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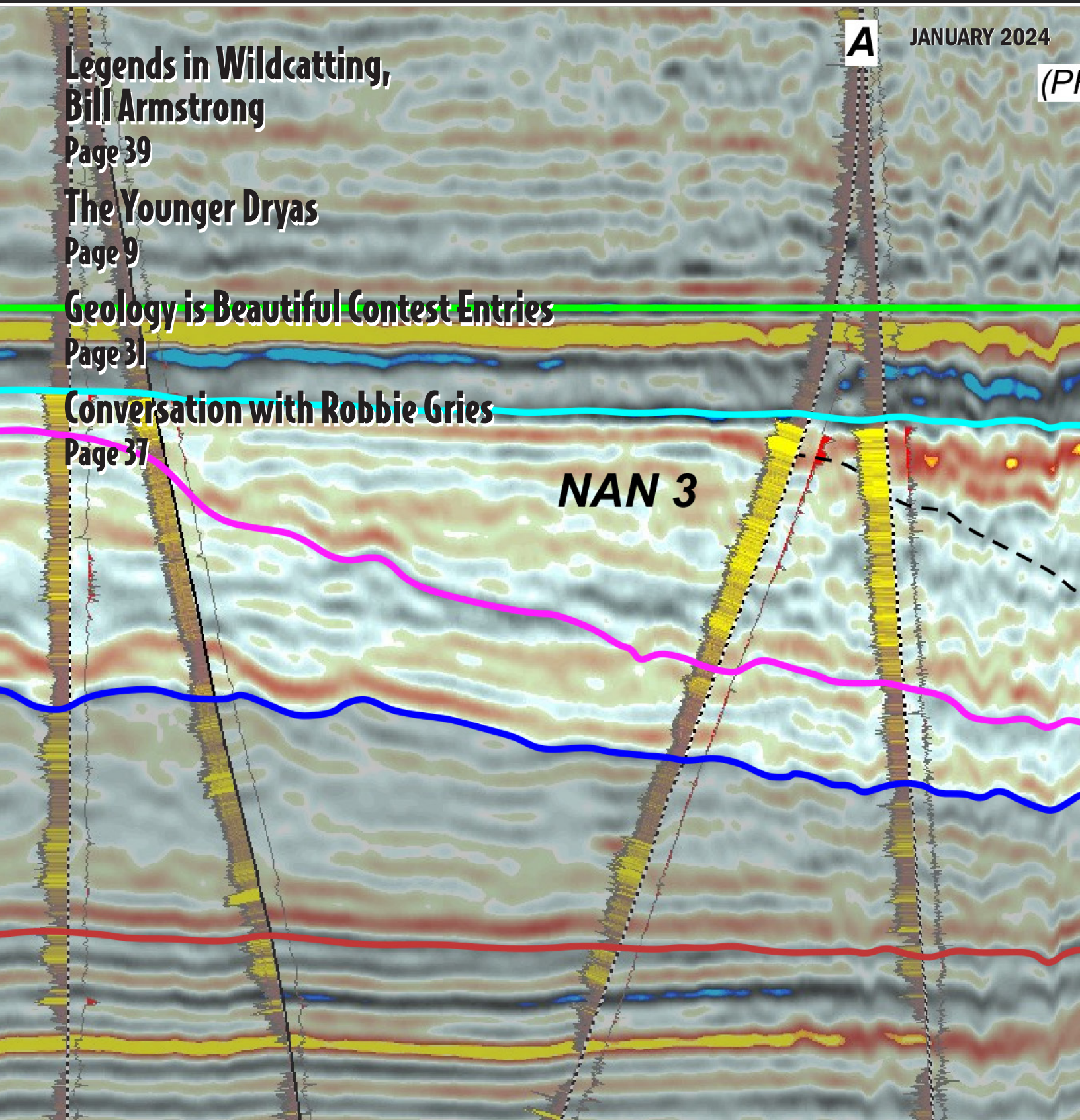

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In Every Issue

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About the Cover: Seismic line highlighting the Nanushuk Formation (NAN 3). Sandstone reservoirs at Pikka field are found in two individual clinothem sequences informally named the Nanushuk 3 and Nanushuk 2 zones that were deposited on a subaqueous shelf and shelf-edge delta.

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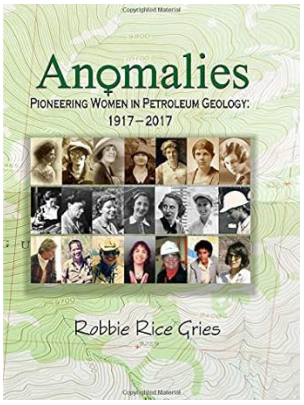

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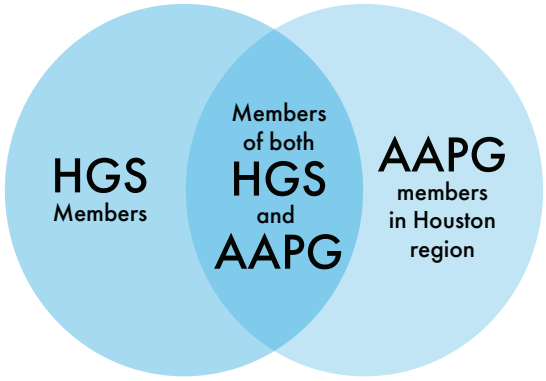
Happy New (Mid) Year

It is the beginning of the new calendar year for most of us, but for the HGS it is the mid-year of fiscal year 2023-24. Six months in and things are tracking pretty well for the Society. In-person dinners and events are filling up as we get our post-pandemic footing. Last month, we hosted the second annual Holiday Party at the Cadillac Bar, and it was well-attended. A special thanks goes to the sponsors that made it possible. We had an excellent turn out at the Sporting Clays tournament that was last held in 2019. Both the International and the E&E Dinners were well attended. Things are lining up for a robust second half as we begin 2024.

A strong technical month begins with Legends Night featuring Bill Armstrong delivering a spirited talk on Wildcatting in Alaska. Next on the schedule is the E&E Dinner, an International Group (Zoom) Luncheon, a continuing education course of Basin Modeling, an in-person luncheon with Art Berman. Don't forget the NeoGeos happy hour that is open to everyone.



CHANGES OVER THE PAST 40 YEARS

I decided to do a look-back to 1980, the year I joined HGS. The dues were $15 after an increase that year, and the (Friday) Evening Dinner was $16.50 at the Galeria Plaza Hotel. Using one of many web-based inflation calculators, it is equivalent to $61.48 in 2023 dollars, not far from the present $65 for an HGS Dinner today. The $15 dues in 1980 are equivalent to $55.90 in today's dollars, well above the current $36. The Bulletin had 8-10 pages of advertising and three pages of business card ads. There was also the HGS Auxiliary, long since gone. There have been many changes over the years.

CHANGES FOR AN AAPG-AFFILIATED SOCIETY

The HGS was founded in summer of 1923 and received an invitation from the newly formed American Association of Petroleum Geologists (AAPG) to host the ninth annual Convention in Houston*. The HGS is an Affiliated Society of the AAPG, one of many worldwide. Now, many HGS members are not AAPG members, and many AAPG members assigned to the HGS region are not HGS members. Each Affiliated Society in the U.S. belongs to one of six AAPG Sections, that are entirely separate entities from the AAPG. The Section in our case is the Gulf Coast Association of Geological Societies (GCAGS). Non-U.S. Affiliated Societies belong to Regions, which are part of AAPG.

So, what do we get as an Affiliated Society, and why does it matter to HGS?

Historically, being an Affiliated Society has resulted in revenue to the HGS from the AAPG Annual Convention & Exhibits (ACE). HGS served as the host society every seven years when ACE was held in Houston and received 20 percent of the net profits in exchange for providing content, manpower, short courses, field trips, and more. This revenue helped keep HGS's prices for dues, meals, short courses and other events low. The changing dynamics of such events dictated that ACE was held in Houston with increasing frequency, because Houston was one of the cities that consistently delivered higher attendance. As a result, the HGS benefited from profit sharing about every three years.

As the ACE rotation spiraled down to fewer cities, fewer local Affiliated Societies were able to serve as hosts. Around 2018 the AAPG decided to reduce the net profit sharing to 15 percent and deliver it to the Sections rather than host societies, leaving it up to the Sections to distribute the funds to their member societies. Finally, as attendance at ACE declined, net profit sharing with Sections was eliminated completely, and the conference was ultimately combined with the Society of Exploration Geophysicists (SEG) Convention into IMAGE. Sections and Affiliated Societies, including HGS, no longer receive any profit sharing from AAPG through ACE or IMAGE.

From the President *continued on page 7*

Caroline Wachtman
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Take a Risk?

Risk-taking is hard. Fear of failure, economic inhibiters, and the potential safety and health consequences can be helpful brakes. The challenge comes in knowing when to apply the brakes instead of accelerating to the unknown. The stories of those interviewed for this month's *Bulletin* provide insight into that question.

I had the pleasure of interviewing Robbie Gries, the founder of Priority Oil and Gas, a pioneer for women in the Oil and Gas industry, and amplifier of women's stories. I was struck by her apparent willingness to take risks. She didn't have a wealthy family as a financial support network. For most of her career, she did not have a husband to provide financial safety net for herself or her daughter. Yet, she demonstrated a willingness to take risks of pursuing employment in a male-dominated profession, moving from a larger company to small independent, reinventing herself as an expert in mergers and acquisitions, and starting her own Oil and Gas production company. Wow!

This month, I also had the privilege to speak with three emergent geologist-artists who pivoted from lengthy careers in Oil and Gas to pursue a passion for their art. Their stories highlight the personal risk required to share their art with the world. Ana Pape described that exploration geologists rely on a team to deliver an interpretation or make a pitch for a new opportunity. However, as an artist the burden to make the pitch or design the product is individual. Pape, along with Julie Mahler and Carmen Fraticelli, took risks to learn new skills, invest in themselves, and share their artistic vision with diverse audiences.

RISK IS INHERENT

Those who have spent their careers in Oil and Gas know that risk is inherent to the business. Cyclic fluctuations in commodity prices result in hiring booms and large capital budgets followed by mass layoffs and shut-in production. Based on operational experience, exploration wells typically have ~10% chance encountering economic quantities of hydrocarbon. Operational risks are layered on top.

MANAGING RISKS

A primary tool used to manage risk is data analytics, i.e., data mining and business intelligence. Cassie Kozyrkov, authored a 2020 article in Harvard Business Review called To Recognize Risks Earlier, Invest in Analytics. She says that mining internal and external data allow companies to identify trends and form hypotheses that cannot be delivered with forward modeling alone. Kozyrkov notes that building databases is time- and effort-intensive, and that not all datasets yield insights. However, a robust database is required to be ready to answer questions as they arise.

Gries alludes to using data analytics as a driver for starting her business. She describes how engineers in the early 1990s believed that one well could effectively drain a square mile of reservoir, but the geologic data did not support this hypothesis. She believed—based on data—that she could be profitable in drilling infill wells.

In addition to data, two other key criteria are essential for effectively accepting and managing risk. First, taking risks requires passion. Pape, Mahler and Fraticelli all demonstrate a passion for their art, evidenced by the long hours, and by the resilience with which they continue to grow and learn. Gries has a passion for geology that led her to fight for her career despite numerous obstacles.

Secondly, risk-taking requires a leap of faith that thing will work out. While data can build confidence in marketing strategies for artists or in operational strategies for oil producers during times of success, a jump beyond the data is required to build confidence that the tough times won't last, either. Gries describes how she routinely took leaps of faith: "There were months when I wouldn't have money for rent, but then a deal would come together and the money would work out," she says.

READ MORE ABOUT RISK-TAKERS IN THIS EDITION OF THE BULLETIN

- 15 artists took artistic risk to submit their work to the Geology is Beautiful art contest. You can vote for your favorites here: Vote now!
- Read about risk-taker and HGS legend, Robbie Gries.
- Learn about how geology, art and risk are intertwined in the article Exploring Creativity: Parallels Between Geoscience and Art.
- Attend the talk by Bill Armstrong on January 8 to hear his perspective on taking exploration risk in Alaska.
- Contemplate flood risk while looking at the impacts of Harvey at the E&E dinner meeting on January 10 with speaker Andrew Sterns.
- Hear Art Berman's perspective on why not to fret over commodity price risk in his lunchton talk on January 24. ■

From the President continued from page 5

Another benefit of being an Affiliated Society is representation in AAPG. They have the House of Delegates that has legislative control within AAPG, similar to the U.S. House of Representatives. Each Delegate is elected to a three-year term in the House by the AAPG members assigned to an Affiliated Society. The HGS has consistently been the largest Affiliated Society and has enjoyed the largest number of Delegates. Lastly, each Affiliated Society gets free advertising in the AAPG Explorer. We usually allocate our advertising to the GeoGulf (GCAGS) Convention ad for that year.

Because of the changes all geoscientific societies are experiencing, such as declining membership, less revenue and lower support overall, the AAPG is currently considering a number of changes in a committee called "Reimagine." One of the items under consideration is the elimination of the House of Delegates. So, I wonder, if AAPG eliminates the House of Delegates, what will being an Affiliated Society mean to HGS?

what do we get as an Affiliated Society, and why does it matter to HGS?

On a brighter note, HGS is a multifaceted organization which is becoming financially solvent and independent. We represent all aspects of geoscience within the Houston community and look forward to being the HGS for a long time.

LOOK AHEAD TO NEXT MONTH

Next month is the Scholarship Night Dinner which helps fund the HGS Foundation and the Calvert Memorial Scholarship Fund. There is a North American Group dinner on Private Equity, the E&E Group Dinner and the NeoGeos. I look forward to seeing you at these events. ■

**HGS Bulletin special edition, August 1998, page 19*

We Are The HGS

Bruce Appelbaum, HGS member since 1974

Bruce Appelbaum has not been afraid to test paradigms during his 50+ year career as a geologist. His willingness to push the boundaries of conventional thinking started with his graduate work at Texas A&M, where he worked with Arnold Bouma in the early 1970s. "I studied turbidites before turbidites were cool," laughs Appelbaum.

Appelbaum started working for Sunoco after graduation and soon learned that 300 feet of water depth was the offshore exploration limit. He also found organizational resistance to the idea that geologists could interpret seismic or understand petrophysics. These experiences led Appelbaum to push paradigms on oil and gas exploration and to push for more inter-disciplinary collaboration. He took these lessons to Texaco, where he rose to the position of President of Worldwide Exploration.

Professional and scientific societies such as HGS, along with AAPG and AGI are helpful in breaking through artificial boundaries, describes Appelbaum. In the 1970s and 80s, geologists were told not to talk with competitors, but Appelbaum says "there was a remarkable free flow of process and information" within societies. For example, Appelbaum recalls taking a log interpretation short course early in his career that allowed him to better perform his job and break down silos between geologists and petrophysicists. In addition to those benefits, Appelbaum says he found "belonging, camaraderie, and common purpose" among society members.

Appelbaum says he found "belonging, camaraderie, and common purpose" among society members

Appelbaum recognizes the challenges that many professional societies face with recruiting and retaining members. He is critical of the notion that growth for growth's sake is worthwhile. Instead, he argues that there must be a connection of societies to the types and numbers of jobs that are available to geologists today. Furthermore, he argues that oil and gas geologists need to be more credible to the general public by owning connection to the products made from oil and gas. "Geologists could go a lot further than talking about it and be leaders in remediating the end results of their endeavors. The connections can't be ingnored," says Appelbaum. ■

Charles Angerman, HGS member since 2007

Charlie Angerman has employed the motto of "always keep learning" during his nearly 17 years in the oil and gas business. Learning from others is one of the reasons why Angerman has been a member of HGS for 16 years. Angerman also appreciates the breadth of topics covered by HGS. In the past, he has enjoyed attending dinner and lunch meetings, E&E talks, and NeoGeos events. He particularly enjoyed viewing talks that were posted to the HGS Youtube channel.

Angerman started his career with ConocoPhillips in 2006, where he worked Louisiana tight gas plays, the Permian basin, and unconventionals. In 2016, he joined Oxy to work South Texas producing assets, and has since worked Permian and Algerian assets. Although the geologic settings among these regions are different, the fundamental geologic concepts like capillary pressure are similar, says Angerman.

The mindset of welcoming change is key to overcoming professional challenges

Angerman muses that perhaps many geologists of his generation will "spend the first half of their careers taking carbon out of the ground and spend the second half putting it back in." The mindset of welcoming change is key to overcoming professional challenges, says Angerman. In addition, he sees the potential for Artificial Intelligence and data science technologies to become a significant component of the oil and gas industry going forward.

"Stay abreast of new technologies, but learn the fundamentals," says Angerman. Towards this goal, Angerman routinely consults the work of geology pioneers, and recently read all 70 pages of M. King Hubbert's 1953 study on hydrodynamic trapping. Publications, along with "network-based knowledge" are critical to learning, he says. ■

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

THE YOUNGER DRYAS: DEEP TIME OR RECENT HISTORY?

By Stephen R. Schutter

As geologists, we are used to thinking about things that happened in "deep time," millions of years ago. We are also used to the idea that things took place slowly and incrementally. Even instantaneous events, like earthquakes, volcanic eruptions, and storms are usually aggregated in observable geological features. We don't think that the whole planet can change dramatically enough to impact human civilization, and perhaps even individual human lifetimes. Many features we accept as unchanging were profoundly different and have changed dramatically in a very short time.

THE RECORD

The Younger Dryas was the last cold pulse of the most recent ice age (**Figure 1**). As such, it marks the end of the Pleistocene and the beginning of the Holocene. The Younger Dryas was named for the reappearance in the fossil record of a characteristic alpine-Arctic flower Dryas octopetala, marking the return of a colder climate in Europe. Isotope dating places the Younger Dryas at 12.8 to 11.5 Kya. Although a global event, the Younger Dryas was particularly pronounced in North America and Europe, where temperatures declined by

Technical Article *continued on page 10*

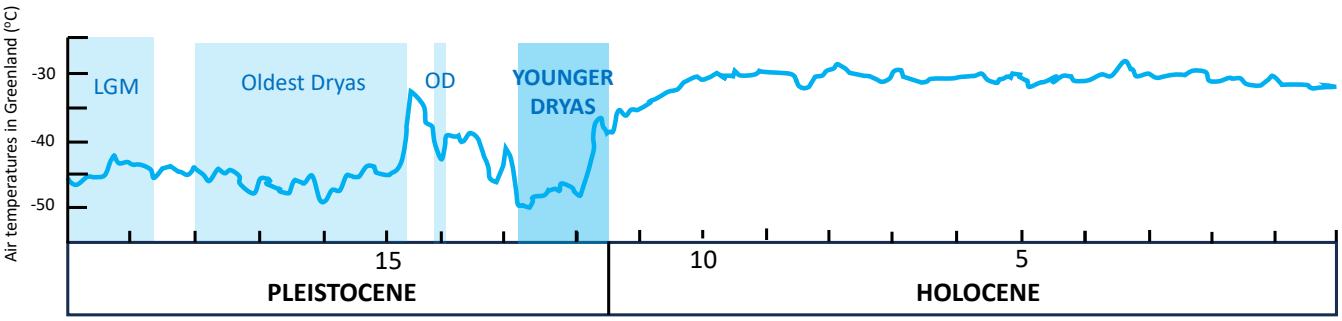

Figure 1. *Timeline of the most recent portion of the Pleistocene and the Holocene, showing part of the Last Glacial Maximum (LGM), the Oldest Dryas, the Older Dryas (OD) and the Younger Dryas. The period between the Oldest Dryas and the Younger Dryas is the Bølling-Allerød Stade. The scale on the bottom is in ka. The vertical scale is air temperature at the Greenland GISP 2 ice core. (From Platt et al., 2017,* ***Figure 5****.)*

Figure 2. *Glacial outwash at the edge of the Algona Moraine, northcentral Iowa. Spruce wood from this moraine dates at 12 ka, in the middle of the Younger Dryas. The rocks should be derived principally from southwestern Minnesota, although they may be recycled.*

Technical Article continued from page 9

10o-15oC (Kindler et al., 2014; Velasquez-Manoff and White, 2021; Wikipedia, 2023d). Its onset and end were very abrupt, taking place in decades.

In north-central Iowa, the Younger Dryas was marked by the formation of the Algona Moraine, the last recessional moraine of the Des Moines Lobe of the Laurentide continental ice sheet (Kemmis et al., 1981) (**Figure 2**). Today, the moraine is a marked rise of about 30 to 50 meters, extending across northern Iowa as a lobe (Figure 3). In front are extensive level outwash plains; the top is lumpy and pitted. It was originally covered with pothole lakes and marshes. Before it was drained and converted to farmland, it was considered to be one of the most biologically productive regions of North America. The Algona Moraine is the topographically highest point between Des Moines and the Twin Cities. North of the moraine, with the exception of the area drained by the East Fork of the Des Moines River immediately around Algona, everything drains north toward the Minnesota River valley and the upper Mississippi River.

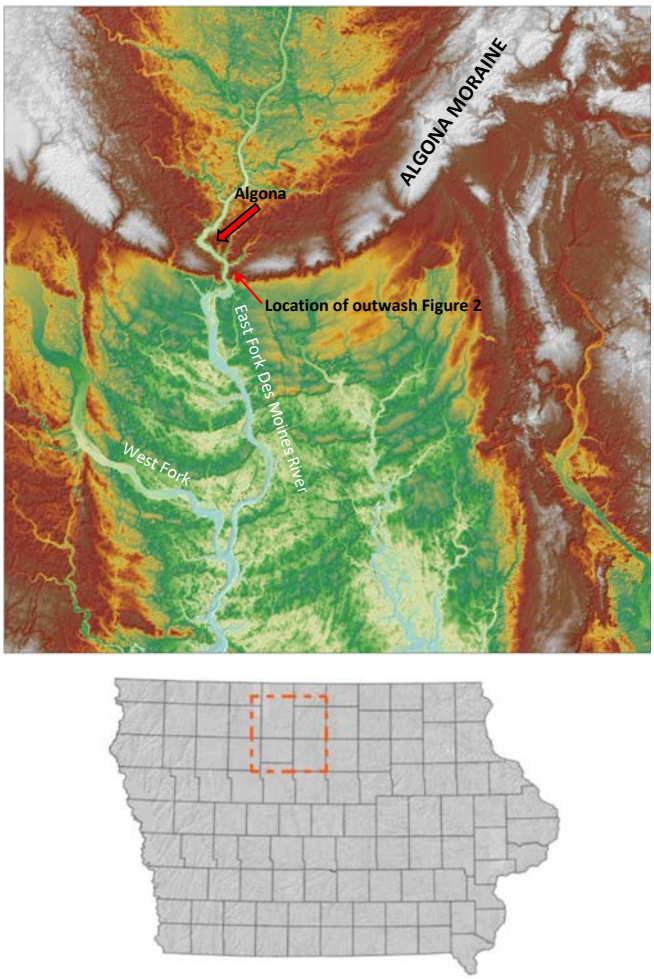

Figure 3. *LIDAR map of northcentral Iowa, showing the Algona Moraine. The white areas are the highest elevation (scale is relative), approximately 1200 ft (350 m) above sea level. The map is about 90 km (50 mi) across. (The base map is from Iowa View: Algona Moraine: Iowa Landforms Revealed. The Iowa View consortium is at the Iowa State University.)*

The East Fork of the Des Moines River was a classic proglacial river, draining meltwater from the glacial lobe in the Younger Dryas. Today, it is a small stream in an enormous flat-bottomed valley a kilometer or more wide. The valley is not a bedrock valley, but was eroded into glacial drift perhaps 100 m thick, overlying the thin edge of Cretaceous shoreline deposits and much older Devonian carbonates. The river valley makes a very wide loop a couple of kilometers across (**Figure 3**). This was not an exhumed paleovalley or an incised meander; it may have developed as subglacial drainage during the Younger Dryas.

The ice must have been active during the Younger Dryas, to bring in sufficient material to create the moraine plus the outwash. The local till is full of erratics, mostly derived from the plutonic and high-grade metamorphics of Minnesota and the Canadian Shield, with a few weathered concretions and rare limestone from the Cretaceous. As active ice, it must have been at least several hundred meters thick and would have been a significant topographic feature (Hooyer and Iverson, 2002). However, it probably would not have been a glittering ice cliff, but rather a brown, possibly vegetated hill, with years of windblown dust accumulating on top of the ice. In front of the ice (if not on top of it) was a black spruce forest, much like that of central Alaska today. Pieces of black spruce logs are common in the outwash; because they are subfossil (not mineralized), they can be burned if dried out (if you are okay with burning 12,000-year-old trees) (Kemmis et al., op. cit.). Because the ice was significantly higher than the adjacent plains, as well as colder, the area near the front was probably very stormy.

In addition to the topography and the erratics, the last glaciation left other traces. The Des Moines River valley marks the westernmost outpost of the eastern hardwood forests, mixed together with northern quaking aspen and sugar maples. A few kilometers to the west, the moraine is covered with virgin prairie (because it was too rocky to be plowed) with a dramatic drop to the outwash plain.

PALEOGEOGRPHY OF THE YOUNGER DRYAS

The climate of the Younger Dryas was cooler and effectively more moist, because summer evaporation was not as intense and snowmelt provided abundant runoff. As a result, the western United States contained many giant lakes: Lake Bonneville covered much of northern Utah and was about the size of Lake Michigan, and Lake Lahontan covered large parts of Nevada. Many of these Pleistocene lakes, both in the West and around the world, dried into playas and salars, concentrating lithium and other critical minerals sought today. Lake Missoula spilled into the Columbia River drainage, with the outbreak floods creating the "channelled scablands." In **Technical Article** *continued on page 11*

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the region of the northcentral states, blocked drainage produced a glacial Lake Superior spilling into the Mississippi drainage. Glacial Lake Agassiz, by some estimates the largest freshwater lake known in Earth history, was ponded by the Laurentide ice sheet. It covered much of Manitoba, and parts of Saskatchewan, Ontario, Minnesota and North Dakota (Langer, 2010).

While the Des Moines Lobe was actively flowing into Iowa, drainage in Minnesota was blocked by ice (**Figure 4**). However, at the end of the Younger Dryas, the waters of Lake Agassiz broke through and poured down into the upper Mississippi. This outlet flood was refered to as glacial River Warren. At the time, there was a tremendous cataract located approximately the position of current downtown St. Paul, where the Platteville Limestone overlaid the St. Peter Sandstone (beloved of frackers). The waterfall rapidly retreated upstream to the outcrop edge, where the valley broadened and flattened out. The Minnesota River (aka St. Peter River) follows the valley and is remarkably underfit. The current Mississippi gorge between Minneapolis and St. Paul has formed since then, retreating to the Falls of St. Anthony, the current knickpoint.

Notably, the outburst floods from Lake Agassiz into River Warren, while initially rapidly eroding subglacial till and regolith, rapidly encountered the granites and high grade metamorphics of southwestern Minnesota (Brown and Kennett, 1998; Dominguez-Villar and Jennings, 2008), the spine of the old Transcontinental Arch. These are markedly older (4.0 to 2.5 Ga) than other Precambrian granites of the Upper Mississippi Valley, and may provide an event marker for the floods.

The Mississippi River drainage was probably much different in the last glaciation (**Figure 5**). It carried the meltwater from much of the Laurentide ice sheet, along with the glacial debris. The Missouri River valley and the lower Mississippi valley were probably braided streams, with shifting sandbars providing the dust for the thick loess deposits downwind (Rutledge et al. 1996). The broader floodplain was incised due to the lowered sea level (Neubeck et al., 2023). The Mississippi may have achieved considerable volumes during the summer melt. Together with the lowered sea level, this enhanced runoff and sediment load may have contributed to the development of the Mississippi Canyon. Sea level was about 120 m lower during the last glaciation (Clark and Tarasov, 2014; Anderson et al., 2022; Worrall, 2023), but had begun rising rapidly as the glaciers melted. The Younger Dryas did not reverse the rise, but only halted it for a time (Bard et al., 2010; Wikipedia, 2023d), with sea levels still about 60 m lower than today.

The Mississippi system is an example of classic sequence stratigraphy. During the lowstand, the fluvial system flowed to the edge of the exposed shelf **Technical Article** continued on page 12

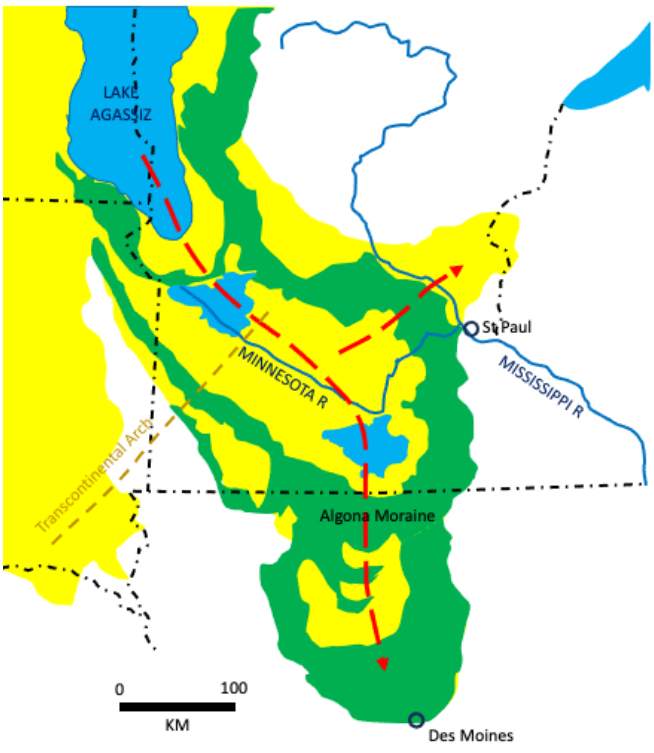

Figure 4. *Extent of the Des Moines Lobe during the last glaciation. (The James Lobe came down across the Dakotas.). Yellow is drift/ground moraine; green is moraine complexes. Glacial lakes are blue. Dashed red arrows show general ice flow direction.*

Figure 5. *An illustration of profound change in a short time. Shovel Point on the Minnesota North Shore of Lake Superior. Lake Superior was occupied by ice until the end of the Younger Dryas. The entire lake basin was scooped out by continental glaciation to well below sea level; thus, the lake is less than 11 ka old. Some have suggested that Lake Superior is still full of Pleistocene melt water. (The exposed rocks are the North Shore Volcanics, part of the 1.1 Ga Duluth Large Igneous Province.)*

and incised the slope, producing a lowstand system in deep water (Sweet and Margoshes, 2023). However, climate change probably played a significant role, too. The Mississippi drainage collected sediment (Sionneau et al., 2010) and glacial meltwater from a large portion of North America, which probably greatly enhanced its ability to incise the slope and deposit deepwater sediments. During the last glaciation and the Younger Dryas, the increased input of glacial sediments into the Gulf of Mexico through the Mississippi was marked by a higher proportion of illite/muscovite (in contrast to smectite/montmorillonite) and fine quartz (from glacial flour), due to the intense physical weathering by glaciers (Brown and Kennett, 1998).

The lowered sea level meant that geography of the coastal areas was much different. For instance, in the Texas region the flat coastal plain extended about 100 km farther seaward. The Trinity and the Sabine rivers flowed together before emptying into the Gulf of Mexico. The Brazos and Colorado rivers similarly produced shelf-edge deltas and deepsea systems. During the last glaciation, the Colorado River carried sediments from the Rockies; increasing aridity and basin changes ended that (Gutiérrez and Stockli, 2023). Onshore, wide flat valleys were covered with pine forests; the coastal barrier system produced during the current highstand is younger (the Bolivar Peninsula, for example, is less than 2 kyr old).

Changing salinity and warmth in the Gulf of Mexico profoundly influenced the transport and distribution of heat in the North Atlantic. This may have led to Heinrich Events, when flotillas of icebergs from land-based glaciers flooded the North Atlantic, resulting in layers of melted-out dropstones, sands, and muds. While it is not clear how the mechanism works, subsurface ocean warming due to the failure of surface circulation (Max et al., 2022) appears to be involved. The most recent Heinrich event was immediately before or during the Younger Dryas (dating is problematic).

The changing patterns of heat distribution probably impacted the path of the jet stream (the polar vortex). The Gulf of Mexico region was not notably cooled, and may have been wetter. Evidence suggests that Florida was actually subjected to more, and more intense, hurricanes during the Younger Dryas (Toomey et al., 2017).

The dramatically different conditions of the Younger Dryas were found around the world, particularly in Europe. For example, the lowered sea level meant that the floor of the North Sea was exposed as Doggerland, a lowland with rich marshes and wetlands between the "Low Countries" and Britain, a rich environment for Mesolithic humans (Spinney, 2012; Wikipedia, 2023a). North Africa was largely covered with grasslands and savannah (Williams, 2021). Many land bridges were exposed then (most notably in the Bering Sea region between Asia and North America), allowing migration and intermingling. Hudson Bay and the Baltic Sea were occupied (and depressed) by enormous continental ice caps. Due to lowered sea level, the Black Sea was dominated by freshwater runoff from the European ice caps. Carbonate platforms around the world were exposed and karstified; many were flooded by rising sea levels or occur in present-day arid environments.

FLORA AND FAUNA OF THE YOUNGER DRYAS

Prior to the Younger Dryas, many of the Pleistocene megamammals were doing well, particularly in North America. Mammoths, mastodons, giant sloths, camels and horses were preyed upon by sabertooth cats and dire wolves. How they fared during the Younger Dryas is subject to debate.

One of the ghosts of this time is the bois d'arc or Osage orange (**Figure 6**). It is a small, crooked tree, rarely more than 10 meters tall, with tough, resilient wood, and covered with enormous spines. Its fruit is a large yellowish-green ball, looking much like a grapefruit, but filled with woody dry fibrous pulp and scattered seeds. Before barbed wire, it was widely planted along the eastern edge of the Great Plains as an effective barrier to cattle. In the modern world, the tree makes no sense, and plays no significant environmental role, but in light of the Pleistocene megafauna, it makes a great deal of sense. It was adapted to browsing by large herbivores, which distributed its seeds (which otherwise had no means of dispersal). Its survival is a reminder of how recently that world has vanished.

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Figure 6. *Osage oranges. The fruits are generally 8 to 15 cm (3 to 6 inches) in diameter. They are not poisonous, but apparently taste bad; maybe giant sloths liked them. (Photo from a website on the Lewis and Clark National Historic Trail, www.nps.gov/articles/osage-apple-orange.htm)*

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Willows and closely-related cottonwoods are well-known for their rapid growth, prodigious seed production, and ability to reproduce vegetatively, both via roots and detached branches. This can be dismissed as a response to growing in physically disrupted environments, but could also be due to heavy browsing by megafauna. Many aspects of our modern environment are relics of a vanished ecosystem, and make sense in that context.

The events at the end of the Pleistocene and the Younger Dryas are significant not only in their profound impact on the world, but also on humanity.

HUMANS IN THE YOUNGER DRYAS

The most recent glaciation was a very harsh environment. Earlier Pleistocene glacials led to hominin depopulation of Europe (Margari et al., 2023). Neanderthals disappeared before the Last Glacial Maximum (LGM) possibly during cold snaps about that time (Stewart and Stringer, 2012) (the onset of glaciation was not linear but stepwise). Homo sapiens was the only hominin that survived. This may be because H. sapiens was uniquely equipped to survive. H. neanderthalensis was never very numerous, and occurred only in small groups. Further, they were centered in Europe and western Asia, which was particularly hard hit with ice caps and hostile conditions. H. sapiens, in contrast, is much more social and can function effectively in larger groups beyond immediate blood relations. This provides an added level of resilience, as well as providing a way to spread and preserve group wisdom and technology.

One key question in relation to H. sapiens and the events at the end of the last glaciation is how they interacted with their environment and spread to new regions, particularly the Americas. For much of the last century, conventional wisdom believed humans walked to North America across the Bering land bridge just before the Younger Dryas, about 13 ka, and spread rapidly throughout North and South America. This was supported by widespread archeological evidence, including the distinctive Clovis hunting points and related technology. But puzzling older evidence kept showing up, with problematic dating (Raff, 2021).

Recently, at White Sands, New Mexico, human trackways have been discovered, with multiple dating techniques indicating a probable age of 23-20 ka, during the LGM (Pigati et al., 2023). The slightly younger (20-16 ka) Gault site in central Texas is also evidence of pre-Clovis humans in North America (Williams et al., 2018). This makes the older evidence more credible, but does make it more difficult to have early humans walk down an ice-free corridor through Canada, which was not ice-free until about 15 ka (Norris et al., 2022); a coastal route may have been an alternate possibility (Anonymous, 2021).

The advent of humans in the Americas raises the issue of possible involvement in the extinction of the Pleistocene megafauna. The first widespread evidence for humanity in the Americas was the Clovis technology (about 13 ka), which was a new way of making hunting points, which may have vastly improved the early humans' ability to hunt large game. Significantly, the White Sands human tracks were interbedded with those of the Pleistocene megafauna (e.g., mammoths, giant sloths, camels) showing that humans and the megafauna coexisted well before the final extinction of the megafauna (Anonymous, 2021; Geggel, 2023).

Notably, however, Clovis technology disappeared with the onset of Younger Dryas conditions. The Pleistocene megafauna survived, but may have been stressed by the conditions. Moore and others (2017) noted the Younger Dryas marked the extinction of 35 genera of Pleistocene megafauna in North America. Thus, it has been an ongoing debate on whether the megafauna was ultimately done in by the rapidly changing environmental conditions or by increasing efficiency in human hunting. It is possible that natural replenishment by the megafauna was relatively slow, and was susceptible to pressures that would not be critical by themselves.

Other possibilities exist. A recent study of the Rancho La Brea fauna in southern California suggests a critical variable was a drying climate at the end of the Younger Dryas, which coincided with a human-mediated increase in wildfires and ultimately a vegetation change. This was inimical to the local megafauna (O'Keefe et al., 2023).

The end of the Younger Dryas was apparently a critical factor in the development of human civilization. The warming climate apparently became sufficiently stable that agriculture became feasible, appearing at Göbekli Tepe in Turkey (at the upper end of the Tigris-Euphrates valley and the Fertile Crescent) at the end of the Younger Dryas (Wikipedia, 2023b). The first proto-cities appeared soon after, as did the use of pottery, domestication of many animals for food, draft power and transportation, along with many plants, including grains and fruit (such as grapes). This constituted the Neolithic Revolution (Wikipedia, op. cit.). Similar patterns were followed in other parts of the world within a few thousand years of the end of the Younger Dryas, including in the Americas. Once civilization became possible, humans were up to the opportunity.

WHY?

Why did the Younger Dryas occur? What lessons can we learn from it? It is probably not surprising that there is a list of "usual suspects."

First, it is necessary to recognize what the Younger Dryas was not. The Late Cenozoic glaciations have been tied to the Milankovitch cyclicity; that is, systematic variations in insolation due to regular changes in the Earth's orbital **Technical Article** continued on page 14

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parameters, particularly precession and obliquity. Clark and others (2009) attributed the end of the Last Glacial Maximum to increasing northern insolation (changing orbital parameters), increasing tropical Pacific sea surface temperatures, and increasing atmospheric CO^2; sea level rise was punctuated by the breakup of the West Antarctic Ice Sheet (about the end of the Oldest Dryas). However, there are two significant caveats for the Younger Dryas: one, it is not clear precisely how variable insolation is related to climate – is it through changing albedo? Changing carbon dioxide levels (if so, how)? Changing vegetational patterns, which relate to albedo and CO^2 levels? Changing atmospheric and/or oceanic circulation? All of them, or something else?

The second caveat is that while orbital changes provide the pacemaking for the principal glaciations, other events can impact climate change. The Younger Dryas is clearly such an event, since it is apparently irregular in timing and intensity.

One of the principal suspects has been the weakening of the Atlantic Meridional Overturning Circulation (AMOC). This involves warm saline waters from the Caribbean and Gulf of Mexico being carried north across the northern Atlantic, cooling and sinking in high latitudes, and returning as cold deep flow to repeat the cycle. The possibility of increasing fresh water influx into the North Atlantic would weaken and displace the northward flow of warm water, resulting in an abrupt cooling of the lands around the North Atlantic. This could displace the circulation of the subpolar jet stream and its weather patterns; ultimately there could be global repercussions (Wikipedia, 2023d).

A possible mechanism to the abrupt flow of fresh water into the North Atlantic could be the draining of Lake Agassiz or a similar periglacial meltwater lake. Draining the lower Great Lakes basin down the St. Lawrence River is a possibility (Lowell et al., 2005; Carlson et al., 2007), as is a northwestern drainage down the Mackenzie River to the Arctic Ocean and thence to the North Atlantic (Langer, 2010; Norris et al., 2022). Condron and Wilsor (2012) modeled both paths, and found both could effectively stifle the AMOC, although floods from the Mackenzie drainage into the Arctic Ocean were potentially more effective. One caveat to such a model as a trigger for the Younger Dryas is that the disruption from a flood would recover in a century or so (Wikipedia, op. cit.), while the Younger Dryas persisted for 1300 years, implying a persistent or frequent inflow of fresh water. Condron and others (2020) suggested that exceptionally thick ice-age sea ice would be such a source of fresh water, and its breakup could provide a greater volume of fresh water than outburst floods from Lake Agassiz.

If weakening of the AMOC resulted in the climate change, was it a unique event, or a recurring phenomenon? There is some evidence that such events occurred at the end of every major Late Pleistocene glaciation, with the Younger Dryas being the most recent and best documented (Wikipedia, op. cit.). The weakening of the AMOC may have also led to deeper warming in the North Atlantic, resulting in subsurface melting of coastal ice and the Heinrich Events (Max et al., 2022), which apparently occur every 7 to 10 kyr.

Another possibility is a relationship to the Dansgaard-Oeschger Events, with abrupt cooling and warming with a 2 to 3 kyr periodicity (Bond and Lotti, 1995) over the last 120 kyr. These may be linked to volcanism (Wikipedia, op. cit.). The Younger Dryas could be the most recent, and exceptionally intense such oscillation.

A possible extraterrestrial origin has been suggested, involving possible airbursts of a comet at least 4 km in diameter colliding with the earth (due to the lack of a crater or impact debris such as shocked quartz). Much of the evidence is based on interpreted "nanodiamonds" across much of Noreth America and Greenland, and possibly beyond. May locations across North America have "black mats" (organic-rich soils) at the base of the Younger Dryas sediments; platinum-group anomalies, metallic microspherules, and fullerenes enriched in He3 have also been identified (Firestone, et al., 2007; Kennett et al., 2009; Kinzie et al., 2014; Moore et al., 2017; Morton, 2017; Wolbach et al., 2018). The carbonaceous "black mats" have been interpreted as the result of widespread biomass burning (wildfires) which consumed 10 percent of the Earth's biomass (based on isotope anomalies). This would have been greater than the wildfires following the end-Cretaceous Chicxulub impact. This would have led to an "impact winter" from the soot, and the onset of the Younger Dryas. The cataclysm has been blamed for the extinction of the Pleistocene megafauna in North America and the end of the Clovis technoculture.

This hypothesis has been widely popularized and augmented, but also frequently refuted (Pinter and Ishman, 2008; Daulton et al., 2010; Holiday et al., 2023). It was discussed on the National Geographic Explorer (2007), the History Channel (2008), and PBS Nova (2009).

The issue of wildfires and loss of megafauna was the subject of a detailed study in southern California (O'Keefe et al., 2023) mentioned previously. That was attributed to climate and vegetation change, possibly augmented by human technology.

The possibility of an asteroid impact was considered. The Hiawatha crater, about 31 km wide, was discovered in northwestern Greenland, buried beneath the ice cap. Originally, this was considered to be of the right age (Kjaer et al., 2018; Voosen, 2018), with evidence suggesting an Fe meteorite about 1.5 km in diameter. Later analysis of the peat layer at the base of the ice indicated it was about 2.4 Ma (Garde et al., 2020), and thus too old to be the culprit for

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the Younger Dryas. Further analysis of shocked zircons indicate an actual impact age of 58 Ma (Paleocene) (Kenny et al., 2022); with that, some thought has returned to the possibility of an airburst (Voosen, 2022).

Another possibility is a fluctuation in solar luminosity. The "Maunder minimum" is a regular fluctuation over a centennial scale. Recent study of carbon isotopes in subfossil wood in France has been calibrated with such a minimum coinciding with the Older Dryas cool period, estimated to have been 6o-7oC cooler for a period of about a century (14 ka to 13.9 ka) (Bard et al., 2022) (**Figure 1**). Such evidence is not available for either the Oldest Dryas or the Younger Dryas, which were both considerably colder and longer.

A cataclysmic volcanic eruption has also been suggested as the reason the global climate was tipped into the Younger Dryas. The search is on for a "smoking gun" volcano. One suggestion is a maar volcano (Laacher See) about 2 km in diameter in the Eifel region of Germany near Bonn. It erupted catastrophically at approximately the right time, and spread ash across much of Europe. The dating was subjedt to discussion, but was eventually corrected for the "dead" volcanic CO^2 incorporated in the buried wood (Baldini et al., 2023). The revised age coincided with a sulfur spike in a Greenland ice core.

Volcanic eruptions as a cause for global climate change are very problematic in that it is difficult to predict or model their effects. Critical variables include not only the amount of ash produced, but how effectively it is dispersed, and at what altitude in the atmosphere. The amounts of carbon dioxide, sulfur dioxide and even water vapor can have variable effects. (The recent eruption of Hunga Tonga injected huge amounts of water vapor higher into the stratosphere than any other eruption; the climate effects are yet to be determined.). Whether the volcano was onshore or offshore is important, and even its latitude affects how its results are expressed.

It is worth observing that while the Laacher See eruption was catastrophic, estimated to be the same magnitude as the eruption of Pinatubo in the Philippines in 1991 (Wikipedia, 2023c), other gigantic eruptions did not have similar effects. For example, Mt. Mazama (which created Crater Lake in Oregon) occurred about 7.7 Ka (the local Klamath tribe remember the event in their legends; Nunn, 2023); but this had no apparent climate impact, certainly to the extent of the Younger Dryas.

The nature of the Younger Dryas may be related to the pattern of warming since then. From the end of the Younger Dryas to about 8 ka, mean annual temperatures rose rapidly, controlled by melting ice caps; since then it has risen more slowly, in response to rising greenhouse gases (with the rise in modern agriculture). This is in contrast to the previous last interglacial, when temperatures rose immediately, with limited control from smaller icecaps, and stabilized in respect to greenhouse gases (Bova et al, 2021; Phys Org, 2021).

IMPLICATIONS

The world of the Younger Dryas was dramatically different from the modern world, but it is not so distant in time that it needs a different mindset or viewpoint. It wasn't millions of years ago; only a few million days. The world of the Younger Dryas profoundly influenced our world today, and it does matter.

Long Island, Cape Cod and the offshore islands are piles of glacial debris, being reworked by the sea. The English Channel formed when a huge proglacial lake, fed by the Thames, Rhine, Scheldt and Meuse, broke through the Artois-Weald arch, and began eroding the unstable rocks of the coasts. Every estuary and fjord is evidence of rising sea level of rising sea level re-equilibrating with the land. The Younger Dryas, only 11.5 ka, is the exclamation mark at the end of the Pleistocene (**Figure 5**).

The Younger Dryas tells us that Earth's climate can change very rapidly in ways we don't yet entirely understand. It can have a profound impact on humanity, not necessarily in ways that are beneficial. Our world may be changing in ways that preceded the Younger Dryas. The Younger Dryas was not a hoax or a figment of someone's imagination, but real history. It behooves us to understand it better.

One implication is that there may be no such thing as steady-state equilibrium. The world may still be adjusting to the end of the Pleistocene and the Younger Dryas. Our geological, environmental and ecological paradigms may need to be viewed as dynamic systems, responding to changing inputs, and unlikely to "return" to a pre-disturbance "norm."

Another implication is that care and critical thinking must be applied to scientific interpretation. Incomplete analysis based on partial data can lead to problematic conclusions and solutions. Reporting in the popular media can be a problem if eyeballs are emphasized at the expense of accuracy. ■

BIOGRAPHICAL NOTE

I grew up in Algona, on top of the Younger Dryas Algona Moraine, and surrounded by many of the phenomena that were the result of that recent geology.

While at the University of Iowa, I was the head teaching assistant for the "Man and His Physical Moose" introductory earth science course. In that role, I constructed a class exercise on continental glaciation, focusing on Iowa geology.

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Technical Article *continued on page 18*

Technical Article continued from page 17

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73rd Annual GCAGS Meeting
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- Critical Minerals
- AI/Data Science and its Future with Geosciences
- Environmental Geology and Engineering
- Carbon Capture and Sequestration
- Seismic Imaging and Data Analytics
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CONFERENCE HIGHLIGHTS

- Geologic Field Trips
- Short Courses
- Technical Sessions
- Networking Events

Please consider supporting this non-profit event that supports local geological communities! Sponsorship information below.

GENERAL SPONSORSHIP LEVELS

LEVEL	AMOUNT	Transactions Ad	Complimentary Registrations to Entire Convention	Complimentary Passes to All-Convention Luncheon	Company Logo on Scrolling PowerPoint	Company Logo in Convention Program Book	Company Logo on Signs at Registration and Exhibit Hall Entrance	Announcement on LinkedIN
Diamond	25,000+	2-page Composite Landscape, bleed, color	5	4	Listed as "DIAMOND"			
Emerald	20,000+	2 Page Portrait, bleed, color	4	3	Listed as "EMERALD"			
Platinum	15,000+	Portrait full page, bleed, color	3	2	Listed as "PLATINUM"			
Gold	10,000+	Portrait full page with margins	2		Listed as "GOLD"			
Silver	5,000+	Landscape ½ page with margins	1		Listed as "SILVER"			
Bronze	2,500+	Portrait ¼ page			Listed as "BRONZE"			
Copper	1,000+	Logo only			Listed as "COPPER"			
Patron	500+	Name only			Name as "PATRON"			
Friend	100+	Name only			Name as "FRIEND"			

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November NeoGeo Happy Hour and Trivia Event Sponsored by Southwestern Energy

HGS NeoGeos 2023-2024 Happy Hour Schedule

*Locations may be subject to change as dates approach

~~Thursday, September 28th - Walking Stick Brewery~~
~~Wednesday, October 25th – Kirby Ice House (Memorial)~~
~~Thursday, November 30th – GeoTrivia @ Cottonwood~~

Thursday, January 25th – Walking Stick Brewery
Thursday, February 22nd – Kirby Ice House (Memorial)
Thursday, March 21st – GeoTrivia @ Cottonwood
Thursday, April 18th – Walking Stick Brewery
Thursday, May 23rd - Kirby Ice House (Memorial)

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

Houston Geological Society

Scholarship Night

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

Norris Conference Center, Houston, TX

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

Guest Speaker
Robert (Bob) Lindsay

Member $65.00
Non-Member/Walk ups $75.00

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

CLICK HERE TO SIGN UP EARLY!

The Houston Geological Society Continuing Education Committee Presents

Fundamentals of Basin Modeling in Oil Exploration

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

COURSE DESCRIPTION

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

PRICING

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

*Non-members can receive the member price by submitting a membership application and paying their HGS dues online (https://www.hgs.org/membershipApplication) before calling the HGS office, 713-463-9476 to register

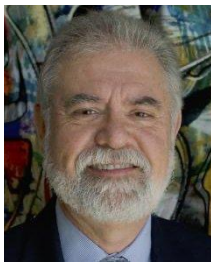
SUMMARY

This course aims to equip geoscientists with knowledge and skills in basin modeling workflows and the associated data requirements. The curriculum is designed to provide an introductory understanding of the fundamentals necessary for effective basin analysis. Participants will explore basin modeling topics such as petroleum systems, thermal history, hydrocarbon generation, migration, and preservation mechanisms. For an example of a 2D basin modeling study, see the paper at this link https://link.springer.com/article/10.1007/s13202-021-01310-2

KEY LEARNING OBJECTIVES

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

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



ABOUT THE INSTRUCTOR

Petroleum Systems Assessment Specialist

MS Geochemistry at Universidad Central de Venezuela and
a BS Chemistry at Universidad Simón Bolívar

https://www.linkedin.com/in/callejon/

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

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

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

Thursday, January 18, 2024 • 8:00am – 12:00pm • Zoom Class
Please make your reservations on-line
https://www.hgs.org/civicrm/event/info?id=2537
For more information about this event, contact Angel Callejon, callejon@yet2find.com

The Houston Geological Society Continuing Education Committee Presents

Geological Problem-Solving Using Biostratigraphy

February 13-14, 2024 • 8:00 AM Assemble and breakfast
Course 8:30 AM – 5:00 PM CST
In-person event, maximum registration 15
Ellington Geological Services • 1414 Lumpkin Rd, Houston, TX 77043

OVERVIEW

Learn how biostratigraphy can enhance your understanding of the sub-surface. This course will showcase how biostratigraphy can be utilized to solve geological problems in Oil and Gas operations. Most of the time will be spent on case studies and practical exercises. Participants are encouraged to bring their own data to discuss.

PRICING

$650 for HGS Members
$325 Student/Emeritus/ In-transition members
$900 Non-Members

Non-members can receive the member price by submitting a membership application and paying their HGS dues online (https://www.hgs.org/membershipApplication), before calling the HGS office, 713-463-9476 to register

DESCRIPTION

Micropaleontology has been widely used in the oil and gas industry for decades. It plays an important role in understanding the subsurface, de-risking prospects, steering deviated wells and identifying casing points while drilling. This course will focus on case studies and practical exercises, such as well correlations and bio-steering a horizontal well.

AFTER THIS COURSE, YOU WILL BE ABLE TO

- Understand the principles of biostratigraphy and which fossil groups can be used in a specific geological setting
- Awareness of how to use biostratigraphic data in basin- to reservoir-scale projects; including understanding the pitfalls of sampling and sample preparation
- Understand how to correlate wells using biostratigraphy data
- See the added economic value of biostratigraphy during well operations; including understanding how biostratigraphy is used to TD wells in real-time operations and how to bio-steer a horizontal well using micropaleontology

You will not be a paleontologist after this course, but you will be able to ask the right questions.

COURSE OUTLINE

- Introduction to fossil groups used in biostratigraphy: nannofossils, foraminifera, palynology, and others
- Sampling and preparation for biostratigraphic analysis
- Applications of biostratigraphy to interpretation of age, paleoenvironment, and sequence stratigraphy

CASE STUDIES

- Exploration phase: Well correlations and volumetrics
- Wellsite Operations: TD-ing a well using biostrat
- Baffle/Barrier modelling using micropaleontology

EXERCISES

- Well correlation
- Bio-steering exercise

Continuing Education *continued on page 25*

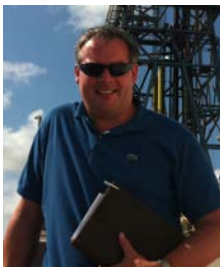
February 13-14, 2024 • 8:00am – 5:00pm
Ellington Geological Services 1414 Lumpkin Rd, Houston, TX 77043
Please make your reservations on-line

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

Continuing Education continued from page 24

BIOGRAPHICAL SKETCHES

Katrin Ruckwied has a PhD. in Geology and Paleontology from Darmstadt University of Technology (Germany). In 2007 she joint Shell as a biostratigrapher and provided support to Exploration and Production Teams globally. She has worked projects in the GoM (USA and Mexico), US Onshore (Unconventionals), Nova Scotia, Kazakhstan, North Africa, South Africa, Australia and South America. She also taught biostratigraphy courses for students as well as for oil and gas professionals. Katrin is a Geological Advisor for EGS and enjoys framing projects and integrating different geological data sets.



Iain Prince has a PhD in Palynology from the University of Wales, Aberystwyth (1996) where he studied dinoflagellates from the Late Cretaceous (UK). After his PhD he worked as a consultant looking at North Sea, West of Shetlands and Danish Basin wells. In 1998 he joined Statoil where he supported active drilling in the Faroes and Norwegian Sea, completing the first wellsite biostratigraphy completed in Statoil and the first offshore acid palynology. He was also actively involved in geosteering wells in the Tertiary (N Sea) Siri and Glitne fields. Outside of the North Sea he worked on West Africa, Venezuela and Brazil. In 2003 he became head of the biostratigraphy group. During this time he began working on the GOM when Statoil entered this basin. Subsequently in 2007, he moved to Statoil in Houston where he farther gained experience in the GoM and began using palynology to assist with the Wilcox. In 2008 he joined Shell as their team leader and head of biostratigraphy. Since that time he has worked extensively in the GoM (more lately the Mexican GoM) and is still active looking after wells. His most recent wells were from Mexico and involved drilling megaflaps and repeated thrusts; wells in which the wellsite biostratigraphy was critical to reaching a safe TD.

Maria Antonieta Lorente is a highly experienced biostratigrapher with expertise in the study of spores, pollen, palynofacies, and palynological organic matter. Her expertise includes fossil assemblages from the Paleozoic throughout the Pleistocene, such as the Paleozoic of the western-northwestern US and the Permian Basin, the Triassic-Jurassic of Kurdistan, and the Mesozoic-Cenozoic of Belize in Central America, Venezuela and Colombia in Northern South America, Brazil, and the South Atlantic. She has managed biostratigraphy teams in the oil and gas industry for several decades and has taught stratigraphy courses at the Central University of Venezuela and for major professional private training programs for many years. ■

WORD BRECCIA – A GEOLOGY WORD JUMBLE

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

RICELAG _ _ _ _ O _ O

KNIGAB _ _ O _ _ _

TRIATS O O _ _ _ O

DENGEL O_ _ _ _ _

LAKASA _ _ _ O O_

Being a geologist often requires you to be a

_ _ _ _ _ _ _ _ _ _ _

The Houston Geological Society Continuing Education Committee Presents

Clastic Depositional Systems

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

COURSE OBJECTIVES

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

COURSE OUTLINE

This course will cover the following topics:

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

PRICING

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

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

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

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

ABOUT THE INSTRUCTOR

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

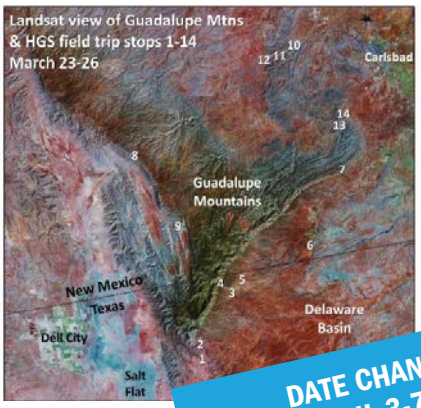
Previously, Sweet spent 18 years working as a stratigrapher for the ExxonMobil Research Company where he described kilometers of core and taught numerous field and classroom courses in clastic stratigraphy. He won the ExxonMobil Excellence in Instruction Award seven times. In addition to his experience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

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

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

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

GUADALUPE MOUNTAIN AND DELAWARE BASIN FIELD TRIP



~~March 2~~ **DATE CHANGED TO APRIL 3-7, 2024**

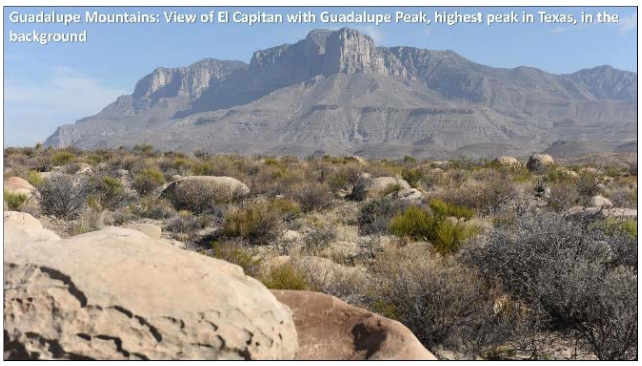
Where: Starts/ends in Midland, Texas and base camp is Carlsbad, New Mexico

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

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

Registration Deadline: March 9, 2023

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



Exploring Creativity: Parallels Between Geoscience and Art

By Caroline Wachtman

HOUSTONIANS AND GEOLOGISTS LOVE ART!

On a recent Saturday afternoon at Sawyer Yards near downtown Houston, hundreds of Houstonians roamed the former warehouses that have been converted to gallery space. Resident artists open their studios to showcase their work and even more artists set up their tents outside. A wide cross-section of people, including geologists, are drawn to this and other art events around town. The recent "Geology is Beautiful" art contest sponsored by the HGS Bulletin received 15 submissions—a record compared to previous contests. This suggests that HGS members are interested in capturing the beauty in geology.

To better understand why and how some geologists become artists, I interviewed three geologists who recently pivoted to art after long careers in Oil and Gas. These artists shared that many of the skills they developed as geologists, such as communication, relationship-building, and 3D visualization are highly applicable to successful art careers. Furthermore, art allows them to explore their creativity, invest in themselves, and continue to learn. Courage, confidence, and community are three of the themes they echoed.

MEET THE ARTISTS

"Metalsmithing helped my brain wake up and think about things differently," says Carmen Fraticelli, Houston-based geologist, metalsmith and jewelry artist. Fraticelli started her jewelry making journey by taking a metalsmithing class while working as an exploration geologist. She found the class offered a way for her brain to relax and allowed her to think about geoscience differently. Fraticelli has continued her education by taking online classes and learning from a community of diverse and energetic artists. In 2020, she left the Oil and Gas industry to pursue jewelry full time. She now makes and sells jewelry direct to customers via art sales, through her online storefront, and by word of mouth to other geologists.

"In my work, I try to capture texture and detail. I tell a story beyond, 'this is delicious,'" says Ana Pape, a geologist, food artist, and food photographer. An experienced baker, Pape decided to explore food photography in 2021. She left her role as an Oil and Gas exploration geologist and later took an eight-week photography and composition course. Since then, she has taken multiple courses and worked with coaches to develop marketing strategies for her business. She now partners with local businesses, such as Local Hive, and national brands, like Watkins, to showcase her recipes created with their products.

"In 2019, I folded 1000 origami cranes," says Julie Mahler, a geologist, Oil and Gas unitization expert, and paper artist. "Folding cranes takes a lot of patience; it's a lot like reading unitization contracts or sitting through long zoom meetings," laughs Mahler. Following that year of 1000 cranes, Mahler moved into folding book pages into sculptural designs. As a self-taught artist, she has learned from online courses, through experimentation, and many hours practicing her skills. For example, Mahler's tree of life design takes over 40 hours to fold. Mahler spends much of her daytime hours volunteering on non-profit boards, but "I always have origami paper in my purse," she says. Mahler now sells her work at art shows, such as Sawyer yards, and at galleries in the Houston area.

GEOLOGISTS ARE PARTNER OF CHOICE

Fraticelli attributes her customer success to relationship-building and communication skills. She says that other geologists trust her because they know she will give them an honest answer. This allows her to build credibility and attract repeat customers. Furthermore, Fraticelli works hard to explain the science behind the stones she uses. "I simplify the science so that it is readable by the average person, but also interesting to scientists," she says. The ability to effectively communicate with diverse audiences is one of the key geology skills that translate to the art business.

Pape shares a similar story and says she approaches her business with a 'partner of choice' mentality. "I tell prospective clients that I'm in their corner and here to help," she says. Pape says she learned this mindset while working as an exploration geologist to establish credibility with governments and joint venture partners.

Pitching is a big part of her business, too. Pape says she contacts up to four businesses per week with an individualized pitch of how she can help their business. For example, Pape says that she earned one client's business by suggesting improvements to their website with 'lifestyle' shots. Like Fraticelli, Pape's experience in describing Oil and Gas prospects has helped her deliver clear and compelling messages to clients. She works to build relationships with these clients and has earned repeat business.

GEOLOGIST'S SKILLS ARE ARTIST'S SKILLS

Mahler says that visualizing in 3D is directly applicable to both

Exploring Creativity *continued on page 29*

geology and to her art. "Pages of a book are like layers of rock," she says. Mahler uses her training as a structural geologist to visualize her design before she begins to fold. Similarly, Pape says that she visualizes her photo compositions thinking about shapes and colors. "Editing a photo is like using Petrel," she says. In both cases she uses a color bar to tell a story.

Conducting research is a focus for Pape and Fraticelli. Pape says it takes hours of research to determine the right proportions of ingredients in a new recipe. In addition, she works diligently to determine how to make a recipe unique. For example, Pape recently developed a recipe for a spiced pear pie. "People always think about apples for pie, but pears are in season and really delicious," she says.

art allows these geologists to explore their creativity, invest in themselves, and continue to learn

Fraticelli publishes a newsletter in which she describes the science behind gemstones and metals. For example, a recent post focused on the causes of fluorescence in rubies. Another post explored different alloys that are combined with gold to produce different hues and hardness. "To me, jewelry is a beautiful thing. To really understand what is in the jewelry makes it so much more special," she says. Understanding the science of jewelry materials requires research skills and scientific understanding, in addition to the communication skills to explain what she learns.

Focus on financial discipline is a key part of Mahler's approach to her art business that she learned by working in Oil and Gas. She says that she takes a "fast failure" approach by testing new points of sale for the minimum contract period and then moving on if it's not profitable. While Mahler values the creativity, resilience, and self-expression from her art, she approaches it with a business-focused mindset.

KEYS TO SUCCESS

Pape and Fraticelli say finding a community of like-minded artists is key to their success. During the recent COVID19 pandemic, online communities were the primary sources of learning and mentoring. Many of these online communities have survived and continue to provide critical support for artists. "Collaboration over competition," is the mantra of her online baker community, says Pape. "Even though I haven't met these people in person, I consider many of them friends," she says. Her community supports each other by amplifying the content of their members, by carefully attributing work to content creators, and calling out sources that are not appropriately attributed. Fraticelli says that similar to geoscience teams, there are some highly supportive art communities "that come together to create amazing things." Like geoscience teams, not all art communities are supportive, so it's important to find a group that works for you.

Courage, confidence and resilience are a key themes echoed by Mahler, Pape and Fraticelli. Mahler says it takes courage and resilience to share her art with the world. "It was big change in perspective to think of myself as an artist rather than a crafter," she says. The validation of customers and others viewing her work has helped to build confidence and courage. Similarly, Pape says it's important to "gain confidence that you have something to offer." She has gained this confidence through lots of practice in pitching to prospective clients. Fraticelli says, "Dip your toe in and try it out. If you don't like it, try something else."

A mindset of continuous learning is also shared by all three of the artists interviewed for this story. Pape explains that she wants to add to her skill set by learning videography. Fraticelli is training to be a gemologist. Mahler is learning a new folding technique to produce tessellations. "Sign up for a class," says Pape. "It's an investment in yourself that will help you get there faster and have accountability," she says.

Exploring Creativity *continued on page 30*

Exploring Creativity continued from page 29

ART IN ACTION

You can view the artists' work at the following locations:

Visit Pape's website: justabitmorecinnamon.com




Visit Fraticelli's online store: ArtisanJewelryTX - Etsy, subscribe to the "Treasure Trove" newsletter on LinkedIn




Visit Mahler online at Linktree @juliannemahler at in-person events such as Second Saturday | Events | Sawyer Yards




HGS Bulletin Art Contest—Your Vote Counts!

Thanks to all participants of the 2023 HGS Bulletin "Geology is Beautiful" art contest. The contest received tremendous positive response and 15 entries. Now its your chance to vote for your favorite! Cast your ballot by February 15, 2024. The HGS Board will make a final determination and announce winners of each category in March 2024.

GEOLOGY IS BEAUTIFUL - VOTE NOW

Category: Geologically Interesting Landscapes
Title: Sunset on Antarctic Iceberg A57a
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.

Category: Geologically Interesting Landscapes
Title: Hubbard Glacier, Alaska, 2019
By: Henry M. Wise
Hubbard Glacier, 2019, where it enters Disenchantment Bay. Hubbard Glacier is 76 miles long. This portion of the glacier is located in the Wrangell-St. Elias National Park and Preserve. Layering in the glacier can be seen at the base of the glacier. The glacier is several hundred thick here. Broken ice can be seen in the water from icefalls from the glacier.

HGS Bulletin Art Contest *continued on page 32*

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Category: Geologically Interesting Landscapes
Title: San Andres Fault at Palmdale, California
By: Rich Schoen
View where the highway cuts through the fault.

Category: Geologically Interesting Landscapes
Title: The Prettiest Peak in Texas - that no one has ever seen
By: William DeMis
Shely Peak, Marathon Basin, Texas. 5,208 feet. Flat-lying Cretaceous carbonates and shales of the Trinity and Fredericksburg groups lie on south-dipping Mississippian Tesnus sandstones and shales in an angular unconformity. The vertical relief is 1,700 feet. View is looking due east. The picture is copyrighted by William DeMis

Category: Geologically Interesting Landscapes
Title: Mendenhall Glacier medial moraine
By Dorene West
Mendenhall Glacier near Juneau. Picture taken from a prop plane (through a scratched Plexiglass window). The glacier is flowing from the Juneau Icefield to Mendenhall Lake. Each flow line represents 1 year. Two arms of the glacier meet with a medial moraine (scraped rock dust/dirt . . .) in between. (Dark rocks at the top; glacier is flowing downhill.)Picture taken September 2010 with a little point and shoot Pentax (before iPhone camera). Notes above were for my non-geologist family to understand what the picture was showing.

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HS Bulletin Art Contest continued from page 32

Category: Geologically Interesting Landscapes
Title: A Ceramic Study of River Deltas
By: Sara Tirado
The image is a compilation of five photographs of pottery created by Sara Tirado, a professional geophysicist and armature potter. These ceramic pieces reflect the natural beauty of individual river deltas, with artistic license in presentation. By using the wheel, hand building techniques and hand carving, each work attempts to represent a different river delta around the world, while maintaining a cohesive set. The clay used is Longhorn White, a low fire clay with no grog. A combination of underglazes and layered glazes help to define the topographical features while also abstractly representing water and land. The pieces unite art and science, engage viewers with their aesthetic appeal, and encourage the contemplation of the intricate relationship between geological formations and human activities.

Category: Geologically Interesting Landscapes
Title: Folaldafoss, East Fjords, Iceland
By: Charlie Curtin
The Folaldafoss waterfall is located in the East Fjords region of eastern Iceland, northwest of the town of Djupivogur. This waterfall of the Berufjardara River cuts through Upper Miocene aged (8.5-10.0 mmya) basaltic lava flows as it winds its way to the coast. Visiting the waterfall involves taking a detour from the main Icelandic highway, the "Ring Road" (Route 1), and taking a shortcut on the Oxi Pass road (route 939) when traveling to the northwest. Folaldafoss has a drop of approximately 65' (20 meters).Photo taken 7/2023.

Category: Geologically Interesting Landscapes
Thrust-related anticline, Tarim Basin, China
By Sandro Serra
Box-shaped anticline in the Kuqa fold and thrust belt on the northern margin of the Tarim Basin, western China. The fold is developed in Tertiary interbedded clastics above a Lower Tertiary sequence of salt, gypsum, and mudstone. The width of the outcrop is approximately 2.5 kilometers..

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HS Bulletin Art Contest continued from page 33

Category: Rocks Up-close and Personal
Title: The Great Unconformity in the Grand Canyon
By: Jeff Lund
During the HGS Grand Canyon raft trip in June 2018, an incredible stop was to view (and touch) the "Great Unconformity" a short hike from the river level in the deep inner canyon. My arm separates the Cambrian Tapeats Sandstone (with rip up clasts) from the Precambrian Vishnu Schist basement metamorphic rocks. About 1 billion years of rock record is missing due to erosion of the Vishnu surface

Category: Rocks Up-close and Personal
Title: Red Rocks of Antelope Canyon
By: Sharma Dronamraju
Beautiful sunlit Antelope Canyon, reaching about 120ft below the ground. A private land in the Navajo Nation is both a geologist's and photographer's delight. These are Jurassic dunes, carved beautifully by rain and desert streams.

Category: Rocks Up-close and Personal
Title: Cross-bedding in the Hickory Sandstone, Llano Uplift, Texas
By Henry M. Wise
The Hickory Sandstone Member is the basal member of the Riley Formation, middle(?) to late Cambrian. This member is used as frac sand. The photograph shows cross-bedding in the formation.

HGS Bulletin Art Contest *continued on page 35*

HS Bulletin Art Contest continued from page 34

Category: Rocks Up-close and Personal
Title: Playa Hermosa in Nicaragua
By: Tania Campbell
Surfing in Nicaragua is favorable because of the consistent winds coming from the mainland, where you can catch waves daily. The hermit crab trails were briefly captured with the fading sunset, before they were quickly erased with the next gust of wind. The sand grains are a mix of shells and volcanics, making it a beautiful vacation spot.

Category: Energy
Title: Wyoming Windmills
By: Henry M. Wise
Windmills in Casper, Wyoming. Observed during the AAPG Casper, Wyoming/Solar Eclipse Field Trip in 2017.

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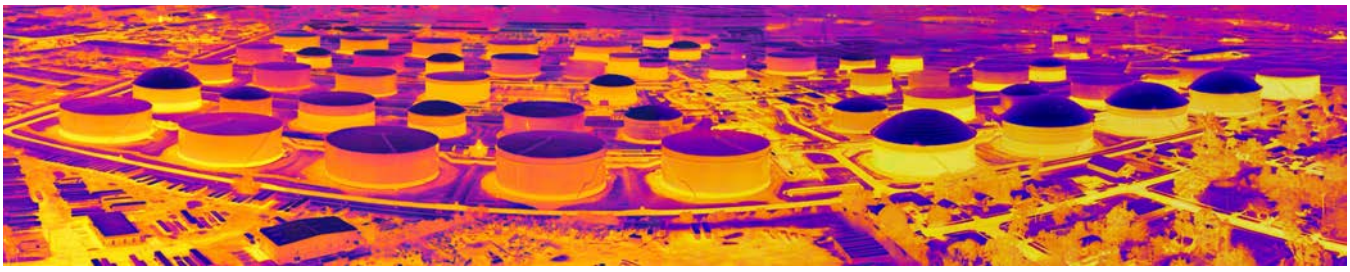
HS Bulletin Art Contest continued from page 35

Category Energy
Title: Behind Every Dark Cloud
By: Dan Moss
Behind Every Dark Cloud' - These two photos were taken by myself (slide film) in 1982 after an afternoon thunderstorm when I was working as a young Petroleum Engineer in the Permian Basin. Located in the Means S. Wolfcamp Field, Andrews County, TX

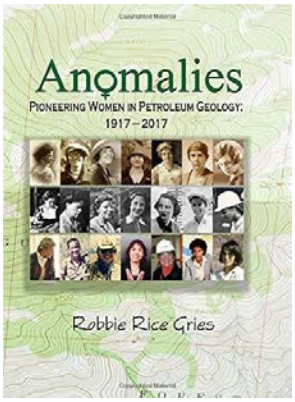


Category Energy
Title: Thermal View of Petroleum Storage Tanks
By: Michael Allison
This is a composite image of 23 individual thermal Infrared (IR) photos. The IR photos were taken early in the morning by a drone with a thermal camera payload flying at 392 feet above ground level. This technology is used to determine petroleum storage tank level fluid volumes.

A Conversation with HGS Legend Robbie Gries

By Caroline Wachtman

Robbie Gries was named a HGS Legend in 2003, along with Michel T. Halbouty, Tom Barrow, Bill Barrett, and Marvin Davis. She remains the only woman featured in the HGS legend series, a recognition periodically shared in the January *Bulletin*. This designation is fitting for Gries, who has worked throughout her career to break barriers for herself and other women in Oil and Gas careers. In addition, Gries has worked to highlight and amplify the stories of women geoscientists and published many of their stories in her book, *Anomalies—Pioneering Women in Petroleum Geology: 1917-2017*.



Risk-taking is one of Gries' key characteristics. Her entry into geology, education, and professional career are marked by taking chances and demonstrating resilience. For example, Gries took an introductory geology class "on a whim" at Del Mar University in the fall of her sophomore year. She says she was "mesmerized," so she took the second introductory course in the spring semester. As the top student in geology, she was awarded a scholarship and took the risk to move out of state continuing her education at Colorado State University in Ft. Collins. In 1964, she qualified for a National Defense Education Act loan that allowed her to finish her geology degree and become the first woman to graduate in the university's geology department. Unlike her male counterparts, she wasn't offered guidance on how to get a job. So, she decided to continue her education and take advantage of in-state tuition, by returning to Texas to earn a MS degree from the University of Texas at Austin.

Following graduation, marriage, and the birth of her daughter, Gries moved with her husband to Kansas where he commenced a teaching assignment at Wichita State University. Gries wanted a geology career of her own. To achieve that goal, she ended her marriage and took a risk by moving Houston in 1973. The risk worked out, because it was that year that the federal government required Oil and Gas companies to implement a diversity plan to hire women and minorities.

Gries joined Texaco in their Denver office. "I had a great boss who was very supportive. He called me 'token,'" she laughs. Gries' approach of using tolerance and humor to address gender bias is another of her key characteristics. "Most men didn't know any better. I found that tolerance and humor worked better than anger," she says.

Gries continued to take risks by leaving the relative stability of a large corporation in 1977 to join small independent Oil and Gas companies in Denver. She learned a broad set of geoscience, geophysics, land and business skills, and developed the confidence to go out on her own. After an industry downturn in the late 1980s, Gries again took a risk by pivoting her skill set into mergers and acquisitions. The risk paid off and resulted in Gries becoming an officer in a company for which for which she facilitated a merger.

In 1994, Gries founded her own company, Priority Oil and Gas, LLC by buying up uneconomic oil fields that she sought to develop. "At that time, engineers thought that one well could drain one square mile,

Robbie Gries *continued on page 38*

HGS LEGENDS

2000 George Mitchell
Joe Foster
Marlan Downey
John Seitz
Gene Van Dyke

2003 Michel T. Halbouty
Tom Barrow
Robbie Gries
Bill Barrett
Marvin Davis

2006 Pete Rose
Arnold Bouma
Peter Vale
Bert Bally

2007 Legendary Oil Fields
(Zafiro) Joe Bruso
(Mars) Mike Mahaffie
(Cantarell) Jesus Garcia Hernandez

2008 T. Boone Pickens

2011 John Amoruso
Dan Smith
Dick Bishop
Dave Rensink

2012 Unconventional Plays
Dan Steward
Gregg Robertson
Michael Johnson
William Zagorski

2013 Sedimentology
George Devries Klein
James Coleman
Miles Hayes
Robert Folk

2015 IBA Mentors
Brian Lock
Chris Zahm

2016 Geophysicists
Alistair Brown
Tom Smith
Peter Duncan

2023 Bill Armstrong

Robbie Gries continued from page 37

but we were learning that was crazy," Gries says. Gries recruited partners to supply the drilling capital and ultimately drilled 134 wells.

Developing and maintaining relationships is another of Gries' key characteristics. This focus on relationships allowed her to fund drilling campaigns at Priority and maintain friendships with some of those investors today. Gries says that she has always focused on building relationships and prioritized professional service to organizations such as AAPG and Rocky Mountain Geological Association. She believes that the professional relationships she developed through societies allowed her to be a successful consultant and independent. "You need a network of people, unless you are independently wealthy," laughs Gries.

Reflecting on the risks she took in her career, Gries says, "I grew up poor, and knew how to be poor again." She says its in her nature to tolerate risks. "There were months when I wouldn't have money for rent, but then a deal would come together and the money would work out," she describes.

Now at 80 years old, Gries describes herself as semi-retired. She still holds some production acreage, but has focused more of her time on studying the history of women in petroleum geoscience and telling their stories in talks and in print. Like the women she amplifies, Gries took risks to break multiple barriers, such as being one of the first women to be admitted to the Petroleum Club of Denver. She continues to approach business and life with humor, tolerance, and a focus on building relationships. ■

WELCOME TO NEW MEMBERS, EFFECTIVE NOVEMBER/DECEMBER 2023

Michael Antonelli	Wassim Daghri	Caroline Mandujano	Patrick Ryan	Johanna Villagomez
Robert Aylsworth	Nick Damon	Jena Ngalawa	Alexandra Staub	Eric A Williams
Aislyn Barclay	Jose Miguel Gorosabel Araus	Basil Nwator	Leon Thomsen	
Sophie Broun	Robert Kervin	Sabrina Reichert		

Monday, January 8, 2024

5:30 – 9:00 p.m.

HGS Members/Emeritus/Honorary Life $65
Students $25 • Non-Members & Walkups $75
To guarantee a seat, you must pre-register on the HGS website and pay with a credit card. You may walk up and pay at the door if extra seats are available. Please cancel by phone or email within 24 hours before the event for a refund. Online & pre-registration closes Monday, January 8 at 5:00 a.m.
Norris Conference Center, Citycentre
816 Town and Country Blvd #210 • Houston, TX 77024
https://www.hgs.org/civicrm/event/info?id=2479
Event Contact: Linda Sternbach • linda.sternbach@gmail.com

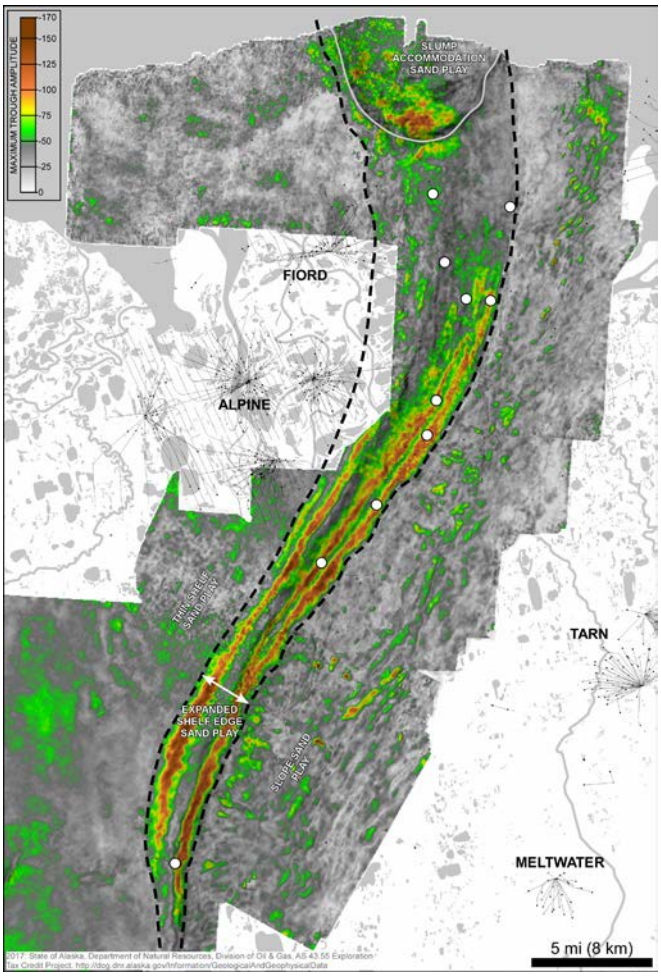
2024 HGS Legends in Wildcatting Bill Armstrong

Bill Armstrong is the 2024 HGS Legends in Wildcatting 2024 speaker. Armstrong has made many discoveries over the years. His largest discoveries have been on the North Slope of Alaska, where he and his team found numerous 100+ million-barrel oil fields. The Horseshoe/Pikka Field is expected to be developed into the third-largest conventional oil field in U.S. history. The discovery has 880 feet of oil pay and the reserves may be as large as 1.4 billion barrels of oil.

In 1985, Armstrong founded Armstrong Oil & Gas, Inc. (AOG), a privately held oil and gas exploration company headquartered in Denver. Armstrong graduated in 1982 from Southern Methodist University with a B.S. degree in geology, a Phi Beta Kappa key, and a wife that he met in Geology 101. After spending time doing what one-man companies are "supposed to do" — chasing deals in Kansas, the DJ, the Permian, and other independent friendly regions — Armstrong shifted his efforts to internally generating, assembling, and drilling large company impact exploration opportunities. By seeking out top geologic, geophysical, land, and engineering talent, and also by pursuing big potential "wildcats," Armstrong created a unique business model in the energy sector that proved successful for AOG and the companies with whom they worked and partnered.

Armstrong is a member and past chairman of the All-American Wildcatters. He also sits of the National Petroleum Council. The American Association of Petroleum Geologists chose Armstrong as its Michel T. Halbouty lecturer in 2018. In 2019, Armstrong and geologist Jesse Sommer received the Michael S. Johnson Explorer of the Year Award from the Rocky Mountain Association of Geologists, and Armstrong was profiled in The Wall Street Journal as "One of the Last Wildcatters." In 2020, Armstrong and Sommer received the Norman F. Foster Outstanding Explorer Award.

Armstrong and his wife, Liz, are active in numerous business ventures, investments, and philanthropies. In 2004, they founded Epoch Estate Wines, an ultra-premium vineyard/winery operation located in Paso Robles, California. He currently serves on the boards of Tourmaline Oil Corp. (Calgary) and Southern Methodist University (Dallas) where in 2021, both he and his wife received SMU's Distinguished Alumni Award. Armstrong is a former board member of the Denver Art Museum and is trustee emeritus at Colorado Ballet. The couple manage The Armstrong Foundation that focuses on education and arts philanthropy. ■



Wednesday, January 10, 2024

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

Pre-registered HGS Members $35
Non-Members & ALL Walkups $40
To guarantee a seat, pre-register on the HGS website and pay with a credit card. You may walk up and pay at the door if extra seats are available. Please cancel by phone or email within 24 hours before the event for a refund. Online & pre-registration closes Wednesday, at 5:00 a.m.
Craft Republic Houston • 11470 Westheimer Rd.
https://www.hgs.org/civicrm/event/info?id=2512
Event Contact: Matthew Cowan • mrcowan1@hal-pc.org

HGS E&E Dinner Meeting

Andrew Stearns
Well Data Products (WDP)

Sediment Routing in an Incised Valley during Hurricane Harvey (2017) in Houston, TX: Implications for Modern Sedimentation

The Houston area recorded the largest flooding event in US history during Hurricane Harvey from August 25-31, 2017, mobilizing millions of m3 of sediment in fluvial-estuarine systems. An integrated quantitative analysis to determine the net minimum volume of sediment transported during the storm demonstrates that the 12 fluvial-estuarine streams and two controlled reservoir drainages transported a minimum of ~2.723×107 m3 of sediment. This volume is ~6-51 times larger than the average annual volume of sediment delivered to Galveston Bay in modern times (<200 years), and ~30-118 times larger when compared to Holocene rates. Nearly ~26% of the measured volume was deposited in Addicks and Barker reservoirs. In the stream drainages, sediment was mobilized from west-northwest of Houston and pulsed towards Galveston Bay, highlighting the extreme short-term variability in sediment delivery. Sediment flux during Harvey is an example of sediment storage followed by a pulsed delivery of high sediment volume rather than continuous delivery of sediment. Comparison of sediment volumes transported through natural and modified drainages through Houston demonstrates that channel modification resulted in significant bypass of sediment downstream. Urban watershed management is more effective when continual updates are implemented based on regional circumstances rather than based on historical fluxes.

BIOGRAPHICAL SKETCH

Andrew Stearns is a Product Owner for the Well Data Products (WDP) group at TGS since 2021. In that role, he is responsible for managing the full product lifecycle of pressure data and in-house basin models across North America. Andrew holds an MSc Geology from the University of Houston and a BSc Geology from the University of Texas. He also serves as the organizing committee chair for the HGS Student Expo, the largest job fair for geoscience students in the US.

Above: Buffalo Bayou Park

Left: August 31, 2017 NASA

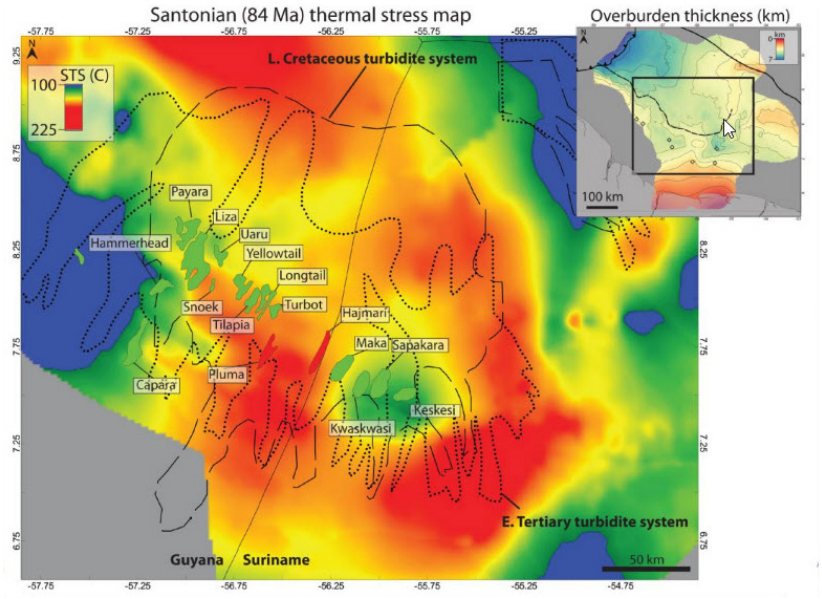
Wednesday, January 17, 2024

Noon – 1:00 p.m.
HGS Members $20 • Students $10 • Non-Members $25
Register using the HGS website calendar.
Zoom link will be emailed to registrants.
https://www.hgs.org/civicrm/event/info?id=2527
Event Contact: Linda Sternbach • linda.sternbach@gmail.com

Predicted Hydrocarbon Trends of the Guyana-Suriname Margin Based on a 3D Full Thickness Lithospheric and Basin Model

Speaker 1 – Kenneth Shipper, *University of Houston Department of Earth and Atmospheric Science*

The 8-km-thick, rifted-passive margin of northeastern South America in Guyana and northwestern Suriname thins from 40-50 km thick crust of the Guiana shield to 6-8 km Jurassic oceanic crust over a 167-74 km tapered necked zone. As hydrocarbon exploration continues offshore from the highly productive "Miracle Mile" along the slope of Guyana and northwestern Suriname, prediction of future trends for productive offshore drilling will depend on quantifying lateral variations in thermal stress related to crustal thickness and type, source rock thickness and type, and overburden thickness.



Standard thermal stress (STS) map at the Santonian source interval based on variations of radiogenic heat production (RHP) and crustal thickness within the Guyana-Suriname basin. RHP from the oceanic crust is assumed to be zero (Allen and Allen, 2013). The map on the top right indicates 3D basin model size and compares STS to overburden thickness of the Maastrichtian-present interval. STS values in the green oil window and red gas window are observed to match several oil and gas fields indicated by green and red polygons. The extent of Cretaceous and Tertiary turbidite systems is indicated by the dashed and dotted lines, respectively (Ballard, 2019).

My study has completed a 3D basin model based on a new 3D gravity inversion constrained from previous refraction surveys and my interpretations of a 2D KPSTM seismic grid. I also used downhole temperature measurements calibrated from thermal models to calculate the total radiogenic heat due to the granitic composition of the area of necked, continental crust. Three crustal domains were identified based on basalt flow extent previously indicated by seaward dipping reflectors (SDRs) related to the Demerara volcanic margin in southeastern Suriname. The crustal structure of the margin was constrained using seismic, and radiogenic heat production (RHP) from thermal modeling. The three crustal domains include: 1) 10-30-km-thick continental crust with ~46-12 mW/m² RHP with absent or minor volcanic rocks adjacent to the continent-ocean boundary; 2) 15-km-thick continental crust with ~16 mW/m² RHP with thick, overlying SDRs that are more landward from the COB; and 3) 6-8-km-thick oceanic crust with zero RHP in the deep, oceanic area of the Guyana basin. The resulting 3D thermal stress model shows increasing maturity is validated by the successful oil and gas fields and predicts the how the productive areas will extend onto the elevated area of the Demerara volcanic margin. ■

BIOGRAPHICAL SKETCH

Kenneth Shipper is a second year Ph.D student at the University of Houston Earth and Atmospheric Sciences Department working with Dr. Paul Mann and CBTH Caribbean Consortium. Ken earned a BS in Geophysics and Seismology at University of Houston in 2021. He supported the UH GeoSociety student group as President in 2020. Ken presented posters on his research at the GeoGulf23 Conference in April, and at the HGS Sheriff Lecture in November 2023.

HGS International Group Virtual Zoom Luncheon *continued on page 42*

Crustal Architecture of the Colombian Basin and Its Implications for the Early Evolution and Hydrocarbon Potential of the Caribbean Sea

Speaker 2 —Juan Carlos Ramos Vargas, *PhD student in Geology at the University of Houston*

This talk aims to present new insights into the geology, tectonostratigraphic evolution, and potential petroleum systems in the deep and ultra-deep waters of the Colombian Caribbean margin. I summarize the exploration potential of the 235,000 km2 Magdalena Fan System, one of the last large unexplored, deep sea fan systems in the world. I also provide a detailed analysis of 1) the basement fabric and crustal structure of the Colombian and Venezuelan basins; 2) the stratigraphy and sedimentary sequences that infilled areas above these differing basement types; and 3) how the basement morphology and overlying basins have led to potential petroleum systems known from direct hydrocarbon indicators.

This paper is based on the interpretation of 8,210 km of 2D seismic data, 13,000 km^2 of 3D seismic data, the compilation, and integration of published information from scientific (DSDP/ODP) and hydrocarbon exploratory wells, sea-floor samples, oil seeps, geochemical evaluations, potential field methods, and seismic refraction data. The seismic data used for this project was provided by the oil and gas industry and includes recently acquired and processed seismic reflection data in the Colombian Basin and the Northern Panama Deformed Belt (NPDB). Interpretations from potential gravimetric and magnetometry methods reveal the basement architecture and the location of the main depocenters in the area.

Our results show that the basement in the ultra-deep waters of the Colombian Basin consists of parallel basement ridges bounded on both sides by troughs with more than 20 km extension that formed as Cretaceous spreading ridges in the central Caribbean. These now-extinct spreading centers were also interpreted based on the satellite gravity and magnetic maps. This Cretaceous basement fabric had a direct impact on the sedimentary fill evidenced by the presence of high amplitude reflectors filling the troughs as potential source rock pods, which could be time-equivalent to the Upper Cretaceous rocks drilled by DSDP/ODP wells 153, 151, and 146 where organic-rich intervals in the Coniacian-xx interval are well documented.

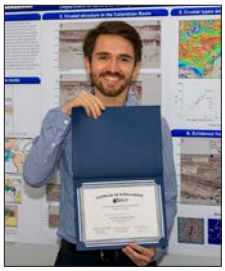
The upper part of this pelagic sedimentary sequence contrasts with turbidites, and deep-water deposits associated with the development of the Miocene and younger Magdalena Fan, as well as a marked interpreted MTCs of possible Pleistocene age, observed over a large extension of the basin. This thick accumulation of Miocene to recent clastic rocks reach values greater than 10 km and provides high-quality reservoirs, seals, and overburden for underlying source rocks of Turonian-Santonian age.

This turbidite Miocene-to-recent sedimentary sequence shows in the 2D lines and in the 3D survey numerous amplitude anomalies that are consistent with 4-way structures with more than 8 km of length located mainly at the toe of the slope. The relationship between the location of these structures with recent piston core results, and the presence of oil seeps, allows us to conclude the potential presence of a deep and ultra-deepwater petroleum system with potential thermogenic origin.

In addition, the geology interpreted in the Northern Panama Deformed Belt shows the marked presence of Bottom Simulating Reflectors (BSRs), as well as gas chimneys that support the deeper water extensions of >5 TCF, recent gas discoveries along the Colombian Caribbean margin that include Gorgon, Orca, Kronos and Uchuva.

The results derived from this work bring new insights into the geological understanding of the little-explored the Colombian Basin and the Northern Panama Deformed Belt. Interpretation of seismic data acquired by the oil industry during the last 10 years allows for more detailed analysis of their tectonostratigraphic evolution, as well as guiding future exploration activities in the region. In addition, the integration of our seismic interpretation with recent evidence from seafloor samples and oil seeps in the region supports a deepwater thermogenic system that has not been drilled by exploratory wells to date. ■

BIOGRAPHICAL SKETCH



Juan Pablo earned his BS degree in geology from the National University of Colombia and is currently a PhD candidate in geology at the University of Houston. As a researcher with the Conjugate Basins Tectonics and Hydrocarbons (CBTH) Consortium, he has published research on the tectonostratigraphic evolution of frontier deepwater sedimentary basins of the Caribbean and its implications for hydrocarbon exploratory potential. Juan Pablo

HGS International Group Virtual Zoom Luncheon *continued on page 43*

International Explorationists Luncheon *continued from page 42*

has conducted research at UH on a carbon sequestration project in depleted fields in the NW Shelf of Australia. He has been an active participant in several professional associations such as AAPG, SEG, HGS, GSH, SEPM and AGU. Juan Pablo will join BP as a geologist in the summer of 2024 after defending his PhD dissertation at the University of Houston.

Vote for your favorite entries in the HGS Bulletin *Geology is Beautiful* art contest

Cast your ballot before February 15 to help choose the winners

Vote Now!

HGS Legends in Wildcatting

With Bill Armstrong

January 8, 2024

Norris Conference Center, Houston

Social 5:30 PM, Program 6:30-9:00 PM

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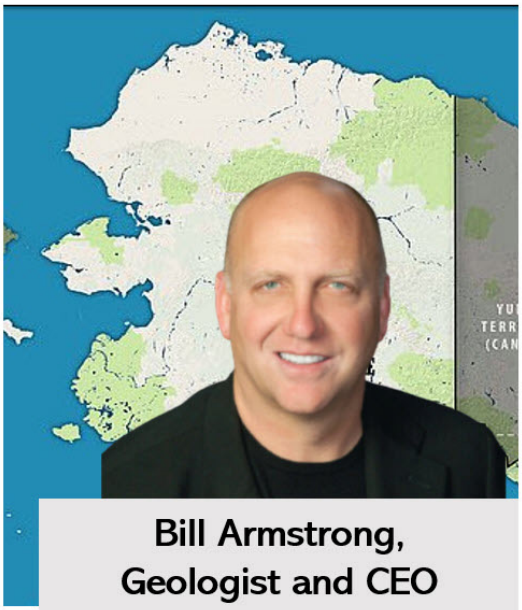

Bill Armstrong,
Geologist and CEO
Armstrong Oil and Gas

Wednesday, January 24, 2024

Social 11:15 AM, Luncheon 11:30 AM- 1:00 PM
Cost: $50 pre-registered members
$60 for non-members/ALL walk-ups
$50 for Emeritus/Life/Honorary.
Students: email office@hgs.org if you want to attend.
The Petroleum Club of Houston
1201 Louisiana Street, 35th floor, Houston, TX
https://www.hgs.org/civicrm/event/info?id=2487
Event Contact: Linda Sternbach | linda.sternbach@gmail.com

HGS General Luncheon Meeting

Art Berman
Labyrinth Consulting

Don't Be Fooled by Lower Oil Prices or Alarmed About Forecasts for Higher Prices

2023 was a year of failed memes about much higher oil prices. The China demand-rebound meme flopped by June, and the supply-deficit meme cratered in November. Now, most analysts expect relatively low prices in 2024 because of a supply surplus.

How did smart people get things so wrong? Partly by believing memes instead of asking how these could be wrong. I believe that the world is and will be in a secular period of relative oil supply urgency for much of the next decade. That will be modulated by a weak global economy.

The result should be price-cycling as the two opposing forces gain and lose investor and trader attention. James Galbraith described a phenomenon that he called "the choke-chain effect" in which scarce resources in a financialized market lead to cycling of both oil prices and capital availability.

Price cycling and its associated price volatility create market anxiety and unwillingness to invest in new supply. Once this kind of price cycling is established, it is likely to persist until some new technology emerges—like shale in the 2010s—or an economic slump reduces demand. Some investors are betting that renewable energy is this new technology. I wouldn't count on it.

Permian well performance has dropped 30 to 50% over the last few years as the play has been over-drilled. Production is still increasing but when this change becomes evident to markets, supply urgency will strengthen. At the same time, it seems unlikely that the world economy will improve much so the same dialectic seen at present will probably persist until some fundamental structural change occurs in the market. ■

BIOGRAPHICAL SKETCH

Arthur E. Berman is a petroleum geologist with 36 years of oil and gas industry experience. He is an expert on U.S. shale plays, and has published more than 100 articles on oil and gas plays and trends. He has been interviewed about oil and gas topics on CBC, CBS, CNBC, CNN, Platt's Energy Week, BNN, Bloomberg, Platt's, The Financial Times, The Wall Street Journal, Rolling Stone and The New York Times.

Art Berman earned an MS in geology from the Colorado School of Mines, Colorado, and a BA in History from Amherst College. Art has previously served as Editor of the HGS *Bulletin* and as HGS Vice President.

The Choke-Chain Effect: cycling of prices and economic activity. Once scarcity is established and financialized, prices rise until consumer demand falls. Consumers adjust and prices rise again above marginal price.

January 2024

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	1 Make your reservations online at hgs.org	2	3	4	5	6
7	8 **HGS General and North Amerian Dinner Meeting** *Legends in Wildcatting with Bill Armstrong* *Page 39* *https://www.hgs.org/civicrm/event/info?id=2479*	9	10 **HGS E&E Dinner Meeting** *Buffalo Bayou Flooding* *Page 40* *https://www.hgs.org/civicrm/event/info?id=2512*	11	12	13
14	15	16	17 **HGS International Zoom Meeting** *Research on Suriname and Colombia from U of H* *Page 41* *https://www.hgs.org/civicrm/event/info?id=2527*	18 **Continuing Ed** *Fundamentals of Basin Modeling in Oil Exploration* *Page 23* *https://www.hgs.org/civicrm/event/info?id=2537*	19	20
21	22	23	24 **HGS General Luncheon Meeting** *Don't Be Fooled by Lower Oil Prices or Alarmed About Forecasts For Higher Prices* *Page 44* *https://www.hgs.org/civicrm/event/info?id=2487*	25 **HGS NeoGeos Happy Hour** *Page 21* *https://www.hgs.org/civicrm/event/info?id=2531*	26	27
28	29	30	31			

RESERVATIONS The HGS prefers that you make your reservations online through the HGS website at WWW.HGS.ORG. If you have no internet access, you can e-mail OFFICE@HGS.ORG, or call the office at 713-463-9476. **Reservations for HGS meetings must be made or cancelled by the date shown on the HGS website calendar, normally that is 24 hours before hand or on the last business day before the event**. If you make your reservation on the website or by email, an email confirmation will be sent to you. If you do not receive a confirmation, contact the HGS office at OFFICE@HGS.ORG. Once the meals are ordered and name tags and lists are prepared, no more reservations can be added even if they are sent. **No-shows will be billed.**

INSTRUCTIONS TO AUTHORS

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

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

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

HGS 2023 Holiday Party

By Penny Patterson

A festive and fun-filled evening was had by all that attended the second annual HGS Holiday Party that was held on December 4, 2023 at the Cadillac Bar. The HGS Holiday Party brought together roughly 50 HGS members, spouses, and friends. The venue was festively decorated in the holiday spirit, had a Mexican flare, and (of course) had a few dinosaurs adorning the tables. Throughout the evening there was much cheer and laughter as you will see from the photographs taken at the party. HGS extends sincere thanks to the sponsors, Thunder Exploration, Inc., Infinity Hydrocarbons, and Patterson Geoscience Group, LLC. Please mark your calendar for next year's HGS Holiday Party celebration! ■

HGS 2023 Holiday Party attendees

Sharma Dronamraju, Penny Patterson, and J.D. McConnell and his wife

Edward Yao, Mary Nelis, and Bob Weiner

Thanks to our generous sponsors!

INFINITY HYDROCARBONS

Patterson Geoscience Group, LLC

THUNDER EXPLORATION, INC.

HGS Holiday party dinosaur enjoying the party

HGS Revives Annual Sporting Clays Event

By David Perez

The Houston Geological Society hosted its inaugural Sporting Clays Tournament at Westside Sporting Grounds on December 9, drawing in over 90 enthusiastic participants for a day of camaraderie and competition. The Westside Sporting Grounds provided a picturesque backdrop for participants to enjoy a full day of clay shooting with lunch and refreshments. The challenging clay targets set the stage for an exciting event. The collaborative spirit and friendly competition were evident throughout the day.

The event also included a silent auction filled with unique items, including a large section of mammoth tusk and mammoth tooth slabs, a 1932 Geologic Map of Texas, a limited edition six pack of Donald Trump revenge beer, pyritized ammonite sections, a megalodon shark tooth, and various other fossils and minerals. Raffle and Squares prizes included an over and under shotgun, a deer rifle, professional shooting instruction, and a guided fishing trip.

Mona Ansley and Greg Nasar emerged as overall winners. Both received a prestigious engraved rock hammer, a Roadside Geology of Texas book, a leather belt loop, and safety glasses. First, Second and Third Place teams received sporting clays themed trophies, nice enough for the hall of fame champion trophy cabinet.

- The 1st place team included: Bill Mann, Jim McFadden, Albert Lew, and Tommy Mitchell.
- The 2nd place team included: Ron Honefenger, Ed Grisham, Larry Feland, and Jake Grisham.
- The 3rd place team included: Tim McGinty, Mike Kasecky, Michael Van den Bold, and Greg Nassar.

Many thanks to the sponsors who contributed to the success of the Clay Shoot. They played a crucial role in supporting various aspects of the tournament, such as lunch, swag bags, and other essential items. Special thanks to the HGS Clay Shoot Committee for organizing the event: David Perez, HGS Committee Chair; Mona Ansley, Bob Burnett, Sharma Dronamraju, Andrea Peoples, and Paul Britt.

Looking ahead, the Houston Geological Society aims to build on the success of this inaugural event. Plans for the next year include expanding participation, introducing new elements, and enhancing the overall experience for attendees. ■

First place winners

Second place winners

Third place winners

High Overall Ladies Winner
Mona Ansley

High Overall Mens Winner
Greg Nasar

HGS Clay Shoot Committee

Remembrance

Robert Wilder Cossum, Jr.

08/07/1927 - 11/19/2023

Robert Wilder Cossum Jr., beloved husband, father, grandfather and great-grandfather passed away on November 19, 2023, in the presence of family and while resting next to his dog Sophie.

Bob was preceded in death by his loving wife of 71 years, Carol Cossum, by 142 days. Also preceding him in death were his father, Robert Wilder Cossum Sr., mother, Margaret Duthie Cossum, and sister Sarah Cossum Redfield.

Surviving are his sons Bobby and his partner Debra, John and his partner Kelly, David and his wife Ann; grandchildren Taylor, Zachary and his wife Lauren, Hunter, Quentin, and Andrea; and great-granddaughter Blakelyn; nieces Suzy Blundred, Barbie Angel, Becky Redfield and Wendy Redfield, and nephews David Inglis and Sam Redfield; as well as God daughters Kathryn McNiel and Catherine Raffaele.

Bob was born on August 7, 1927, in Evanston Illinois, where he later met his wife Carol. After graduating from high school, Bob entered the Navy Reserves 27 days prior to Japan's formal surrender bringing an end to World War II. He served a year in the Navy Reserves before entering Princeton University where he graduated in 1952 with a degree in geology. Bob and Carol were married in Winnetka Illinois on June 21, 1952 and moved to Houston shortly after where Bob went to work as a geologist for the American Republic Corporation which soon merged with Sinclair Oil. Sons Bobby, and then John, were born in Houston. Bob went to work for Sohio in 1957 and was later transferred to New Orleans for a brief time where David was born. After Bob returned to Houston, he went to work for Zapata Norness in 1963. Bob's work as a geologist led to many great adventures. The entire family was able to join him in Scandinavia one summer when he was working in the North Sea. His work also took him to South Africa and Venezuela. Much of his work later in his career, consulting with smaller oil and gas ventures, kept him closer to home in Texas, Louisiana, and the Gulf of Mexico. While his work did require travel, Bob was always a family man and very involved in the life of his children at home, in Indian Guides, little league baseball, church youth groups, and even ice hockey. He was also Carol's biggest fan and supporter as she pursued master's and doctorate degrees and her own career in education and counseling. Bob loved staying active. Early on he enjoyed bowling and then became an avid tennis player, and then an avid golfer into his 90's, engaging with others and making friends along the way. Later in life, he and Carol enjoyed volunteering on various projects at Christ Church Cathedral in Houston and dedicated their time and resources on issues reflective of their values. Bob always enjoyed time spent with family, especially grandchildren and most recently a great-granddaughter. ■

Published by *Houston Chronicle* on Dec. 3, 2023.

HGS Membership Application

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

Active Membership

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

Associate Membership

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

Student Membership

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

Membership Benefits

Digital HGS Bulletin

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

Discount prices for meetings and short courses

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

Networking

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

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

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

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

Phone _____

Preferred Address for HGS mail_____

This is my home address _____ business address _____

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

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

Student **$0.00**_____

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

Total remittance_____

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Signature: _____ Date: _____

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

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

Company Address _____

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

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

Year Graduated _____

School *(optional)*_____

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

Year Graduated _____

Years Work Experience *(required)*_____

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

AAPG Member Number _____ OR

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Signature: _____ **Date:**_____

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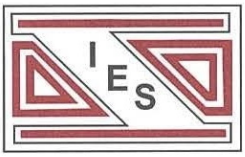

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