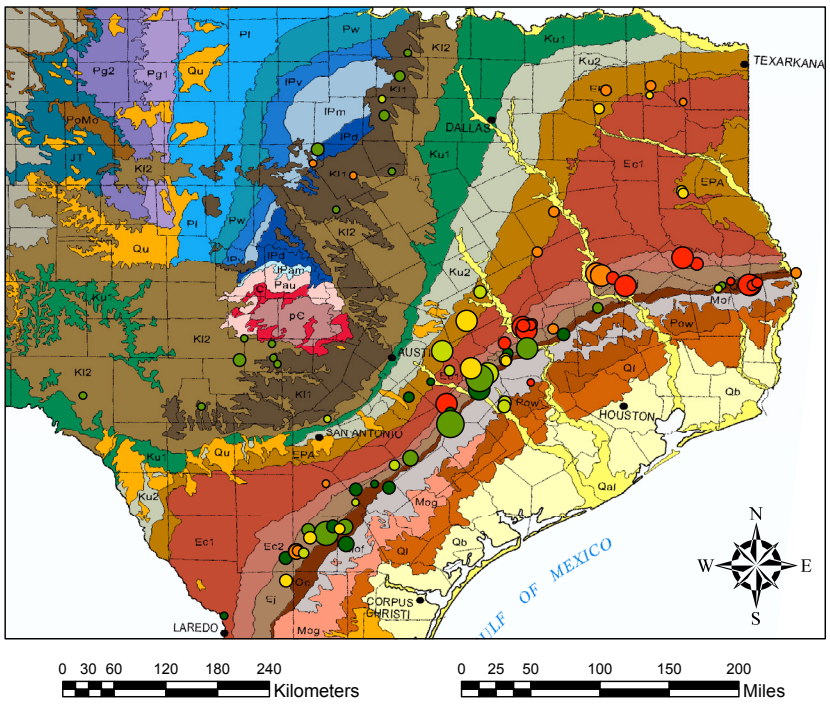

Figure 1. *Texas fossil wood localities, sample sizes, and overall sample quality. Background geology from Geology of Texas (BEG, 1992) reproduced with permission of the Texas Bureau of Economic Geology.*

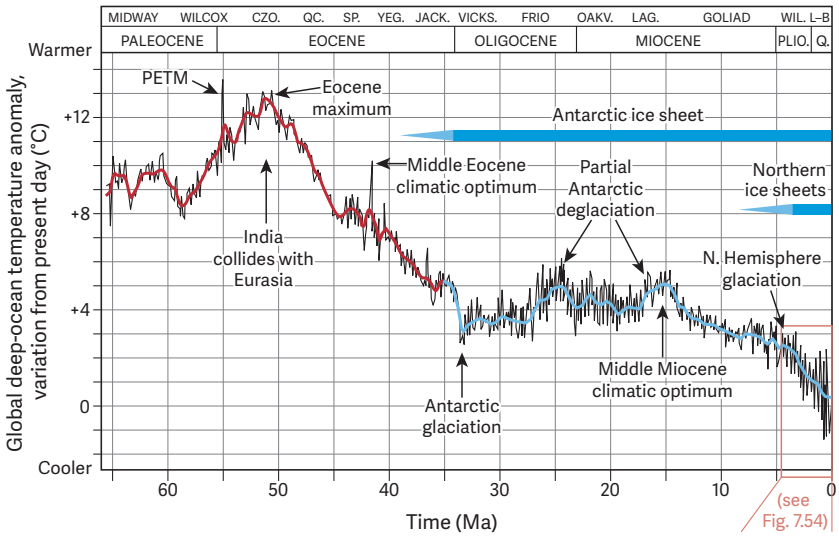

Figure 2. *Global temperature through the Cenezoic (from Raymo and Raymo, 2005, via Ewing, 2016; reproduced with permission of the Texas Bureau of Economic Geology.*

Fossil Woods in Texas continued from page 23

the first temperate species such as elms and oaks. This assemblage does not change significantly through most of the Miocene. I will describe each of these periods in the following sections:

Early Cretaceous: There are several petrified wood occurrences in the earliest Cretaceous, primarily due to the rising (transgressive) seas through the interior of the North American continent. In Texas, the earliest Cretaceous (lower Aptian and older Coahuilan Epoch) was a time of low sedimentation and the entire epoch is represented by the Hosston sands, also known as the Twin Mountain Formation (Ewing, 2016) (**Figure 3**). This formation grades into what has traditionally been referred to as 'the Trinity Sands' (lower Albian Trinity Group), which represent transgressive sand units (Hensel, Paluxy, and Antlers) located both above and below the Glen Rose marl. The Glen Rose thins out in Central Texas, leaving all these Lower Cretaceous sands as essentially a single mappable unit that is referred to as the Antlers Sand on BEG Geologic Atlas of Texas maps and stratigraphic charts in the central portion of the state.

Preserved fossil wood belongs to the conifer families Araucariaceae (Norfolk Island Pine), Cheirolepidiaceae (proto-Cupressaceae), and Cupressaceae (cedar, juniper). Araucaria is the most ancient of these trees, having originated in the Pennsylvanian but became widespread in the Permian. This group is still living today in the Andes of South America and in Australia and New Zealand. Cheirolepidiaceae are an interesting group of extinct conifers that evolved from the Araucariaceae and then subsequently gave rise to the Cupressaceae (cedars). In Central Texas, Cheirolepidiaceae are found in close association with dinosaur remains in the Glen Rose area. Cupressinoxylon is a diverse form genus within the Cupressaceae family, and it represents at least three distinct types of Cretaceous conifers, all of whom may be ancestors of trees we still have in this area such as bald cypress, red cedar, and juniper.

Fossil Woods in Texas *continued on page 25*

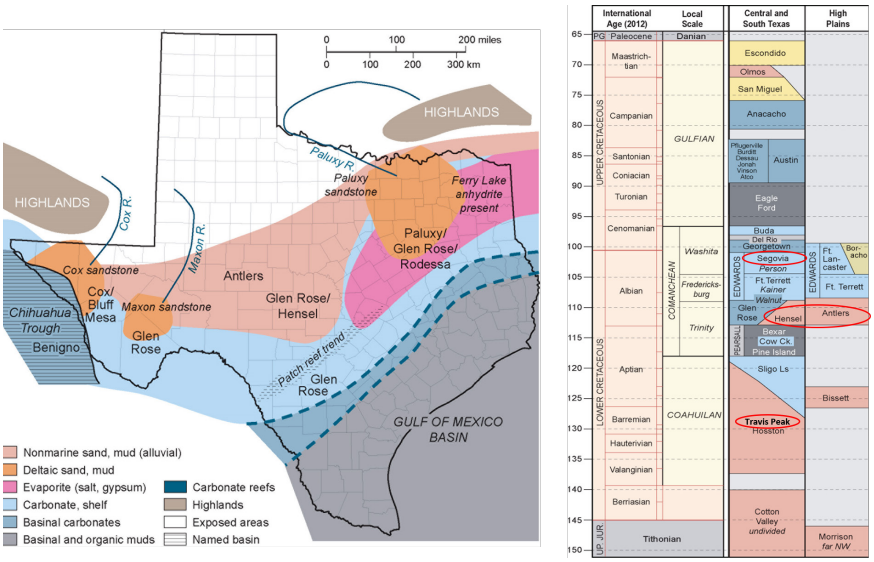

Figure 3. *Early Albian (~110 Ma) depositional environments and rock types (left); Cretaceous strat chart and rock types with petrified wood occurrences circled in red (right). From Ewing, 2016; reproduced with permission of the Texas Bureau of Economic Geology.*

Figure 4. *Teredo-bored Cupressinoxylon from the upper Albian Segovia Formation of the Edwards Group, Kerr County, Texas. Dimensions are 6 x 9 inches per face.*

Fossil Woods in Texas continued from page 24

The Albian Segovia Formation of the Edwards Group in south-central Texas contains a unique, isolated layer (likely an anoxic event) that preserved Cupressinoxylon logs encased in chert nodules, some bored by Teredo clams (**Figure 4**), indicating a coastal growth position and subsequent transport to, and preservation in, a shallow lagoon on the occasionally emergent late Albian Edwards Platform.

Late Cretaceous/Paleocene: A continuous sequence of Campanian-Maastrichtian-Paleocene formations in the Big Bend area (Aguja Fm., Javelina Fm., Black Peak Fm.) documents the withdrawal of the Cretaceous seaway and the creation of floodplain environments along those shores. Conifers and the first preserved Texas hardwoods have been well documented (Wheeler, 1991; Wheeler and Lehman, 2005 & 2009). As in the earlier Glen Rose deposits, these trees are typically found in close association with abundant dinosaur remains.

The Late Paleocene / Early Eocene Wilcox deltas of central Texas (such as the Rockdale Delta) had extensive floodplains and lowland swamps which produced the primary lignite deposits in Texas. In the upper Wilcox Calvert Bluff Formation, fossil wood is ubiquitous in coal seams, occasionally being preserved as silicified, lignitized logs, both within and on top of lignite layers. These conifers belong to the form genus Taxodioxylon, whose source family contains, among other genera, swamp-loving bald cypress. In the floodplain deposits outside of these swamps, hardwoods were common. These hardwoods are described in slightly earlier deposits in Big Bend, thus demonstrating the pervasiveness of the woodland environment both before and after the demise of the dinosaurs at the end of the Cretaceous.

An interesting sidelight is that logs from the Calvert Bluff Formation are (or were) so

Fossil Woods in Texas *continued on page 26*

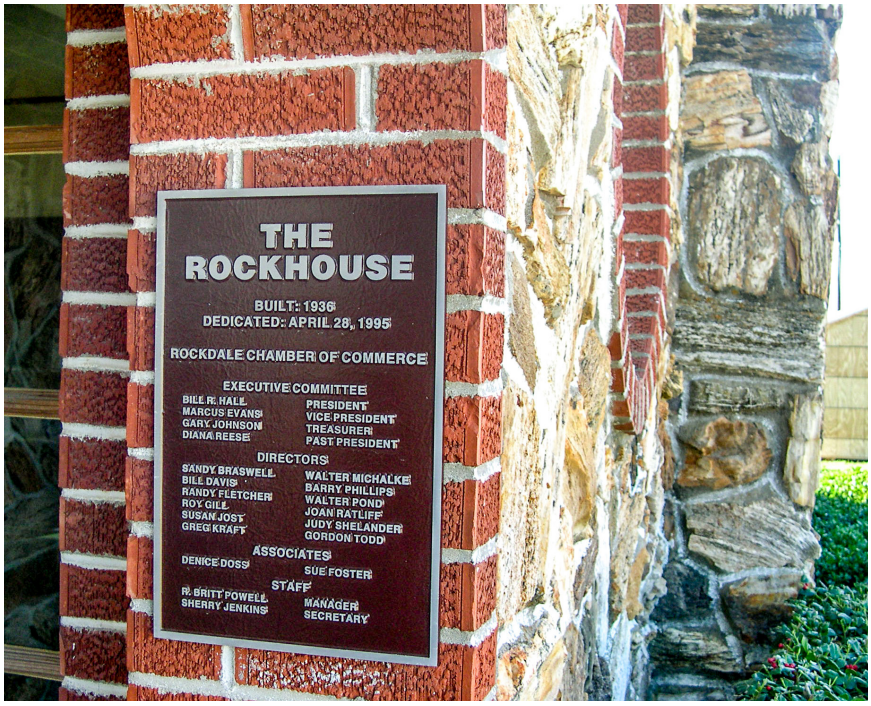

Figure 5. *A house and wall built from petrified wood sourced from the lower Eocene Calvert Bluff Formation of the Wilcox Group, Rockdale, Texas.*

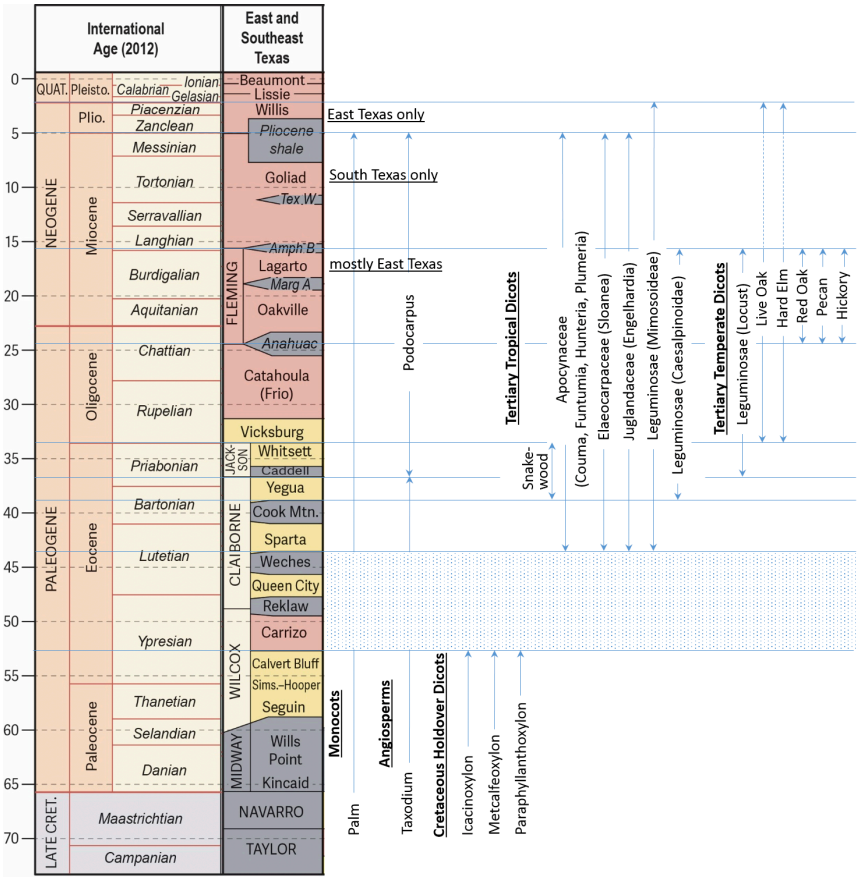

Figure 6. *Tertiary fossil wood assemblage. Only families commonly seen are listed. Stratigraphic column modified after Ewing (2016); reproduced with permission of the Texas Bureau of Economic Geology.*

 continued from page 25

Figure 7. *Lenticular stream deposit with large, petrified wood pieces as lag. Black line indicates the approximate outline of the channel. Geologist pick handle is 13 in, paint scraper is 7.5 in. Pen indicates contact of the sticky gray silty clay of the Catahoula Formation with Fleming Formation. Black object at far left in the channel is a piece of coarse red sandstone whose exterior has oxidized to black.*

abundant that it is common to see retaining walls and houses in several towns in Central Texas using petrified wood as building material, mostly dating from the Works Progress Administration (WPA) in the 1930s (**Figure 5**).

Mid-Tertiary (mid-late Eocene): There is a gap in specimen coverage between the Calvert Bluff Formation (53 Ma) and the mid-Eocene Sparta Formation (44 Ma) (**Figure 6**). This is significant because the early Eocene Thermal Maximum (51 Ma) occurs within this gap. Between the Thermal Maximum and the Sparta Formation global deep ocean temperatures cooled by 5° (Ewing, 2016), one of the steepest temperature declines in the Tertiary (**Figure 2**).

When specimen coverage resumed for the last half of the Eocene (Sparta Formation, Yegua Formation, Jackson Group), a distinctly modern-looking tropical assemblage had taken the place of the Cretaceous assemblage (**Figure 6**). The new assemblage consisted of the families Apocynaceae (the dogbane family), Juglandaceae (the walnut family), and Leguminosae/Fabaceae (the legume/pea/bean family), among others.

Apocynaceae is well-represented. There are at least four genera in my database and sometimes this family consists of half of all the specimens in a locality. The current-day family exists world-wide, including representatives in the American tropics and subtropics. Leguminosae is common and their numbers increase through the Eocene and Miocene. Engelhardioxylon is a tropical member of the Juglandaceae (walnut) family. Manchester (1983) named the Texan species Engelhardioxylon texana. His specimen is from the Yegua Formation in Houston County. The species continues to have a presence in Texas at least through the end of the Miocene. Engelhardia still exists today, with genera in southern Mexico and Central America as well as southeast Asia.

The Eocene Mennegoxylon jonesii (Hueber et al., 1991) is otherwise colloquially known as "snakewood" (**Figure 7**). This species was originally described from the Yegua Formation in Texas and the Jackson Group in Louisiana, and I have not found reliable occurrences outside of this range. This species has a very distinctive appearance caused by ovals of included phloem (groups of phloem cells located within the secondary xylem rather than being in the cambium outside the secondary xylem) in a regular to irregular tangential array. The distinctiveness of these specimens results in them being popular among collectors. The only fossil wood more distinctive and more collected is Palmoxylon, which is ubiquitous throughout the Cretaceous and Tertiary in Texas.

Conifer abundance varies by location and shows no temporal preference. It is noteworthy that conifers are represented by the Taxodiaceae until about the end of Yegua time (33 Ma) when they seem to transition to the Podocarpaceae (the Podocarpus genus that currently resides in South America). This is indicated by the large-featured cellular structure of the Taxodiaceae that abruptly becomes distinctly smaller in the Late Miocene Jackson Group.

Late Tertiary (Oligocene/Miocene): Although some tropical dicots continue their presence at least through the end of the Miocene, in the Oligocene (the Catahoula Formation, 31 Ma) temperate genera started invading from the north as the climate significantly cooled. It is at this point that growth rings start to occur in fossil wood specimens, as seen in locust (Leguminosae), live oak (Quercus virginiana), and elms of the hard elm group (elms that have a single vessel at the growth ring boundary, such as the winged elm, Ulmus alata). A few specimens of red oak (Quercus rubra), and pecan and hickory (both are from the Carya genus) have been recovered from the East Texas Miocene Fleming Formation.

It is at this point that gradation in botanical assemblages begins to be observed between East and South Texas. The Goliad Formation in South Texas is temporally younger (mid to late Miocene) than the Fleming Formation (early to mid-Miocene), which only occurs in East Texas and **Fossil Woods in Texas** continued on page 27

 continued from page 26

Louisiana. Nonetheless, the Goliad Formation predominantly contains tropical dicots and the occasional live oak, which is distinctly different from what occurs in the slightly earlier Fleming Formation of East Texas (**Figure 6**), indicating that zonal differentiation had begun.

I've done an extensive amount of field work in the Fleming Formation near Sam Rayburn Reservoir in East Texas. The sediments are a mottled gray to orange sandy and silty clay that is indicative of soil formation. The clay contains lenses of coarser sand and gravel (lag) that contain fossil wood (Singleton, 2008) (**Figure 7**). The Willis Formation lies unconformably above the Fleming Formation and is a sandy, cross-bedded fluvial deposit. Petrified wood collected from the Willis appears to be identical to that found in the underlying Fleming, except that the Willis material is usually abraded and weathered, indicating it is merely redeposited Fleming material.

SUMMARY

This ongoing research project has documented fossil wood occurrences in the Texas Paleozoic, Mesozoic, and Cenozoic. Primary occurrences are in the Albian/Aptian strata of the Lower Cretaceous and in the Tertiary (Eocene, Oligocene, Miocene). Locality coverage in each of these epochs/stages is good. The highest coverage is in the Eocene Yegua Formation and Jackson Group, followed by lesser but still significant quantities in the lower Eocene Wilcox Group, the Oligocene Catahoula Formation, and the Miocene Fleming Formation.

The Early Cretaceous assemblage consists of a mixed conifer forest consisting of Araucariaceae (Norfolk Island Pine), Cheirolepidiaceae (proto-Cupressaceae), and Cupressaceae (cedar, juniper). In the Upper Cretaceous strata of Big Bend, Araucariaceae and Cupressaceae are found but not Cheirolepidiaceae. Additionally, extensive dicot forests, whose structural properties were a primitive mix of large diameter vessels mostly with scalariform perforation plates, wide rays, and abundant axial parenchyma, were present in the Early Cretaceous. Elements of this primitive assemblage survived to the time of the Eocene Thermal Maximum at about 51 Ma and are found in the Calvert Bluff Formation of the Wilcox Group. Following deposition of the Calvert Bluff Formation there is a gap in fossil wood coverage of 8 Ma, during which time ambient earth temperatures significantly declined.

As a result of these worldwide temperature declines, by the mid-Eocene (~43 Ma) the dicot species mix changed to a modern-looking tropical assemblage containing members of the Apocynaceae, Juglandaceae, and Leguminosae. Following further cooling at the Eocene/Oligocene boundary (31 Ma) temperate dicots start being observed, including ring-porous woods such as locust (Leguminosae), live oak (Fagaceae), and elm (Ulmus). In the Miocene, biotic zonation is noted between East Texas and South Texas, resulting in distinctly more temperate species in the North and tropical species in the South. Data coverage is sparse in the late Miocene and Pliocene, but research is continuing to define these intervals. ■

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BIOGRAPHICAL SKETCH

In his day job, Mr. Singleton is a geophysicist with 35 years of experience in the oil industry spanning from offshore acquisition as a doodlebugger to seismic processing, interpretation, geophysical reservoir characterization and shale reservoir geomechanics. He has been working unconventional resource plays for the last 15 years. He has a BS in Geophysics from New Mexico Tech and a MS in Geophysics from Texas A&M.

HGS Educational Outreach Committee: Spring 2024 Update

The HGS Educational Outreach Committee (EOC) has been busy this spring! Committee members participated in events with community members ranging from pre-school to adult. In the first four months of 2024, HGS members interacted with over 1,400 students and adults throughout the greater Houston area at events including school and community festivals, career days, and other specialized programs.

Special thanks to all our volunteers! If you wish to help in future events, reach out to the EOC Chair, Phil Caggiano.

SCHOOL AND COMMUNITY EVENTS FOR KIDS

HGS EOC participated in four Science, Technology, Engineering and Mathematics (STEM) events this spring. In addition, the EOC participated in two Career Day events, special education events for students in local-area magnet high school programs, an event at a local public park called NatureFest, and a program for pre-school students.

Jennifer Califf and Haider Rizvi interact with a community member at Smith Elementary's family STEM night

Carl Steffensen at Nottingham Elementary family STEM night

Elementary School STEM Festivals

- Jennifer Califf, Haider Rizvi, Carl Steffensen, Ken Thies, and Steve Johansen volunteered at Nottingham Elementary (Energy Corridor) on January 24. Volunteers interacted with 70 - 120 children and 60 - 90 adults. Ken Thies, as always, brought a great collection of fossils to the Nottingham Elementary event.
- On January 25, Jennifer Califf, Haider Rizvi, and Steve Johansen volunteered at Smith Elementary (Alief). The volunteers interacted with up to 80 children and a similar number of adults. Jennifer brought a great collection of personally collected fossils and minerals that she shared with the Smith Elementary students.
- On January 30, Paul and Diane Britt volunteered at North Pointe Elementary. The Britts hosted a booth where they displayed objects to spark interest in paleontology and geology, including a mammoth tooth, model of a dinosaur skull, and rock samples. The event was attended by 150 – 200 children and parents of the school.
- Debbie Caperton, Leslie Bernal, Paul Riegler, and Steve Johansen volunteered at Morales Elementary (Pasadena) on February 8. Approximately 60-90 children and a similar number of adults engaged in geoscience discussions with volunteers.

Educational Outreach Committee *continued on page 29*

Ken Thies at Nottingham Elementary family STEM night

Educational Outreach Committee continued from page 28

Haider Rizvi at family STEM night at Nottingham Elementary

Elementary School Geology and Career Day Events

- Ken Thies presented a paleontology-focused program on the Pleistocene of the Texas Coastal Plain on April 26 and 29 at Bendwood School for Gifted & Talented Students. The audience included approximately 40 students and their instructors.
- Steve Johansen engaged with over 200 students in career day presentations on April 26th (Moore Elementary in Pasadena) and April 30th (Sullivan Elementary in Sugarland). The students were in 4th and 5th grade. The presentation reviewed the wide variety of things that geologists do and suggested how a young student might prepare for a career in geology. It finished with a hands-on examination of some common minerals. They students received rock salt samples and a handout on salt domes and salt mines.

Community Festival: NatureFest 2024

Four HGS members hosted a booth at the 20th annual NatureFest event at Jesse Jones Park and Nature Center, west of Humble, on March 2nd. Sarah Heinlein and two students from UHD also joined us. We displayed an 8-panel poster that explained basic fluvial processes and deposits that are visible along Spring Creek. The posters described information on flooding in river systems and the hydrology of river systems and their sediments. HGS volunteers included Alan Foley, Steve Johansen, Leslie Bernal, and Mike Erpenbeck. Debbie Caperton provided coloring sheets that kids enjoyed. This is the 3rd year that HGS has attended this event. Park staff estimate that over 1,200 visitors attended and the EOC interacted with 200-350 adults and children at the event.

Pre-schoolers Introduced to Rocks!

Chuck Caughey, Mike Erpenbeck, Leslie Bernal and Steve Johansen brought rocks, minerals, and fossils to pre-schoolers at The Yellow School on Memorial Drive. Over the course of two days (February 28 and 29) we had discussions with about 90 very young children and 10 supervising adults. The impetus for this engagement was a request from one of the educators who noticed that the children spent much of their playground time shifting through the gravel in the schoolyard, picking out the more attractive bits.

High School Magnet Program Outreach

HGS provided funds and volunteers to assist with geoscience education events for high school students enrolled in magnet school programs in the Houston area. This support included two events in the first quarter of the year.

- Letha Slagle, Sarah Castro, Phil Caggiano, Beverly DeJarnett, and Chuck Caughey took 100 high schoolers and their instructors to the Texas Bureau of Economic Geology core warehouse in North Houston on January 25th. The visit included an examination of geologic samples and cores coupled with lectures on geoscience in the petroleum business. It was a great event.
- Letha Slagle, Sarah Castro, Janet Combes, Inda Immega, and Phil Caggiano took about 180 high school students and their instructors to the Houston Museum of Natural History on February 23. The event featured a career panel discussion with professional geoscientists. It also included tours of the Paleontology Hall, Gem and Mineral Hall, the Wiess Energy Hall, and lunch. HGS graciously picked up the cost of admissions and docents.

Community Outreach Programs for Adults

On March 18th, Steve Johansen spoke to adults enrolled in training organized by the Gulf Coast Chapter of the Texas Master Naturalist Program. The audience included 30 individuals who study natural history in their evenings and weekends. The presentation reminded participants of the role that geologists have played in the study of natural history. The lecture reinforced the importance of understanding processes when studying soils and rock. It ended with a brief review of geologic features that one can see in Texas parks. ■

SPECIAL THANKS TO EOC SPRING VOLUNTEERS

Leslie Bernal	Debbie Caperton	Beverly DeJarnett	Inda Immega	Letha Slagle
Paul and Diane Britt	Sarah Castro	Mike Erpenbeck	Steve Johansen	Carl Steffensen
Phil Caggiano	Chuck Caughey	Alan Foley	Paul Riegler	Ken Thies
Jennifer Califf	Janet Combes	Sarah Heinlein	Haider Rizvi	

Engineering Science Technology Council of Houston (ECH) Awards Banquet

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

Recipients of the 2024 ECH/SEFH Awards

The ECH banquet celebrated the scientific achievements of students competing in three competitions as well as the students who received Houston Museum of Natural Science (HMNS) summer internships. The three competitions included the Science & Engineering Fair of Houston (SEFH), which was held Feb 16 - 17, 2024. Top students in the SEFH competition then went to the Texas Science & Engineering Fair held March 22-23, 2024 at Texas A & M University. The third competition was the Regeneron International Science & Engineering Fair (ISEF) that was held May 11-17, 2024 in Los Angeles, California. Students that competed in these STEM events are junior and senior students from high schools across the greater Houston area.

The ECH celebration dinner **ECH Awards Banquet** *continued on page 31*

Recognition of the 2024 Teacher of the Year Recipient Errol Larkins who is a STEM specialist at Killough Middle School.

ECH Awards Banquet continued from page 30

also recognized students who received Houston Museum of Natural Science (HMNS) summer internships. Three HMNS interns are being sponsored by HGS this year; they are Shri Chada, Ram Magathala, and Prachi Natoo.

Four categories were awarded at these competitions: Place Award Winners, Special Award Winners, Grand Award Winners, and Teacher of the Year Award. Over 20 Junior and Senior high school students attended the banquet along with their proud parents. Each student received a Certificate of Excellence Award in recognition of their first, second or third place in science, engineering, and technology categories of the competition. There is a wealth of information regarding the awards and the science fair on the web. We highly recommend you visit the SEFH website: /sefhouston.org/sefh-winners-yearwise/.

Students seated at the HGS sponsored tables were Shri Chada (HGS Special Award 1st Place), Cera Easterwood (Effects of Electromagnetic Wave Frequencies on Plant Development/ Plant Sciences), Justin Huang (1st Place Earth & Environmental Sciences), Sohan Kureti (Urine Biomarkers Predicting Renal Activity and Chronicity in Lupus Nephritis/Biomedical Engineering), Ram Magathala (An Approach to Examining Exoplanets with the Use of Remote Sensing Technology/Physics & Astronomy), Ana Olivia (1st Place/Grand Award Mathematics/ Physical Sciences), and Victoria Ou (1st Place Earth & Environmental Sciences). Note that not all the summer internship recipients were able to attend the Awards Ceremony. The students were able to mingle with HGS Special Award Judges (SAJ), Place Judges (SEFH), and incoming 2024-25 officers: Martin Cassidy (SAJ), Glen Lowenstein (Treasurer), Barbara Radovich (SAJ), David Risch (SAJ), Sandy Rushworth (SAJ), Penny Pressler (President), Dorene West (SAJ), and Larry Welch (SEFH). ■

From left to right: Dorene West (Science Fair chair), Penny Pressler (2024-25 President), Shri Chada (HGS 1st Place Special Award Senior Division), Neetha Chada, Ram Chada.

Houston Museum of Natural Science Summer Research Assistant Interns

AChE	Amelia Weiss
GSH	Victoria Velasquez Anderson
HGS	Shri Chada
HGS	Ram Magathala
HGS	Prachi Natoo
IEEE	Arav Mehta
IEEE	Aayan Pattanayak
OS	Heba Badat
OS	Abi Balachandran
OS	Sophie Dai
OS	Suhani Dave
OS	Cera Easterwood
OS	Olivia Esbeck
OS	Ashley Fong
OS	Lilly Gonzales
OS	Himanshi Gupta
OS	Ryan Noorbakhsh
OS	Victoria Ou
OS	Yuliana Petrova
OS	Daniel Vassiliev

Sponsored by

American Institute of Chemical Engineers
Engineering, Science and Technology Council of Houston
Institute of Electronic & Electrical Engineers
Houston Geological Society
Society of Petroleum Engineers
Houston Museum of Natural Science
Geophysical Society of Houston

Open Space (NASA match grant)

SEFH – TXSEF Regeneron ISEF Finalists

Rhea Ahuja	Sophie Melancon
Inu Baek	Jesse Miller
Kaitlyn Bird	Caiman Moreno-Earle
Anshul Desai	Shivani Mundra
Ayaan Dhuka	Anna Oliva
Landon Doughty	Victoria Ou
Nikita D'Souza	Ishan Pendyala
Justin Huang	Madelyn Puza
Aarush Kudariya	Aryan Shah
Melina Kumar	Sumana Subramanian
Felix Li	Shreyas Vatts
Patrick McKenna	Grace Yuan

sefh
Science and Engineering Fair Of Houston

The purpose of the **ECH** is to promote math and science education, enhance opportunities for professional development and discussion and to serve as a focal point for informing the public on engineering, science and technical matters.

UH STEM Center
UNIVERSITY OF HOUSTON

Preliminary Interpretation of the Stratigraphic and Structural History of Buffalo Bayou

By Jerry Kendall, Will Gaston, Richard Lang, Richard Howe, Dorene West, Linda Sternbach, and Caroline Wachtman

STUDY OVERVIEW AND OBJECTIVES

Buffalo Bayou extends for over 50 miles from the Fort Bend County line to the Houston Ship Channel. Despite the number of geologists who live in close proximity to Buffalo Bayou, little is known about its geologic characterization. Tom Helm, long-time Houston resident, local geologist, and canoe aficionado, identified the presence of multiple outcrops in the Bayou nearly a decade ago. Helm's initial investigation sparked further investigation among HGS members.

In December 2023, HGS formed a volunteer-led study group to investigate the structural and stratigraphic history of Buffalo Bayou focusing on the segment from the Woodway bridge to downtown Houston. The study group investigated two key questions: (1) When were the sediments observed in outcrop deposited and in what environment were they deposited; and (2) When were the outcrops exposed and what processes controlled their exposure? To answer these questions the study team commenced a literature search and interviewed geoscientists with knowledge of the surficial environment. Next, the team conducted fieldwork and collected samples from one outcrop near the Woodway bridge.

This report discusses preliminary observations of the mudstone and sandstone outcrops within this segment of Buffalo Bayou, including lithology, cementation, sedimentary structures, depositional environment, and the possible stratigraphic context. The effects of surface faults or other lineaments on Buffalo Bayou are also discussed.

Work is ongoing, and the study team is currently building a database of well penetrations with shallow logs. In addition, thin sections are in preparation for planned petrographic analysis later this summer. A study update is planned before the end of 2024. You are welcome to join the team by sending an email to editor@hgs.org.

INTRODUCTION

Introduction to Buffalo Bayou

Buffalo Bayou is a generally East-flowing stream located in Houston, Texas (**Figure 1**) that is interpreted to be eroded into the Upper Pleistocene Beaumont Formation (**Figure 2**).

Buffalo Bayou overlies ~11 km of passive margin sediments above rift-related Jurassic salt deposits (Verbeek, 1979). Shallow salt features are present in local domes and are the main detachments for presently active SW-NE striking growth faults. Based on currently available data, the growth faults and subsurface salt structures are not considered a primary control on the locations of the Buffalo Bayou modern stream channel. Sea-level change impacts on the Brazos and Trinity River systems are interpreted to have controlled the evolution of Buffalo Bayou.

Buffalo Bayou *continued on page 33*

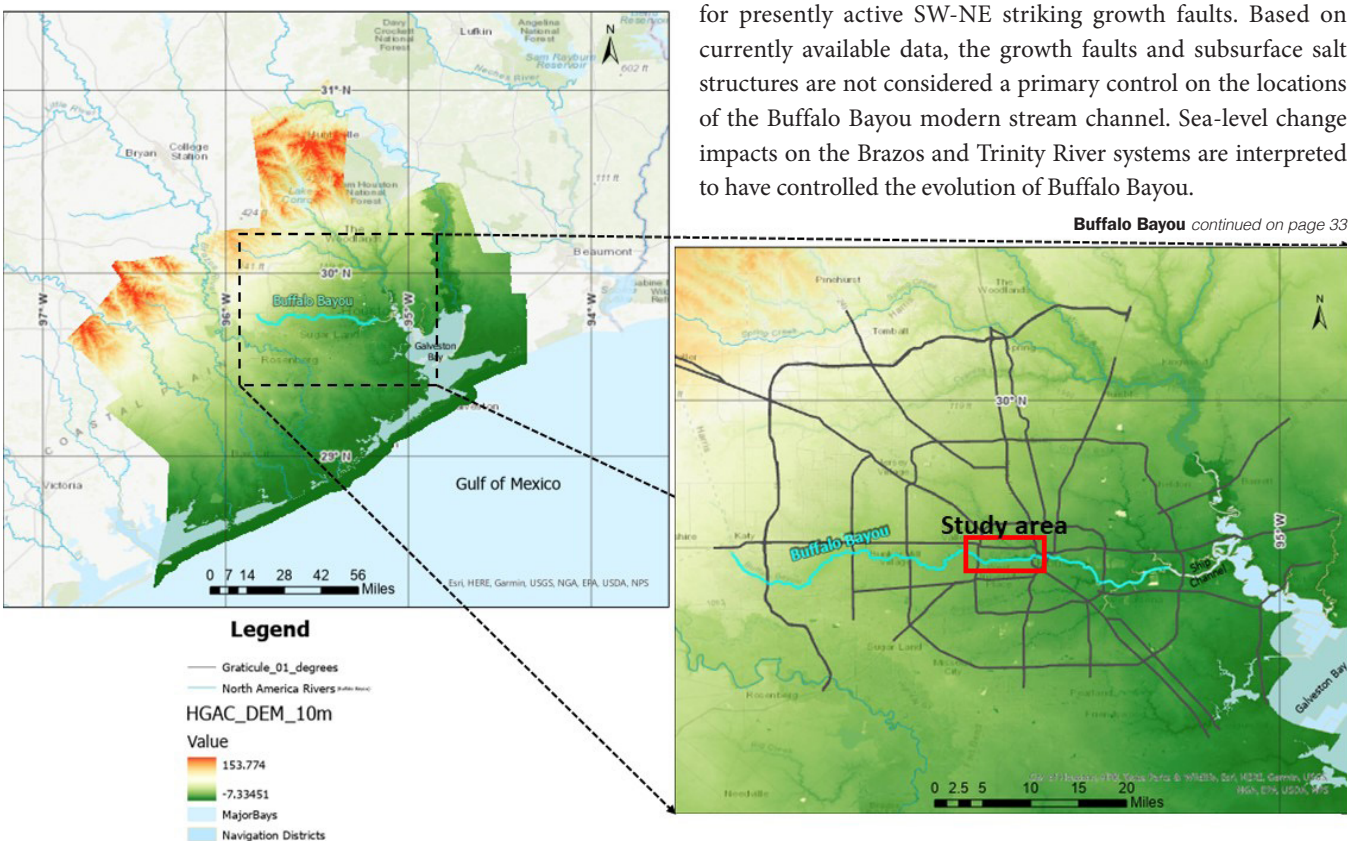

Figure 1. *Map showing a digital elevation model from Houston-Galveston Area Council. Inset map highlights the Buffalo Bayou study area. Elevations in meters.*

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ERA	SYSTEM	SERIES	FORMATION
CENOZOIC	QUATERNARY	HOLOCENE	ALLUVIUM
		PLEISTOCENE	BEAUMONT
			LISSIE
			WILLIS
	TERTIARY	PLIOCENE	GOLIAD
		MIOCENE	FLEMING
			CATAHOULA
		OLIGOCENE	VICKSBURG

Figure 2. *Simplified stratigraphic column highlighting the formations present near Buffalo Bayou.*

Introduction to coastal stratigraphy: Beaumont and Lissie formations

The Pleistocene-age Beaumont and Lissie formations are present near the study area. The Geologic Atlas of Texas, Houston Sheet (Flawn, 1986) places the contact between the Beaumont and Lissie formations ~0.5 – 2.6 miles North of Buffalo Bayou. Based on this mapping, Buffalo Bayou is mapped to cut through the Beaumont formation. Note that the authors of this study follow the stratigraphic terminology of Barnes (1992) where the Lissie formation underlies the Beaumont formation (**Figure 2**). Some older sources divide the Lissie into the Bentley (older) and Montgomery (younger) members.

The age of Beaumont deposition is uncertain and is interpreted to be related to the most recent marine transgression and regression that affected deposition along the Gulf Coast. Radiocarbon dates from wood samples collected from the Beaumont formation South of Houston have been dated to be approximately 35,000 and 44,000 years before the present, (Aronow, 2000); however, no known dated material has been identified in the vicinity of the Buffalo Bayou study area.

The recorded mineralogy of both the Lissie and Beaumont are quite similar. Both formations are primarily composed of clay, silt, and sand that are interpreted to have been deposited in a fluvial-deltaic environment. Therefore, differentiation between the two formations is commonly based on differences in the regional slope. The Lissie regional slope is ~ 2.5 - 3.5 feet per mile, and the Beaumont formation regional slope at ~1 - 2 feet per mile (Aronow, 2000). Although the Beaumont formation is not described as including cemented sandstone (Barnes, 1982), recent observations have identified the presence of at least five localized outcrops of lithified sands in the Buffalo Bayou channel near Memorial Park.

Within the Beaumont formation, sinuous, sandy ridges of fluvial-deltaic origin have been observed by early geologists working in the Gulf Coastal Plain (Barton, 1930; Van Siclen, 1985; Aronow, 1976) and were included in a 1928 Harris County soil survey (Gelb, et. al., 1928). Although present in other areas along the Gulf Coast, the linear sandy deposits in the Houston area are interpreted to have been primarily deposited by the ancestral Brazos River. USGS topographic maps and aerial photographs from 1914 - 1926 were used by Van Siclen (1991) and Dupré (2019) to help identify these ridges, which are also shown on maps prepared by the Houston-Galveston Area Council (1972).

The ridges are characterized as linear sand belts within the predominantly clayey Beaumont Formation (Aronow, 1987, 2000). Sand borrow pits in the Houston-Galveston area are located within these **Buffalo Bayou** continued on page 34

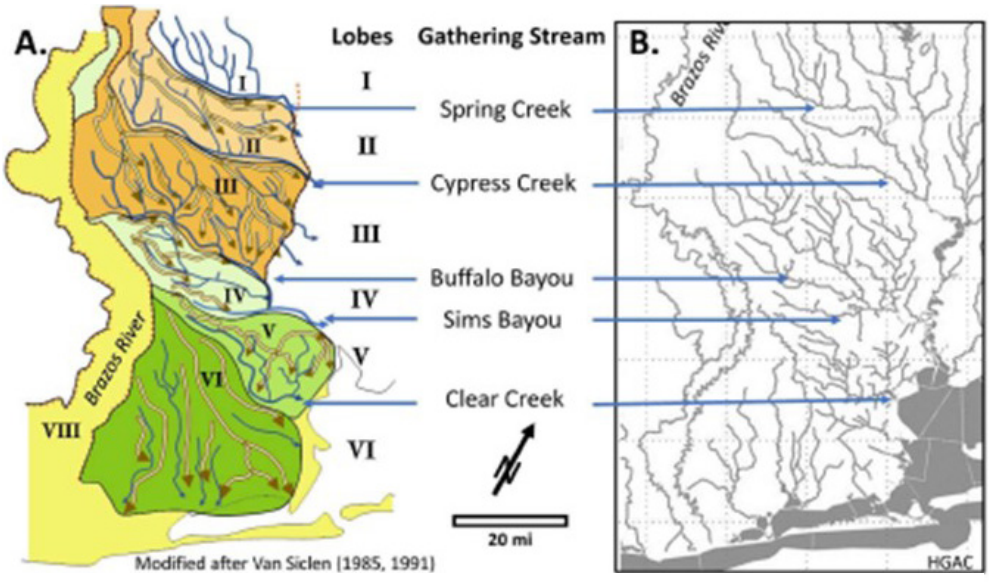

Figure 3. *Paleo-Brazos River fluvial-deltaic depositional lobes and associated modern stream channels. Reprinted with permission from Dupré (2019).*

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linear sand bodies. In the vicinity of Houston, East of the Brazos River, Van Siclen (1985, 1991) observed a relationship between these meander belt ridges and the positions of modern stream drainages. He identified six overlapping fluvial-deltaic lobes that were deposited during interglacial high stands of sea level. These were recently discussed by Dupré (2019), who interprets that radial or palmate distributary channel lobes overlapped earlier lobes and blocked the southward flowing streams, resulting in stream flow directions generally to the East, towards the ancestral San Jacinto River and Galveston Bay (Dupré, 2019). This process was repeated periodically following ancestral Brazos River channel avulsion, resulting in several generally East-flowing modern streams: Spring Creek, Cypress Creek, Buffalo Bayou, Sims Bayou, and Clear Creek (**Figure 3**). It is this regional geomorphic context within which the present Buffalo Bayou flows.

Buffalo Bayou *continued on page 35*

Figure 4. *Typical Beaumont formation red mudstone outcrop North of the Johnny Steele Dog Park. Outcropping, ~0.5 m thick, of layered, poorly consolidated mudstone is visible above the waterline.*

Figure 5. *Red mudstone outcrop. Top and base of channel cuts shown by white dashed lines. Channel cuts are filled with trough cross-stratified sandstones. The outcrop is located in Memorial Park, North of the 3700 block of Willowick Drive. Exposure is ~1 m high and 4 m wide.*

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OBSERVATIONS AND INTERPRETATIONS

Observations and interpretation of outcrops observed in Buffalo Bayou

An investigation of outcrops exposed in Buffalo Bayou at low water (~1 foot at Shepherd Bridge stream gage) along a ~10 km-stretch of the Bayou from just West of I-610 to downtown Houston revealed sporadic outcrops (**Figure 4**) of what is mapped as Beaumont Formation (Barnes et al., 1982). However, the outcrops could be part of the Lissie formation. The Buffalo Bayou study group hopes to determine the age and formation assignment of these outcrops.

Observations and interpretation of red mudstone facies

The outcrops are primarily composed of unconsolidated, layered red mudstones with occasional lithified trough cross-stratified channel sandstone that cut into the mudstones. The red mudstones are poorly consolidated and layered at a cm to mm scale. Occasional concretions are observed (**Figures 4, 5**). Barnes et al. (1982) interpreted these deposits to be interdistributary muds.

In nearby shallow penetrations, the Beaumont is reported to be a dark gray mudstone. The origin of the red color observed in the Buffalo Bayou outcrops could be due to syndepositional processes or recent oxidation. The red color may also be related to the cements in the channel sandstones. A petrographic evaluation of the channel sandstones and mudstones is planned for 3Q2024.

The red mudstones of the Beaumont formation were among the first mineral resources to be exploited in Houston. The mud was mined and made into bricks near the present-day Sabine Street bridge. The bricks were used for roads and drainage systems that transformed Houston from a disease-ridden muddy swamp that Sam Houston refused to live in to a growing metropolis.

Buffalo Bayou *continued on page 36*

Figure 6. *Hammer-ringing outcrops in central Houston. Richard Howe (back) and Richard Lang (front) sitting on an outcrop interpreted to be cemented Beaumont channel sandstone in Buffalo Bayou near Woodway Bridge. Note scale card that is 10 cm wide.*

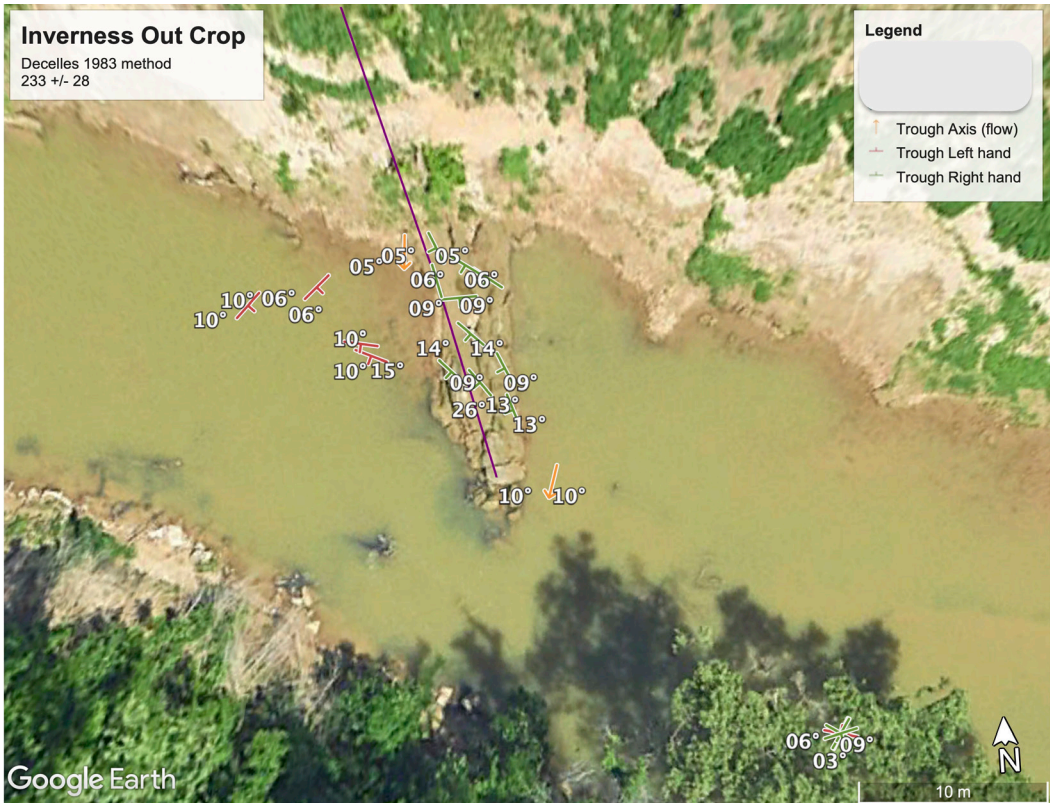

Figure 7. *Google Earth view of typical lithified trough cross-stratified channel outcrop in Memorial Park north of Inverness Drive showing measured trough cross-stratification strike and dips. This is the only outcrop that has exposures on both sides of Buffalo Bayou.*

Buffalo Bayou continued from page 35

Observation and interpretation of channel sandstone facies

We located five large outcrops (~1 m thick and an area of at least 50 m2) of lithified trough cross-stratified sandstones. The outcrops are ~5 – 10 m wide and extend 10 – 20 m into the Bayou at low water (**Figures 6, 7**). The sandstones are gray to light gray, lithified, and contain large scale (0.8-1.2 m) trough cross-beds (**Figure 8**). Grains appear under the hand lens to be well rounded and well sorted, mostly quartz, and fine grained (similar to modern sands in Buffalo Bayou). The cement is interpreted to be calcite, as it vigorously reacts when exposed even to weak acid. At some locales, an erosional basal and lateral contact cut into the red mudstones is observed (**Figure 5**).

Figure 8. *Woodway bridge outcrop of channel sandstone. The outcrop is 0.5 - 2 m thick, ~20 m wide and extends ~10 m into the Bayou. The dashed lines highlight three different sets of trough cross-stratification that were measured for paleo flow.*

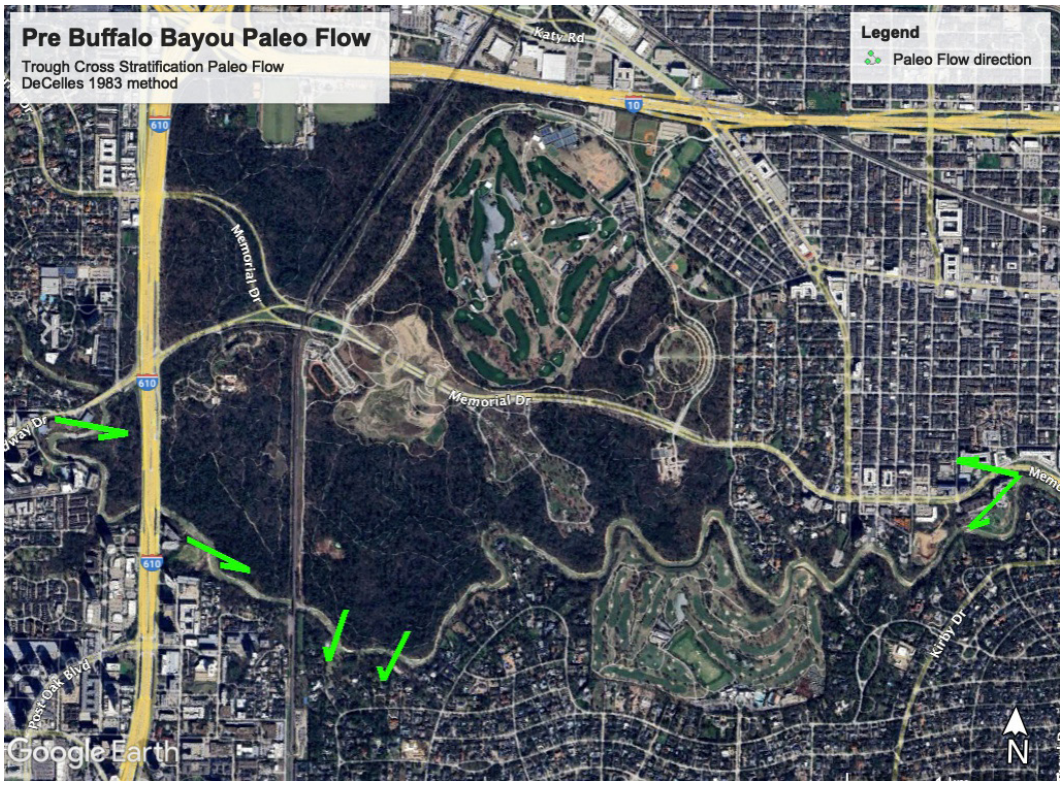

Figure 9. *Google Earth image with arrows indicating paleoflow directions for large outcrops of trough cross-stratified sandstones. Figures 6 and 8 are the western-most channel sand outcrop on the map. Figure 7 is the outcrop located at the fourth green arrow from the left.*

Paleo flow analysis

Applying scaling relationships of Xu et al. (2017) and Snedden et al. (2018) to Buffalo Bayou outcrops indicates that the paleo streams that deposited the Beaumont Formation were significantly smaller than the current Buffalo Bayou. Furthermore, the ~1 m scale of the larger trough cross-beds observed in outcrop is much smaller than the ~3 m trough cross-beds observed in Buffalo Bayou after Hurricane Harvey (Kendall et al., 2019).

Buffalo Bayou *continued on page 37*

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The trough cross-stratification paleo-flow-direction method of Decelles et al. (1983) was applied to the five outcrops large enough to yield significant results. This indicates a southeasterly direction of flow. While not definitive, it appears these paleo streams were much smaller and flowed more southerly than present-day Buffalo Bayou (**Figures 8, 9**).

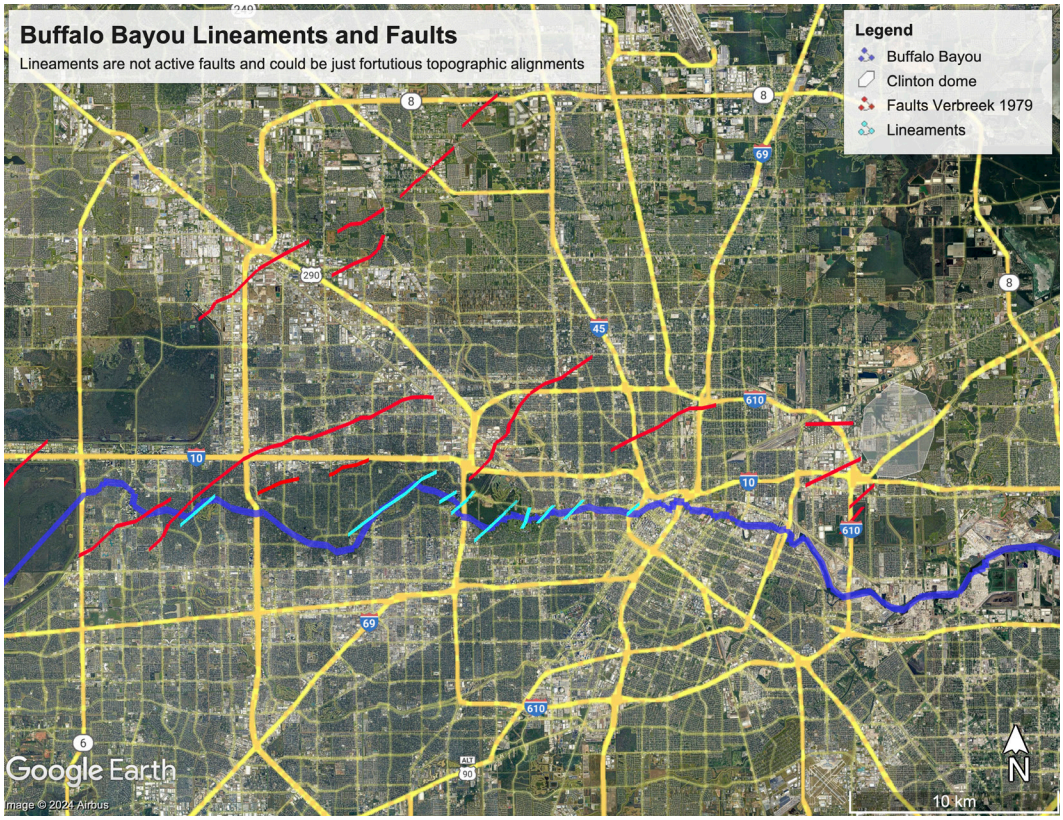

Figure 10. *Know active faults (red) and lineaments (light blue). Basemap image from Google Earth.*

Observations and interpretation of faults and lineaments intersecting Buffalo Bayou

Known active faults (red lines in **Figure 10**) strike NE-SW and are inconsistent with the E-W orientation of Buffalo Bayou. However, the active Long Point fault (LP) and Eureka Heights fault (EH) cut Buffalo Bayou (Engelkemeir et al., 2008; Huang et al., 2015), and are interpreted to influence the modern Buffalo Bayou by changing the gradient and the width of Buffalo Bayou's floodplain (Tolman, 2018). Active faults are mapped to have up to ~1 m vertical relief and exhibit a topographic trellis pattern of northeast trending (fault parallel) tributaries that are coincident with deflection of the main Buffalo Bayou channel.

In addition to mapped active faults, nine NE-SW trending lineaments (blue lines in **Figure 10**) are coincident with Bayou tributaries. These lineaments are not interpreted to be active faults. The features could potentially be the result of enhanced erosion along inactive deformation zones, or other coincident topographic anomalies.

DISCUSSION: A WORKING MODEL FOR THE STRATIGRAPHIC AND STRUCTURAL HISTORY OF BUFFALO BAYOU

Red mudstones and lithified sandstone observed in Buffalo Bayou outcrops are interpreted to have been deposited by pre-Buffalo Bayou streams. The paleo streams were smaller than Buffalo Bayou and may have been oriented N-S. These streams could have been part of a Late Pleistocene Brazos River delta. This Brazos River delta may have been dissected by Holocene incision of the sediment-poor Trinity/San Jacinto River system.

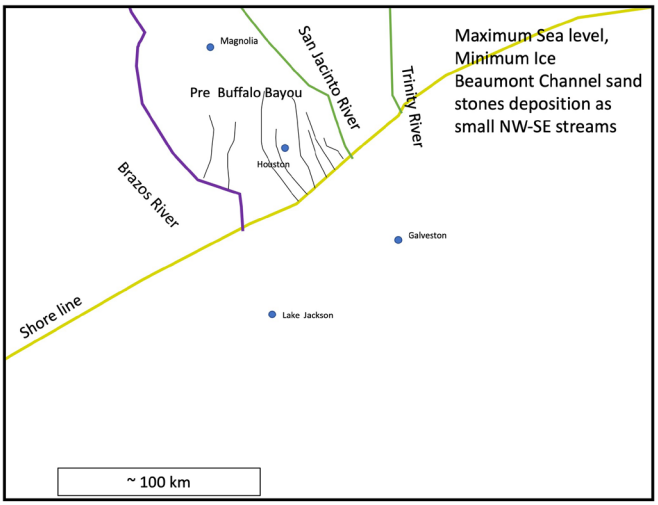

Figure 11A. *Cartoon of Pre-Buffalo Bayou during the time of the last high stand.*

Pre-Buffalo Bayou: Figure 11A

During the last interglacial period there were minimum ice conditions and high sea level. At this time, small NW to SE streams flowed to the coast cutting into muddy bay deposits or interdistributary muds (Beaumont formation red clays) that were proximal to the shoreline (Van Siclen, 1985, 1991; Dupré, 2019). These streams are preserved as the lithified trough cross-stratified channels in the clays, similar to those defined by Fisher (1972).

Buffalo Bayou *continued on page 38*

Buffalo Bayou continued from page 37

During the last high stand (minimum glaciers) smaller streams flowed South cutting into a muddy bay or interdistributary muds that were proximal to the shoreline, possibly the Stage IV Brazos River delta (**Figure 3**).)

Initial Buffalo Bayou: Figure 11B

Sea level was low during the last glacial maximum. As sea level fell, the Trinity and San Jacinto rivers down-cut. These systems formed an estuary due to their limited sediment supply. The larger Brazos system initially down-cut, but with its large sediment supply, it recovered and built out a series of deltas. The Brazos Valley was filled, and the sediment spilled over the margin to form onlapping lobes of alluvial-deltaic deposits (Dupré, 2019) that followed shoreline regression.

According to Van Siclen (1985, 1991), Buffalo Bayou is interpreted to be a gathering stream formed by the diversion caused by the deposition of "Lobe V" (Figure 3). Buffalo Bayou may have started as a tributary to the San Jacinto River that cut into an older Brazos River alluvial-deltaic lobe. In this model, Buffalo Bayou would be older than 9600 years before the present, which is the oldest radiometric age date above the incised San Jacinto River valley cut observed in Galveston Bay (Anderson et al., 2008)

Extending Buffalo Bayou: Figure 11C

During maximum glaciation, sea level was ~60 m lower and the shoreline was distal. At this time, tributaries eroded headward, capturing and consolidating the drainage of small streams to make the modern Buffalo Bayou. Buffalo Bayou eroded headward and extended to the West. Its orientation may have been influenced by the presence of the Clinton Salt Dome, which the Bayou appears to wrap around.

Present-day Buffalo Bayou: Figure 11D

Sea level is presently rising and the section of Buffalo Bayou near downtown Houston is affected by tidal influences. Buffalo Bayou continues to erode headward (West) and is capturing drainage from the Brazos River system. The extension and incision of Buffalo Bayou is influenced by the active Long Point fault (LP) and Eureka Heights fault (EH) (Tolman, 2018).

PRELIMINARY CONCLUSIONS

Multiple outcrops are observed in Buffalo Bayou near Memorial Park. The lithology, mineralogy and stratigraphy of one outcrop near the Woodway bridge was interpreted and the outcrop was sampled for thin sections (in preparation). Field observations indicate well-cemented sandstone overlying red clay. Paleo-flow analysis was performed on five outcrops in Memorial Park, and those results are interpreted to record South-directed stream flow.

These outcrops have been interpreted by previous authors to be part of the Beaumont formation. **Buffalo Bayou** *continued on page 39*

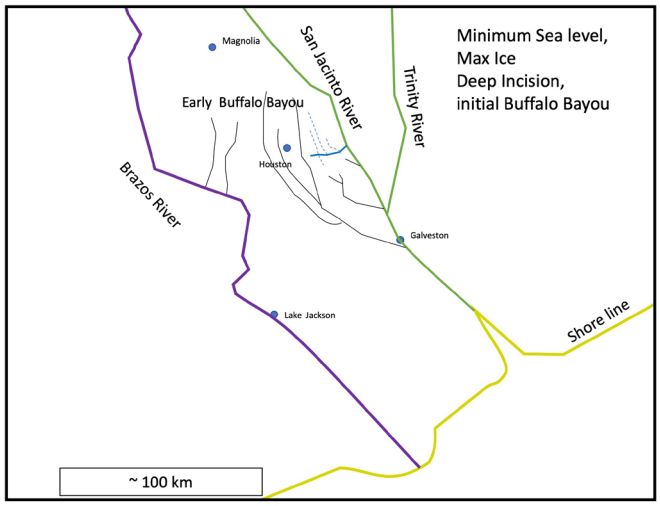

Figure 11B. *Cartoon illustrating the initiation of Buffalo Bayou.*

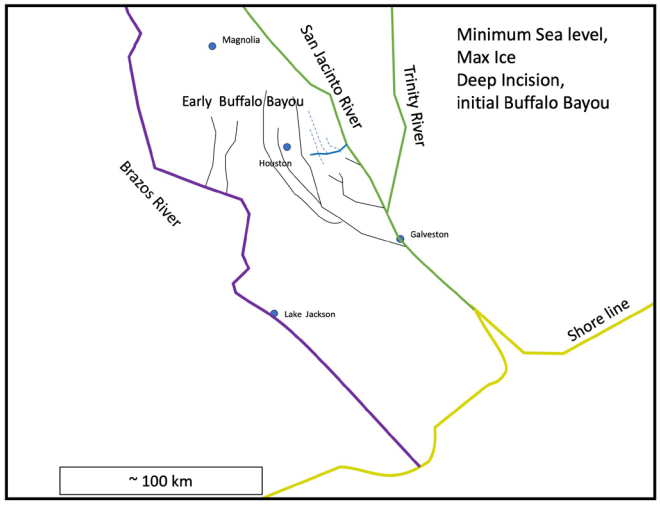

Figure 11C. *Cartoon illustrating Buffalo Bayou extending West.*

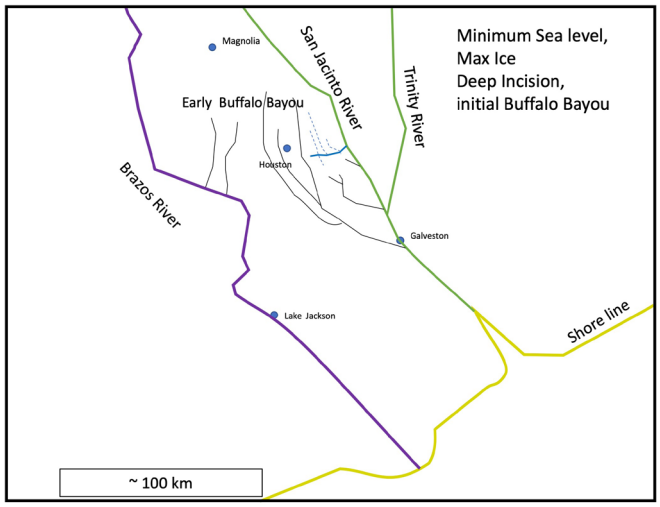

Figure 11D. *Cartoon illustrating present-day Buffalo Bayou.*

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However, the results of this study indicate they may be older and part of the Lissie formation. The sediments exposed in the modern Buffalo Bayou are interpreted to have been deposited during high sea level during the last interglacial period. These rocks were exposed during downcutting and headward erosion as sea level fell. Buffalo Bayou's E-W orientation was initially controlled by existing topography of the Brazos River delta and has continued to be influenced by active faulting in the Houston area.

Planned future efforts

Several additional lines of inquiry could be addressed in subsequent investigations, including:

- Conducting petrologic and diagenetic evaluation of the channel sandstones and the underlying red mudstone
- Identifying and correlating nearby shallow subsurface well logs and other data to inform stratigraphic age control
- Identifying other occurrences of sandstone outcrops within the Bayou
- Further investigating the presence of surface faults or lineaments and their possible impact on the orientation of the Bayou
- Extending deeper well-log control to the shallower Beaumont and Lissie formations
- Investigating the full geologic history of Buffalo Bayou

Potential results of this work could include additional technical study publications, creation of a comprehensive GIS database, and production of a geologic summary and teachers' guide for the AAPG Educator Program Buffalo Bayou field seminar (Bourque et. al. 2024).

This is an ongoing effort and still in the data compilation phase. If you have information on definitive age dates, samples for dating, well control, or other data please contact the editor@hgs.org. ■

Thanks to the entire Buffalo Bayou Study Group

Tony Abdullayev	Mustafa Al-Zehhawi
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Derrick Gelino	Justin Gosses
Ian Hermon	Richard Howe
Jerry Kendall	Richard Lang
Shawn Liu	Josh Novello
Constantin Platon	Barry Rava
Ben Regner	Haider Rizvi
Linda Sternbach	Ken Thies
Raquel Trejo	Caroline Wachtman
Janice Walden	Dorene West

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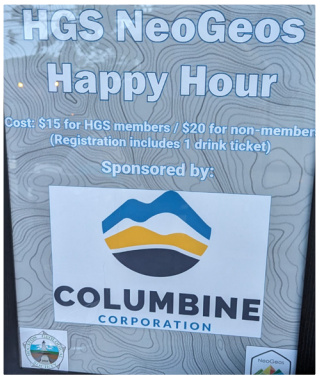
NeoGeos April Happy Hour



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Social 11:15 AM, Luncheon 11:30 AM- 1:00 PM
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HGS CCS Luncheon Meeting

Isabelle Pelletier
CCS implementation

O&G Field Development vs. Geological Carbon Sequestration

Part of the assessment and development of a sink for Geological Carbon Sequestration is to comply with Class VI Permit requirements and ensure a 4D model of the sink and the CO_2 plume displacement is built. Many assume that the workflow from the O&G Field development can be simply followed using experience from the O&G industry as a start. However, to succeed, it needs to be adapted as it is not a straight inverse or cut-and-paste challenge. This presentation will browse through some of the learnings, and raise some technical discussions. ■

BIOGRAPHICAL SKETCH

Isabelle Pelletier started her PhD from France at Institut Francais du Petrole (now IFPEN), in the 90s when interests in CCUS started. Major O&G companies had a Research Department then and initiated efforts in CCUS. It started with Sleipner Field in Norway, Weyburn Project in Canada, and CO2CRC Otway Project in Australia where injection started respectively in 1996, 2000, 1998. Isabelle's majors were Geochemistry and Hydrogeology, which brought her into joining conversations related to dissolutions and precipitations incurred through injection and sequestration. Her career has spanned over 32 years in software development for O&G and currently for CCS implementation. Isabelle's study led her to learn more about computer sciences applied to geosciences (algorithm and numerical equations), (geo)statistics and reservoir development.

To learn more details about her career and interests, visit her LinkedIn Profile: https://www.linkedin.com/in/isabelle-pelletier-28334215/

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HGS CCS Luncheon Meeting
O&G Field Development vs. Geological Carbon Sequestration
Page 42
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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).

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Tel 713-664-7916
Cell 832-287-8320
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nbyoder@comcast.net

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Owner

713.664.9677 [O]

5233 Bellaire Blvd., Ste-B, #467
Bellaire, TX 77401

thinsection@gmail.com

Tulsa, OK

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Sterling, VA, 20167
E-mail: mustafa.touati67@gmail.com