THE UNIVERSITY OF TEXAS AT AUSTIN · JACKSON SCHOOL OF GEOSCIENCES · 2019 NEWSLETTER

2019 Newsletter

Moon Landing at 50: The Impact of UT Geology on Apollo and Beyond

TEXAS Geosciences
The University of Texas at Austin
Jackson School of Geosciences

THANK YOU!

Your gifts help students achieve their dreams.

Dear Alumni and Friends

It is my pleasure to share with you the 2019 Jackson School of Geosciences *Newsletter.* A tradition now for 66 years, the *Newsletter* highlights the work and accomplishments of our students, faculty, scientists and alumni. More importantly, it helps tie the Jackson School community together.

This is the 11th and final *Newsletter* I've had the privilege of sharing with you as dean. As most of you already know, I have decided to step down and return to the faculty. An announcement on my successor should be coming very soon, if it hasn't already happened by the time the *Newsletter* hits your mailbox.

I can't even begin to express how much the students, faculty, researchers, staff and alumni at the Jackson School have impacted my life, and I am very proud of all the amazing things they have accomplished during my tenure.

This edition of the *Newsletter* has great examples of the research and education that made the Jackson School the No. 1 Geology program in the country.

The moon landing feature on page 70 explores Texas geology's close connection to those early Apollo missions and the role our faculty, scientists and students played in the exploration of the moon. It is a great example of how the geosciences are at the heart of so many of the important stories and issues of our lives.

The article on the university's hydrocarbon expertise on page 86 is a great reminder that no matter how much we expand our research and education at the Jackson School, we remain one of the top oil and gas institutions in the world. When you combine the expertise at the Jackson School and the Cockrell School of Engineering, and then add in the law, business and policy expertise the university brings to oil and gas, we are truly a unique institution when it comes to the future of hydrocarbons.

And the story on El Niño and La Niña climate research on page 80 shows the amazing diversity of world-class science performed at the Jackson School. Here, scientists at the Institute for Geophysics are using coral cores and cutting-edge climate models to determine how changes in climate influence powerful weather patterns that impact our lives.

As I step down from my position as dean, I do so confident in the knowledge that the Jackson School is in a great position and poised to do even greater things under new leadership. With that in mind, I'd like to draw your attention to the profile on page 24 on Demian Saffer, who will be the new director of the Institute for Geophysics starting in January 2020. I have come to know Demian well over the past few months in his transitional role at the Jackson School, and I am confident that we have found the person with the vision and experience to make UTIG even better than it already is.

Finally, I would like to draw your attention to the story on page 30 about the summit for department heads and chairs that we hosted as part of the National Science Foundation-sponsored effort to improve the preparedness of geosciences graduate students for the future workforce. This is one of the two national efforts I am leading to help restructure geosciences education, with the other being focused on undergraduate education. I point this out because I want to assure the Jackson School community that even after I step down, I will still be intimately involved with the geosciences, education and the school we all love.

Enjoy the *Newsletter*!

Sharon Mosher, Dean

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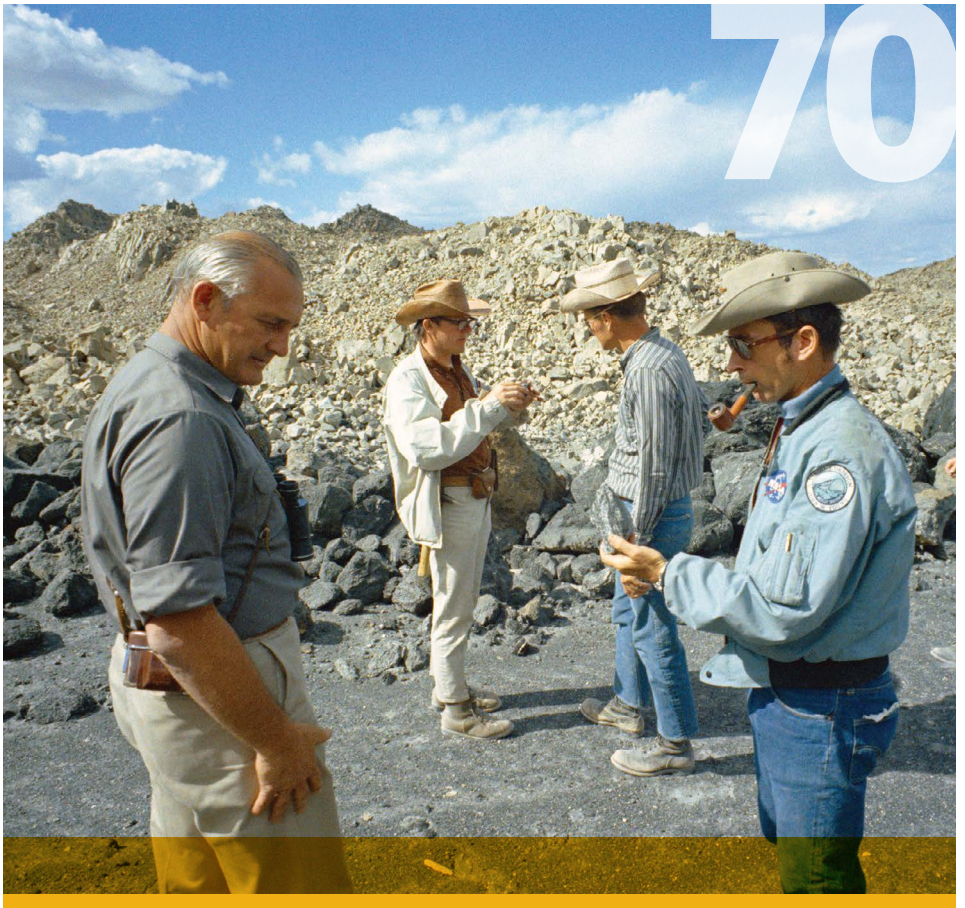
ON THE COVER: JACKSON SCHOOL ALUMNUS UEL CLANTON SUITED UP AND TESTING AN EARLY PROTOTYPE OF A DRILL USED BY APOLLO ASTRONAUTS ON THE MOON. PHOTO: NASA.



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The National Science Foundation-sponsored summit brought geosciences leaders in academia and industry together to discuss strategies for preparing geosciences graduate students for the future workforce.

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Texas Serengeti

Planetary Sciences & Geobiology

TOP TO BOTTOM: A WPA-ERA FOSSIL IN A FIELD JACKET WITH A RHINO SKULL; THE SKULL OF A SHOVEL-JAWED GOMPHOTHERE (PICTURED ON BOTTOM) STILL WRAPPED IN ITS FIELD JACKET; GLEN EVANS (LEFT), WHO MANAGED MUCH OF THE WORKS PROGRESS ADMINISTRATION'S EFFORT TO COLLECT TEXAS FOSSILS, CARRYING A FOSSIL IN A FIELD JACKET WITH A WORKER.

During the Great Depression, some unemployed Texans were put to work as fossil hunters. The workers retrieved tens of thousands of specimens that have been studied in small bits and pieces while stored in the state collections of The University of Texas at Austin for the past 80 years.

Now, decades after they were first collected, a UT researcher has studied and identified an extensive collection of fossils from dig sites near Beeville, Texas, and found that the fauna make up a veritable "Texas Serengeti"—with specimens including elephant-like animals, rhinos, alligators, antelopes, camels, 12 types of horses and several species of carnivores. In total, the fossil trove contains nearly 4,000 specimens representing 50 animal species, all of which roamed the Texas Gulf Coast 11 million to 12 million years ago.

A paper describing these fossils, their collection history and geologic setting was published April 11, 2019, in the journal *Palaeontologia Electronica*.

"It's the most representative collection of life from this time period of Earth history along the Texas Coastal Plain," said Steven May, the research associate at the UT Jackson School of Geosciences who studied the fossils and authored the paper.

In addition to shedding light on the inhabitants of an ancient Texas ecosystem, the collection is also valuable because of its fossil firsts. They include a new genus of gomphothere, an extinct relative of elephants with a shovel-like lower jaw; the oldest fossils of the American alligator; and an extinct relative of modern dogs.

The fossils came into the university's collection as part of the State-Wide Paleontologic-Mineralogic Survey that was funded by the Works Progress Administration (WPA), a federal program that provided work to millions of Americans during the Great Depression. From 1939 to 1941, the agency partnered with the UT Bureau of Economic Geology, which supervised the work and organized field units for collecting fossils and minerals across the state.

The survey found and excavated thousands of fossils from across Texas including four dig sites in Bee and Live Oak counties, with the majority of their finds housed in what is now the Texas Vertebrate Paleontology Collections at the Jackson School Museum of Earth History. May's paper is the first to study the entire fauna.

In order to account for gaps in the collection, May tracked down the original dig sites so he could screen for tiny fossils such as rodent teeth. One of the sites was on a ranch near Beeville owned by John Blackburn. Using aerial photography and notes from the WPA program stored in the university's archives, May and the research team were able to track down the exact spot of an original dig site.

"We're thrilled to be a part of something that was started in 1939," Blackburn said. "It's been a privilege to work with UT and the team involved, and we hope that the project can help bring additional research opportunities."

PHOTOS: JACKSON SCHOOL.

Earthquake Connection

Solid Earth & Tectonic Processes

Years before the devastating Tohoku earthquake struck the coast of Japan in 2011, the Earth's crust near the site of the quake was starting to stir. The proximity of the barely perceptible tremors raises a question: Could they have foreshadowed the big quake or even set it in motion?

This question is driving research into a computer model that is helping untangle the connection between the small shakes and the destruction that followed.

Researchers at The University of Texas at Austin are leading the work, which could help enhance scientists' understanding of forces driving megathrust earthquakes—the world's most powerful type of earthquake—and improve earthquake hazard assessment.

The study was published on Dec. 15, 2018, in *Earth and Planetary Science Letters*. Lead author Thorsten Becker, a professor at the UT Jackson School of Geosciences and a researcher at the University of Texas Institute for Geophysics, said the study was the first to show changes in tremor activity before the Tohoku megathrust earthquake.

"The part of the crust that is close to the place that eventually ruptured changes stress state a couple of years before the event," said Becker. "By demonstrating this, our work complements studies of crustal deformation and our understanding of the forces driving earthquakes."

While the location of the tremors raises questions about their potential linkage to the quake, Becker said that it's unknown at the moment if the two events relate. However, the seismic signature of the tremors is helping refine a computer model that could help answer that question. This new modeling technique allows scientists to create a four-dimensional image of the Earth's crust and interactions between tectonic plates, showing how forces pushing at the fault change over time.

Becker believes that with the right research and support, advanced computer models can be used to study the physics of earthquakes and perhaps contribute to improved forecasts. Currently, scientists can at best offer hazard maps showing known earthquake zones and a vague probability of an earthquake in the coming decades.

PHOTO: NOAA NATIONAL OCEAN SERVICE.

FRENCH FRIGATE SHOALS REEFSCAPE.

Corals Could go it Alone

Climate & Environment

The world's coral reefs are being drained of their color and their life due to conditions created by climate change. But if the future follows in the footsteps of the past, some corals will do fine in a warmer world. They're just not the type of corals you might expect.

Research from The University of Texas at Austin has found that corals with a solitary streak—preferring to live alone instead of in reef communities—fared better than their group-dwelling relatives during a period of warming in Earth's past that resembles climate change today.

The isolated lifestyles of these species could mean that coral ecosystems of the future could be bleak in comparison to the teeming reef communities of today.

"Although corals themselves might survive, if they're not building reefs, that's going to cause other problems within the ecosystem," said Anna Weiss, who led the research and recently earned a Ph.D. from the Jackson School of Geosciences. "Reefs support really big, diverse communities."

The corals themselves could be bleak too. Many of the surviving coral species hunt independently, rather than harboring and extracting nutrients from colorful algae that lend such breathtaking hues to reef corals.

The study examined coral species that lived about 56 million years ago during the transition of the late Paleocene to the Early Eocene, a time interval that lasted about 200,000 years and that included spikes in temperature and atmospheric carbon dioxide. The research was published in the journal *Paleoceanography and Paleoclimatology* on Jan. 21, 2019. Weiss co-authored the paper with her adviser Rowan Martindale, an assistant professor at the Jackson School's Department of Geological Sciences.

Fast Curves

THE REDSTONE RIVER OF ALASKA AND OXBOW LAKES.

PHOTO: NATIONAL PARK SERVICE, ALASKA REGION.

Surface & Hydrologic Processes

Left to their own devices and given enough time, rivers wander, eroding their banks and leaving their old channels behind. It's a behavior that engineers have to keep in mind when managing rivers or planning projects near them. But it turns out that the old methods for estimating migration rates may be overthinking it.

Researchers at the Jackson School of Geosciences' Bureau of Economic Geology have found that the rate of river migration is directly linked to the sharpness of its bends. It's a finding that challenges the prevailing wisdom on how river curvature and migration relate and shows that the relationship is not as complicated as previously thought, said Zoltán Sylvester, a research scientist at the bureau who led the study.

"When we look at the rivers we have studied, the sharper the bend, the tighter the bend, the faster it moves," he said. "It's a simple relationship."

The study involved tracking river migration in the Amazon Basin using satellite photos. The findings were published in the journal *Geology* on Feb. 6, 2019, and co-authored by Paul Durkin, an assistant professor at the University of Manitoba; and Jacob Covault, a research scientist at the bureau.

It is established science that the rate of river migration — how quickly parts of a river move across a landscape — is driven by the curvature of its bends. However, earlier research found that there was a cap on how much curvature could influence migration rate. According to these earlier findings, the maximum migration rate occurred along parts of the river where the radius of curvature of the bend is two to three times the width of a river.

In contrast, Sylvester and his team found that there is no cap. Instead, there appears to be a direct connection between river bend curvature and migration rate, with sharper bends causing a higher erosion rate — which is linked to a faster rate of migration. Another key finding is that the migration linked with the curvature occurs downstream from the bend itself — not exactly alongside as had often previously been considered.

The researchers used satellite data acquired by the Landsat program to reveal the connection between river bends and migration, with the images giving the researchers a bird's-eye view of hundreds of river bends along seven rivers in the Amazon Basin and how they migrated during the past 30 years. The researchers chose to focus on the rivers in the Amazon Basin because of their high migration rate and their location away from the interference of people or complicated geological settings.

SEDIMENT FLOWING FROM THE MISSISSIPPI RIVER INTO THE GULF OF MEXICO.

PHOTO: NASA EARTH OBSERVATORY.

Sediment Flip

Climate & Environment

The onset of the most recent ice age about 2.6 million years ago brought big changes to North America. Glaciers covered the northernmost regions of the land, tearing up rocks and soil as they heaved and creeped across the continent. The ice age affected the local climate, too, turning some places that were once wet and rainy into dry and arid expanses.

Researchers found that these changes completely flipped where the western Gulf of Mexico gets it sediments, reducing sediment production in southern Mexico and ramping it up along the catchment of the Mississippi River. The finding adds new insight into how extreme climate change can directly affect fundamental geological processes and how those effects play out across different environments.

The study was published Nov. 1, 2018, in the journal *Geology*. Angela Hessler, the director of the Deep Time Institute, led the research. It was co-authored by Jacob Covault, a research scientist at the Bureau of Economic Geology; Daniel Stockli, a professor in the Department of Geological Sciences; and Andrea Fildani, a scientist at the Equinor Research Center Austin.

The Gulf of Mexico has been catching sediments transported by rivers for about 200 million years. The layers of sediments that accumulate on the seafloor record information about the origin of the sediments and the erosive processes that lifted them from the rock. In this study, the scientists examined sediments deposited during the 20 million-year transition from the Miocene to the Pleistocene, when the Earth's climate transitioned from a relatively warm period to an ice age.

Based on the composition of the sediments, the researchers were able to determine that the primary supply of sediments during the middle-to-late Miocene came from rivers in southern Mexico, an area in the tropical highlands of Mexico covering about 300-by-500 kilometers. The sediments revealed that what the area lacked in size it made up for with highly erodible conditions, including a wet climate and tectonic activity.

But that environment changed with the global cooling of the Pleistocene, making the highlands dry and arid. And although tectonic activity continued, the lack of precipitation meant that the fresh bedrock and volcanic debris largely stayed in place. In what is now North America, large ice sheets started to form and erode rock as they flowed across the continent.

The study found that this extreme climate shift is reflected by a change in sediments. By the mid-Pleistocene, almost all the sediments in the Gulf of Mexico came from the north via the Mississippi River, which collected sediments from waterways that spanned the continent.

Life's Speed Limit

Planetary Sciences & Geobiology

Mass extinctions have decimated the diversity of life on Earth numerous times. Almost all ocean life was lost during the aptly named "Great Dying" 252 million years ago. And after an extinction was triggered by a massive asteroid strike 66 million years ago, the evolutionary tree of dinosaurs had been chopped down to a single branch: modern birds.

Nevertheless, after extinction,recovery begins. And no matter the circumstances of what caused the extinction, scientists have found that the recovery speed limit—the time it takes for species diversity to reach its pre-extinction heights—is about 10 million years.

What scientists didn't know was why.

Researchers at The University of Texas at Austin Jackson School of Geosciences have hunted the fossil record for answers. They found that evolution—specifically, how long it takes surviving species to evolve traits that can help fill open ecological niches or create new ones—could be behind the recovery speed limit.

The study, published April 8, 2019, in the journal *Nature Ecology & Evolution*, zeroed in on how microscopic life forms called forams recovered after Earth's most recent mass extinction (the one that snuffed out the dinosaurs). The asteroid impact that triggered the extinction is the only event in Earth's history that brought about global change faster than present-day climate change. So, the authors said the study could offer important insights on recovery from ongoing, human-caused extinction events.

The idea that evolution was behind the recovery speed limit was proposed 20 years ago, but this study is the first to find solid evidence for it in the fossil record. Foram fossils are prolific in ocean sediments around the world, allowing the researchers to closely study species diversity without any large gaps in time.

Lead author Christopher Lowery, a research associate at the University of Texas Institute for Geophysics, said that the team found a close association between foram complexity and the recovery speed limit, which points to evolution as the key factor behind the speed control.

"We see this in our study, but the implication should be that these same processes would be active in all other extinctions," Lowery said. "I think this is the likely explanation for the speed limit of recovery for everything."

THE LLANO RIVER FLOODING.

PHOTO: JONATHAN CUTRER.

Take It to the Bank

Surface & Hydrologic Processes

Massive, destructive floods such as those caused by Hurricane Harvey in 2017 are a stark reality in Texas, but so are prolonged ground-cracking droughts.

Ideally, there would be a way to capture water from rivers during storms and other high-flow times and save it for the dry times when it's needed. Researchers at the Jackson School's Bureau of Economic Geology have taken the first step to determining whether this will ever be possible by looking at how much water could be stored underground in depleted aquifers near the Texas coast.

The study, published May 10, 2019, in the journal *Environmental Research Letters*, quantified the amount of water flowing in major Texas rivers during heavy rains and found that there is enough room in coastal aquifers to store most of it. This discovery means that capturing and storing water could be a feasible option for partially mitigating floods and droughts, which are both expected to increase in frequency and intensity as the climate changes, said lead author Qian Yang, a research associate at the bureau.

The idea of capturing water and diverting it into naturally occurring, underground aquifers is not new. It is already being done in the Texas cities of El Paso, Kerrville and San Antonio. But skimming off water on a larger level would take a tremendous amount of new infrastructure and planning, said Bridget Scanlon, a bureau senior research scientist and the study's author.

"This study is the first step, but it looks like the water is worth going after," she said.

The water level in the aquifers along the Texas Gulf Coast has been declining over the years because of agricultural and municipal water use. This has left space that could store about 20 million acre-feet of water, almost as much as can be held in Lake Mead, the largest reservoir in the United States.

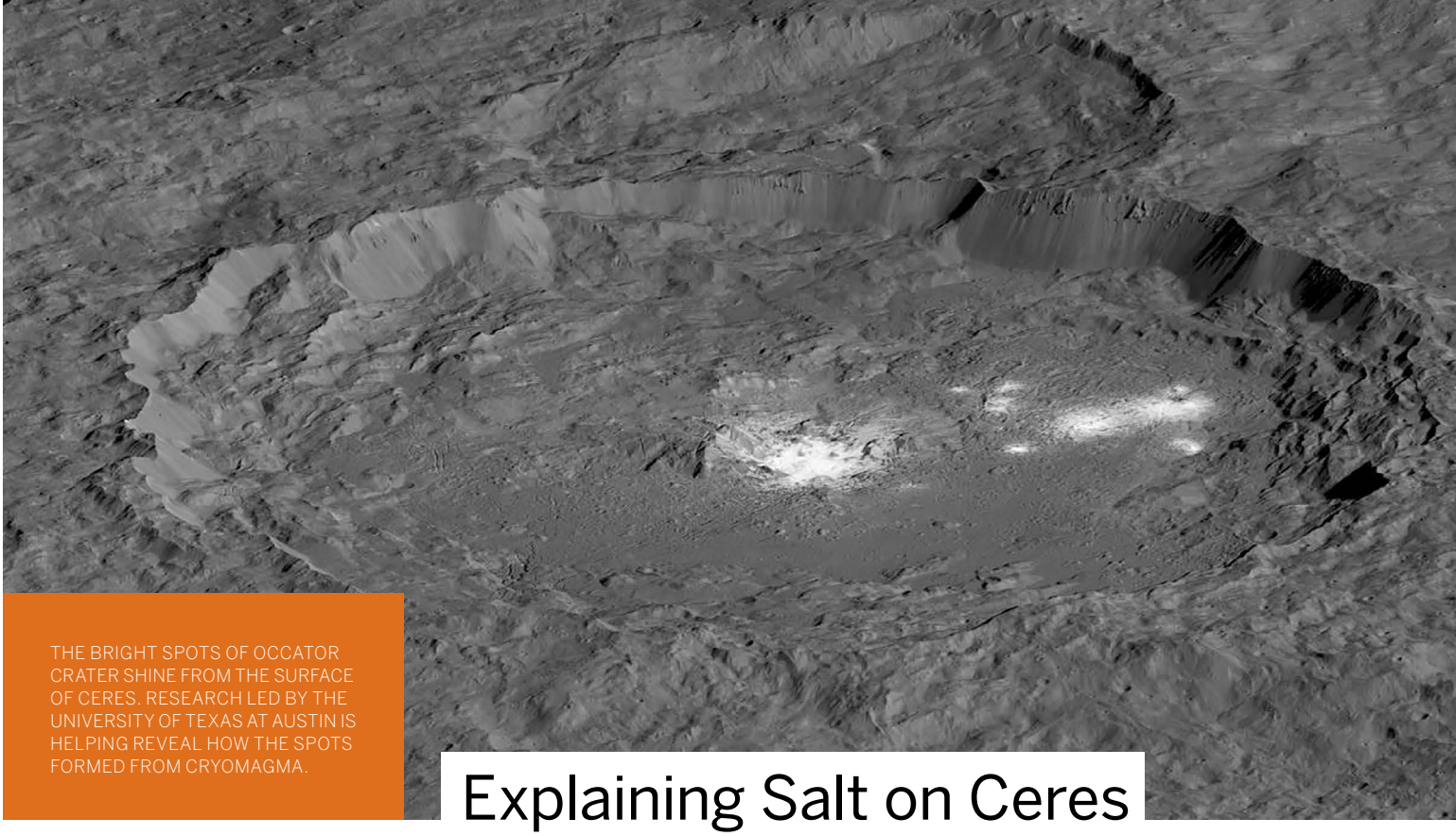
That's enough space to store about two-thirds of the water that flowed in Texas' 10 major rivers during high-flow events from 2015 through 2017, according to the study. The researchers differentiated high flow from normal flow by looking at daily average water volumes during the past 50 years and classifying flows that exceeded the 95th percentile as high magnitude.

Carbon Cooperation

Climate & Environment

The University of Texas at Austin is partnering with two Caribbean universities in Trinidad and Tobago to create a new clean industry that will store greenhouse gasses underground and eliminate the country's contribution to human-induced climate change.

The small, dual-island nation has strong incentives to mitigate climate change. The warm Caribbean Sea around the Delaware-size country is susceptible to sea level rise and tropical storms, both of which are expected to intensify as the world warms. In addition, although the oil and gas industry accounts for 40% of gross domestic product and 80% of exports, it has been declining in recent years, prompting interest in developing a new carbon storage industry to provide a source of jobs. And although the tiny country emits a relatively small amount of greenhouse



THE BRIGHT SPOTS OF OCCATOR CRATER SHINE FROM THE SURFACE OF CERES. RESEARCH LED BY THE UNIVERSITY OF TEXAS AT AUSTIN IS HELPING REVEAL HOW THE SPOTS FORMED FROM CRYOMAGMA.

PHOTO: NASA/JPL-CALTECH/UCLA/MPS/DLR/IDA.

Explaining Salt on Ceres

Planetary Sciences & Geobiology

Forged billions of years ago from rock and ice, the dwarf planet Ceres was thought to have no active geology. But pictures sent back from the NASA Dawn space probe changed that view when they showed bright, white spots of salt on the surface of the alien world.

The spots turned out to be remnants of cryomagma, salty water exuded by cryovolcanoes that tap into underground reservoirs and that could play a key role in mixing the ingredients for life on other worlds, such as Jupiter's moon Europa. And in the case of the spots at the bottom of Ceres' Occator Crater, they were much younger than the crater itself, only 4 million years old compared with 20 million years.

Research led by the UT Jackson School of Geosciences in partnership with NASA's Jet Propulsion Laboratory (JPL) delved into the factors that influenced the volcanic activity and formed the distinctive spots—and proposed an explanation for the age gap between the cryomagma and the crater.

Learning more about how these volcanoes work on Ceres could help scientists get a handle on the primary forces that drive their activity, said lead author Marc Hesse, an associate professor in the Department of Geological Sciences at the Jackson School.

"Cryovolcanism looks to be a really important system as we look for life," he said. "So, we're trying to understand these ice shells and how they behave."

The research was published Feb. 8, 2019, in the journal *Geophysical Research Letters*. The research was co-authored by Julie Castillo-Rogez, a planetary scientist at NASA's JPL.

At 585 miles across, Ceres is the largest planetary body in the asteroid belt between Mars and Jupiter. The presence of the bright spots suggests that heat and energy generated by asteroid impacts could jumpstart geology on Ceres, creating reservoirs of cryomagma that were then brought to the surface by conduits such as fractures. However, earlier research conducted by other scientists found that the conditions on Ceres would not allow for the cryomagma generated by the Occator Crater impact to flow for more than about 400,000 years.

The age discrepancy between the 4 million-year-old salt deposits and the 20 million-year-old impact didn't make sense. But Hesse and Castillo-Rogez were able to significantly extend the life of the cryomagma by including more up-to-date details on Ceres' crustal chemistry and physics.

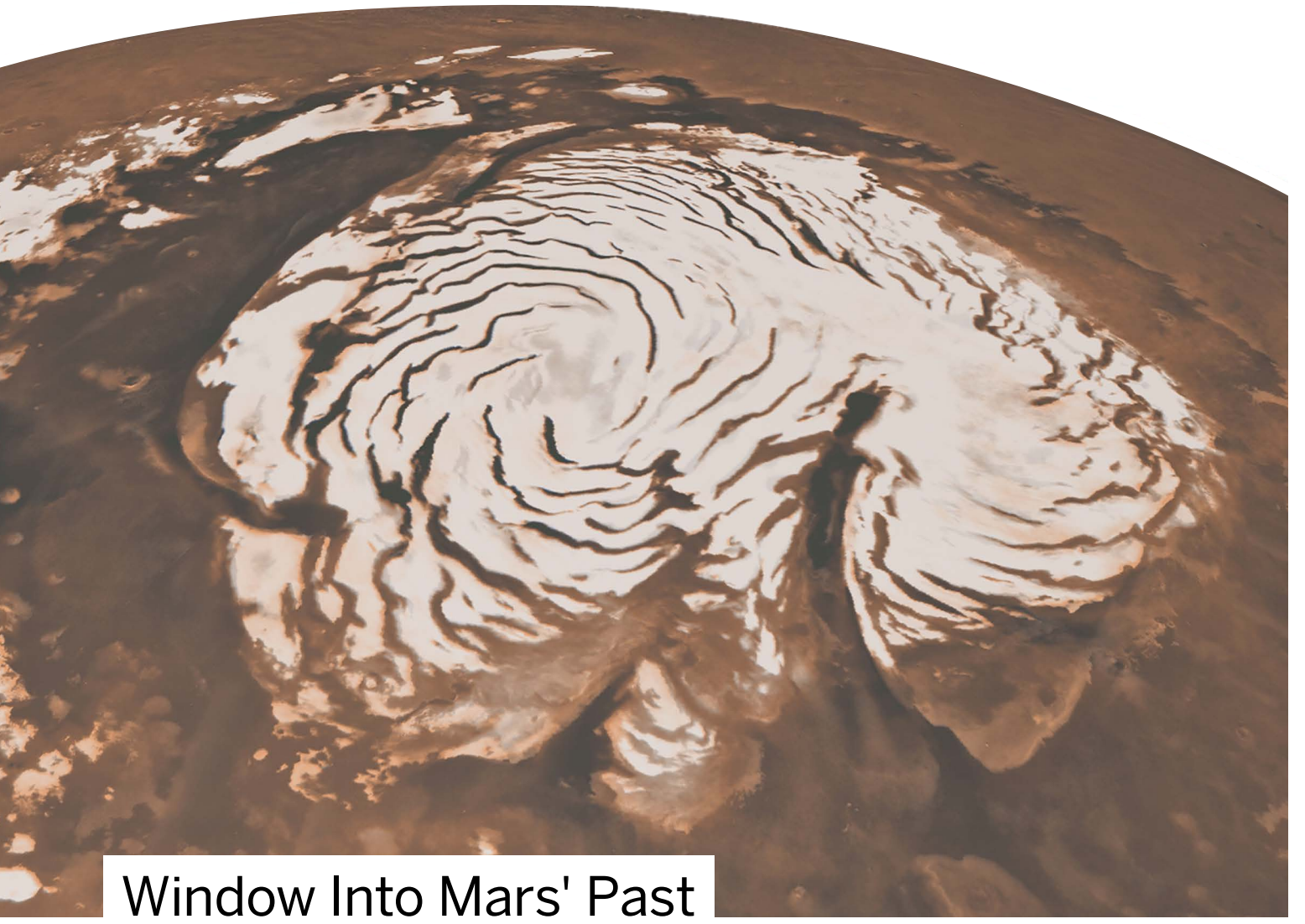
gasses compared with large nations, it is in the top 10 highest in per capita emissions globally due to its industrialized economy.

"For us, we've been declining in [oil and gas] production so rapidly that something needs to be done quickly to protect our economy," said David Alexander, a petroleum researcher at The University of Trinidad and Tobago. "Someone else may perceive this as a problem, but really it's not—it's an opportunity."

UT is partnering with The University of Trinidad and Tobago and The University of the West Indies on the new effort.

"By setting a precedent for what's possible in an international collaboration on climate change mitigation, we hope others will be inspired to follow our footsteps," said Katherine Romanak, a research scientist with the UT Bureau of Economic Geology's Gulf Coast Carbon Center.

In February and April, the universities signed two memoranda of understanding that laid out plans for organizing scientific meetings and workshops and sharing facilities, with the goal of deploying carbon capture and geologic storage technology in Trinidad and Tobago.



Window Into Mars' Past

Planetary Sciences & Geobiology

Newly discovered layers of ice buried a mile beneath Mars' north pole are the remnants of ancient polar ice sheets and could be one of the largest water reservoirs on the planet, according to scientists at The University of Texas at Austin and the University of Arizona.

The team made the discovery using measurements gathered by the Shallow Radar (SHARAD) on NASA's Mars Reconnaissance Orbiter (MRO). SHARAD emits radar waves that can penetrate up to a mile and a half beneath the surface of Mars.

The findings, published May 22, 2019, in *Geophysical Research Letters*, are important because the layers of ice are a record of past climate on Mars. Studying their geometry and composition could reveal whether climate conditions were previously favorable for life, researchers said.

The team found layers of sand and ice that were as much as 90% water. If melted, the newly discovered ice would cover Mars with a global ocean at least 1.5 meters (5 feet) deep.

"We didn't expect to find this much water ice here," said lead author Stefano Nerozzi, a graduate research assistant at the University of Texas Institute for Geophysics (UTIG) who is completing a Ph.D. at the Jackson School of Geosciences. "That likely makes it the third largest water reservoir on Mars after the polar ice caps."

The authors think that the layers formed when ice accumulated at the poles during past ice ages on Mars. Each time the planet warmed, a remnant of the ice caps became covered by sand, which protected the ice from solar radiation and prevented it from dissipating into the atmosphere.

Scientists have long known about glacial events on Mars, which are driven by variations in the planet's orbit and tilt. Until now, scientists thought that the ancient ice caps were lost. The paper shows that in fact significant ice sheet remnants have survived under the planet's surface, trapped in alternating bands of ice and sand, like layers on a cake.

Co-author Jack Holt was a UTIG scientist and research professor for 19 years before joining the University of Arizona in 2018. He has been a co-investigator with SHARAD since it started orbiting Mars in 2006.

PHOTO: NASA/JPL-CALTECH/MSSS.

Bursting the Dam

Planetary Sciences & Geobiology

Today, most of the water on Mars is locked away in frozen ice caps. But billions of years ago it flowed freely across the surface, forming rushing rivers that emptied into craters. Research led by The University of Texas at Austin has found evidence that sometimes these crater lakes would take on so much water that they overflowed and burst from the sides of their basins, creating catastrophic floods that carved canyons very rapidly, perhaps in a matter of weeks.

The findings suggest that catastrophic geologic processes may have extensively shaped the landscape of Mars and other worlds that lack plate tectonics, said lead author Tim Goudge, an assistant professor in the Department of Geological Sciences at the Jackson School of Geosciences.

"These breached lakes are fairly common and some of them are quite large, some as large as the Caspian Sea," said Goudge. "So, we think this style of catastrophic overflow flooding and rapid incision of outlet canyons was probably quite important on early Mars' surface."

The research was published Nov. 16, 2018, in the journal *Geology*. Co-authors include NASA scientist Caleb Fassett and Jackson School Professor and Associate Dean of Research David Mohrig.

From studying rock formations in satellite images, scientists know that hundreds of craters across the surface of Mars were once filled with water. More than 200 of these "paleolakes" have outlet canyons carved by water that are tens to hundreds-of-kilometers long.

However, until this study, it was unknown whether the canyons were carved over millions of years or rapidly by single floods.

Using high-resolution photos taken by NASA's Mars Reconnaissance Orbiter, the researchers examined 24 paleolakes and the topography of the outlets and the crater rims. They found a correlation between the size of an outlet and the volume of water expected to be released during a large flooding event. If the outlets had instead been gradually whittled away over time, the relationship between water volume and outlet size probably would not have held.

A similar process occurs on Earth when lakes dammed by glaciers break through their icy barriers. And whether on Earth or Mars, floods create outlets with similar shapes, the researchers found.

"This tells us that things that are different between the planets are not as important as the basic physics," Goudge said.

The Perfect Spot

Planetary Sciences & Geobiology

For four years, Tim Goudge made the case to send an upcoming Mars mission to Jezero Crater. On Nov. 19, 2018, NASA announced that the crater—the site of a former lake and river delta—will be the landing site for their Mars 2020 rover mission to look for signs of past life.

"It's very exciting," said Goudge, an assistant professor in the Department of Geological Sciences at the Jackson School. "This outcrop is one of the best exposures of a river delta that we have on Mars and it allows us an opportunity to study the record of river sediment deposition."

NASA considered more than 60 candidate locations across the Red Planet before announcing Jezero as the winner during a public teleconference.

Jezero is a 28-mile-wide impact crater on the western edge of Isidis Planitia, a plain in a large impact basin just north of the Martian equator. Today, Jezero is an empty basin. But billions of years ago, flowing liquid water emptied into the crater. The sediment deposited by the river could preserve signs of life that might have called Jezero home eons ago. It's the goal of the Mars 2020 mission to seek out those signs in rock and soil samples and store them so they eventually can be brought to Earth.

Goudge's research focuses on how rivers and lakes modify landscapes on planetary bodies—including Earth and Mars. He proposed Jezero Crater as a landing site for the Mars 2020 mission in 2014, when he was a graduate student at Brown University. As the lead advocate for Jezero throughout the process, he presented research about Jezero at the first two NASA workshops assessing potential landing sites. By the final two workshops, a team of scientists had joined Goudge in making the case for the crater.

Goudge hopes to play a role in the Mars 2020 mission, with NASA planning to issue a call for mission experts at a later date.

OPPOSITE PAGE: AN ORBITAL VIEW OF THE NORTH POLAR REGION OF MARS.

ABOVE: AN ARTIST'S INTERPRETATION OF THE SKY-CRANE MANEUVER DURING THE DESCENT OF NASA'S CURIOSITY ROVER TO THE MARTIAN SURFACE. THE MARS MISSION, LAUNCHING IN 2020, WOULD LEVERAGE THE DESIGN OF THIS LANDING SYSTEM AND OTHER ASPECTS OF THE MARS SCIENCE LABORATORY ARCHITECTURE.

PHOTO: NASA/JPL-CALTECH.

AN ARTIST'S INTERPRETATION OF A GIANT, NOCTURNAL ELEPHANT BIRD FORAGING IN THE ANCIENT FORESTS OF MADAGASCAR AT NIGHT.

Big and Blind

Planetary Sciences & Geobiology

If you encountered an elephant bird today, it would be hard to miss. Measuring in at more than 10 feet tall, the extinct avian is the largest bird known to science. However, while you looked up in awe, it's likely that the big bird would not be looking back.

According to brain reconstruction research led by The University of Texas at Austin, the part of the elephant bird's brain that processed vision was tiny, a trait that indicates they were nocturnal and possibly blind. The findings were published Oct. 31, 2018, in the journal *Proceedings of the Royal Society B.*

A nocturnal lifestyle is a trait shared by the elephant bird's closest living relative, the kiwi—a practically blind, chicken-size denizen of New Zealand—and a clue that is helping scientists learn more about the elephant bird's behavior and habitat, said Christopher Torres, a Ph.D. candidate who led the research.

"Studying brain shape is a really useful way of connecting ecology—the relationship between the bird and the environment—and anatomy," Torres said. "Discoveries like these give us tremendous insights into the lives of these bizarre and poorly understood birds."

Julia Clarke, a professor in the Department of Geological Sciences at the Jackson School of Geosciences and Torres' Ph.D. adviser, co-authored the study. Torres is a student in the UT College of Natural Sciences.

Elephant birds were large, flightless and lived in what is now Madagascar until a mixture of habitat loss and potential human meddling led to their demise between 500 and 1,000 years ago.

Scientists had previously assumed that elephant birds were similar to other big, flightless birds, such as emus and ostriches—both of which are active during the day and have good eyesight. But Torres and Clarke revealed that elephant birds had distinctly different lifestyles by reconstructing their brains using CT-imaging data of two elephant bird skulls.

In both elephant bird skulls, the optic lobe, a bundle of brain nerves that controls eyesight, was very small, with the structure almost absent in the larger species. The lobe had the most in common with that of a kiwi, which has poor vision and is nocturnal.

"As recently as 500 years ago, very nearly blind, giant flightless birds were crashing around the forests of Madagascar in the dark," Clarke said. "No one ever expected that."

PHOTO: JOHN MAISANO/JACKSON SCHOOL.

Seismic Water

Energy Geosciences

In addition to producing oil and gas, the energy industry produces a lot of water: about 10 barrels of water per barrel of oil on average. New research led by The University of Texas at Austin has found that where the produced water is stored underground influences the risk of induced earthquakes.

Beyond supporting the link between water disposal and induced seismicity, the research also describes factors that can help reduce earthquake risk.

"If we want to manage seismicity, we really need to understand the controls," said lead author Bridget Scanlon, a senior research scientist at UT's Bureau of Economic Geology.

The research was published Oct. 31, 2018, in the journal *Seismological Research Letters*. Co-authors include Matthew Weingarten, assistant professor at San Diego State University; Kyle Murray, adjunct professor at the University of Oklahoma; and Robert Reedy, research scientist associate at the Bureau of Economic Geology.

The researchers found that the increased pressure that is caused by storing produced water inside geologic formations raises the risk of induced seismicity. The risk increases with the volume of water injected and the rate of injection, both at the well and regional scale.

Researchers specifically looked at water stored near tight oil plays, including the Bakken, Eagle Ford and Permian shale plays, and Oklahoma overall, which has high levels of induced seismicity in concentrated areas. The study found that, overall in Oklahoma, 56% of disposal wells are potentially associated with earthquakes. The next highest is the Eagle Ford Shale, where 20% of wells are potentially associated with earthquakes.

The study reported that the levels of induced seismic activity relate to, among other reasons, how the water is managed and where it is stored. In Oklahoma, the tendency to store water in deep geologic formations has increased the risk. In the other areas, water is stored at shallower depths, which limits exposure to potentially risky faults.

The findings are consistent with directives issued by the Oklahoma Corporation Commission in 2015 to mitigate seismicity, including to reduce injection rates and regional injection volumes by 40% in deep wells. This study confirmed the changes resulted in 70% fewer earthquakes over a magnitude 3.0 in 2017 compared with the peak year of 2015.

This shows that subsurface management practices can influence seismic risk. However, Scanlon said there can be trade-offs. For example, shallow disposal may help lower the risk of earthquakes, but it could increase the risk of the produced water contaminating overlying aquifers.

"There's no free lunch," Scanlon said. "You keep iterating and doing things, but you must keep watching to see what's happening."

New Tech Behind Gas Boost

Energy Geosciences

Advances in drilling technology are behind a 20% boost in the amount of natural gas recoverable from future well locations in the nation's major shale plays, according to an analysis led by The University of Texas at Austin's Bureau of Economic Geology released in December 2018.

The analysis, which takes into account ongoing drilling that is using up natural gas reserves, is an update on a similar study led by the bureau from 2011 to 2014, which was the most comprehensive report on unconventional resources publicly available at the time.

Svetlana Ikonnikova, the principal investigator of the study and a research scientist at the bureau, said that developments in drilling technologies, market conditions, cost structures and improvement in geological characterization prompted the research team to update the assessment.

"Five years ago, we hardly thought of multilayer or stacked-well drilling, or of quadrupling lateral well length," she said, referring to drilling innovations that have expanded production.

The analysis looked into the production capabilities and the total gas in place at four of the country's top natural gas fields: the Barnett, Fayetteville, Haynesville and Marcellus plays.

The team used 3D modeling and advanced data analytics to enhance the understanding of:

- Geologic reservoir characterization;
- Individual well decline and recovery analysis;
- Individual well geology and engineering improvements that increase productivity; and,
- Economically recoverable resource assessment.

The researchers found that future wells in the four shale gas plays can technically recover about 780 trillion cubic feet (Tcf) of natural gas, in addition to about 110 Tcf of gas already recovered by wells drilled by the end 2017. ("Technically recoverable" gas can be produced using currently available technology and industry practices.) That estimate was about 650 Tcf in the prior study. The United States consumed about 27 Tcf of natural gas in 2017. So, the new estimate suggests the addition of about five years of domestic consumption.

In the study, for the base case scenario, researchers assumed a natural gas price of $3.25 per million British thermal units and an oil price of $65 per barrel. Even with the boost in production, the analysis shows production will plateau around 2030, barring a more dramatic price increase or boost in technology.

The study was funded by the U.S. Department of Energy National Energy Technology Laboratory.

Potential for Quakes in DFW

Energy Geosciences

Though stable now, the geologic faults that pass through the Fort Worth Basin are sensitive to changes that could generate earthquakes, according to research from the Jackson School's Bureau of Economic Geology, Stanford University and Southern Methodist University (SMU).

The study, which was published July 23, 2019, in the *Bulletin of the Seismological Society of America*, found that wastewater injection, if not managed properly, could influence how susceptible faults are to slip and cause the majority of the faults in the region to be just as susceptible to producing earthquakes as faults that have already done so.

"That means the whole system of faults is sensitive," said lead author Peter Hennings, a bureau research scientist and the principal investigator at the Center for Integrated Seismicity Research (CISR).

The study also includes a comprehensive map of more than 250 faults totaling more than 1,800 miles in combined length, some of which extend under highly populated areas in the Dallas-Fort Worth region.

The Fort Worth Basin saw a major increase in seismic activity from 2008 to 2015 as oil and gas operations increased, but a significant reduction in earthquakes during the past four years as injection has slowed. Hennings said that people should be aware that the nature of the fault system means that many areas are susceptible to potentially hosting earthquakes, and that an upturn in oil and gas production that results in increased deep wastewater disposal could also bring an upturn in quakes if not properly managed.

SMU professor and study co-author Heather DeShon pointed out that the strongest earthquakes in the area have been magnitude 4, which is much less powerful than the major earthquakes that hit California in July, but she said that the region needs to prepare for the hazard.

"This study provides key information to allow the public, cities, state, the federal government and industry to understand potential hazards and to design effective public policies, regulations and mitigation strategies," she said.

The team also created maps that show the sensitivity of the faults. One shows that the faults in their natural geologic condition are relatively stable and not expected to slip if left undisturbed. Another map shows the impact of general pressure to the subsurface caused by wastewater disposal and reveals that it significantly increases the likelihood for faults to slip.

"Industrial activities can increase the probability of triggering earthquakes before they would happen naturally, but there are steps we can take to reduce that probability," said co-author Jens-Erik Lund Snee, a doctoral candidate at Stanford University.

Stanford professor and co-author Mark Zoback added that although this research focused on the Dallas-Fort Worth region, it creates a roadmap for those interested in investigating earthquake potential in other regions.

"The methodology could be used in other areas where induced seismicity is of concern but development activities are just beginning, making it possible to identify potentially problematic faults before induced seismicity occurs," Zoback said. "So, it creates a framework for making decisions in the future."

CISR and the TexNet Seismological Network, managed by the bureau at the UT Jackson School of Geosciences, played a key role in the research. TexNet is a collection of seismometers across Texas that was authorized and funded by the Texas Legislature and Gov. Greg Abbott. It has been tracking seismic activity across the state since January 2017.

The study found that the Fort Worth Basin is full of faults, many of which are small in size, yet susceptible to slipping. Most are less than 6 miles long—a fact that underscores the importance in studying the area in detail using high-resolution data.

"Most of the faults that have slipped are too small to have been previously recognized; they're very difficult to find," Hennings said. "We certainly haven't identified all of the faults in the region, but this new work is a big improvement compared to what was previously available."

ABOVE: TEXNET SEISMOMETERS PLACED THROUGHOUT THE STATE, LIKE THIS ONE IN DALLAS, MONITOR SEISMIC ACTIVITY ACROSS TEXAS.

PHOTO: JACKSON SCHOOL.

A CORE SAMPLE OF SAND. THE RESEARCHERS ARE USING THE CORES TO TRACK THE EXTENT OF THE ANCIENT TRINITY RIVER SYSTEM OFFSHORE OF GALVESTON.

PHOTO: JACKSON SCHOOL.

Hunting for Sand

Marine Geosciences

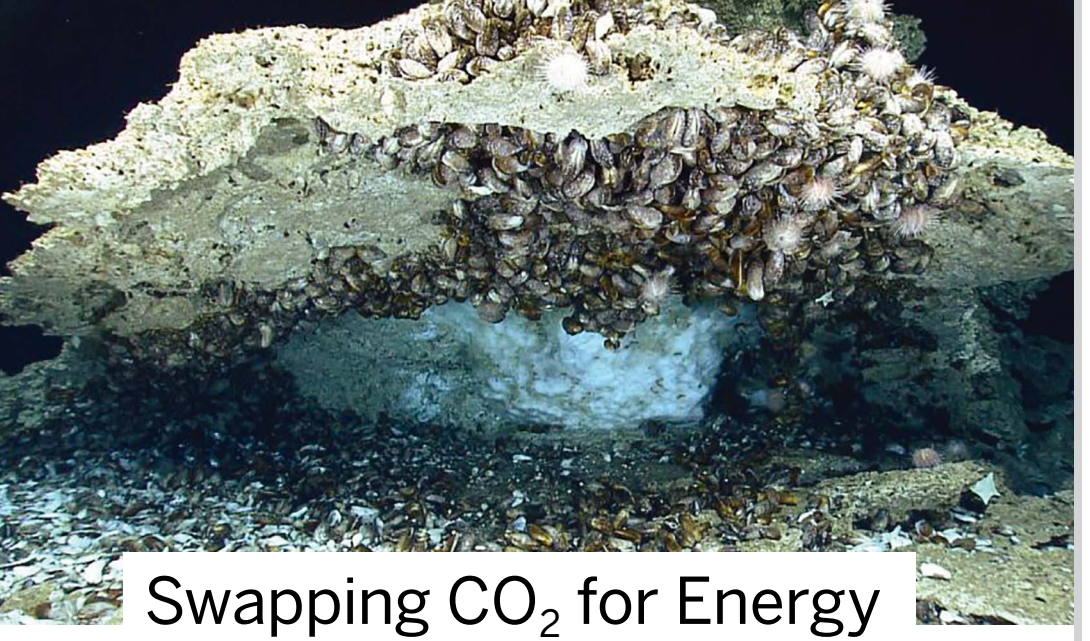
Sand is in the concrete that holds up our buildings and lines our roads. It's in the screens of our phones and the glass of our windows. And billions of tons of it are used to protect coastal communities from erosion, sea level rise and the impact of major storms. But you can't just use any old sand. It's imperative that grain size fits the project at hand.

Ongoing research led by the University of Texas Institute for Geophysics (UTIG) is helping the state to better understand its sand resources by taking inventory of the sand in ancient river valleys that are now buried below the seafloor offshore of Galveston. When sea level was lower, sands were deposited in these valleys by meandering rivers, and then buried and preserved by bay muds as sea level rose. These deposits represent a very large potential resource of commercially and environmentally useful sand.

The project is funded by the Bureau of Ocean Energy Management. The UTIG researchers leading the project are Senior Research Scientist John Goff, Research Professor Sean Gulick and Research Associate Christopher Lowery. The goal of their research is to develop an inventory of the location, character and quantity of the sand resources found in these valleys.

"It's harder to find these things when they're not just sitting on the sea floor," Lowery said. "So, we go out and survey and actually map them."

Their most recent surveys have focused on the sand deposited long ago by the Trinity River. UTIG scientists are using seismic surveys and core samples to locate the extent of the ancient river system and estimate the volume and type of sand it holds. As part of the project, UTIG has teamed up with Jackson School alumnus Bobby Reece, who is now an assistant professor at Texas A&M University, to test a prototype seismic imaging device called SPARKER that is specially designed to map the base of the river valley. If SPARKER works, the team plans on partnering with Reece to map other rivers in Texas.



Swapping CO_2 for Energy

Energy Geosciences

Climate change and energy supply are two of the biggest challenges humans are facing. A new approach for extracting natural gas that also traps carbon dioxide deep underground in the process could help on both fronts.

The approach was developed by researchers at The University of Texas at Austin and works by injecting air and carbon dioxide (CO_2) into methane ice deposits. This triggers a process in which nitrogen in the injected air sweeps the methane toward a production well. The carbon dioxide replaces the departed methane.

A study published June 27, 2019, in the journal *Water Resources Research* used computer models to simulate the chemical swap, which could help unlock vast natural gas energy deposits locked away in deposits of methane hydrate—an ice-like, water-rich chemical compound that forms naturally in high-pressure, low-temperature environments, such as deep in the Gulf of Mexico and under Arctic permafrost.

"Our study shows that you can store carbon dioxide in hydrates and produce energy at the same time," said lead author Kris Darnell, a recent doctoral graduate from the UT Jackson School of Geosciences.

This is not the first time that hydrate deposits have been proposed for carbon dioxide storage. Earlier attempts either failed or produced lackluster results. The new study breaks down the physics behind the process to reveal why previous attempts failed and how to get it right.

The next step, said Darnell, is to test their findings in a lab. The Jackson School and the UT Hildebrand Department of Petroleum and Geosystems Engineering are currently testing the method in a specialized facility in the Jackson School, which is one of the few in the world that can store and test methane hydrate. This work is being led by Peter Flemings, a Jackson School professor and senior research scientist at the Institute for Geophysics, and David DiCarlo, a professor in the Hildebrand Department.

"Two things are really cool. First, we can produce natural gas to generate energy and sequester CO_2," said Flemings. "Second, by swapping the methane hydrate with CO_2 hydrate, we disturb the [geologic] formation less, lowering the environmental impact, and we make the process energetically more efficient."

If the process can be shown to work in the field on an industrial scale, it has enormous potential. Estimates suggest that methane harvested from hydrate deposits found beneath the Gulf of Mexico alone could power the country for hundreds of years.

The computer simulations indicate that the process can be repeated with increasing concentrations of carbon dioxide until the reservoir becomes saturated. The authors said that, unlike some methods of carbon storage, this provides a ready incentive for industry to begin storing carbon dioxide, a major driver of climate change.

"We're now openly inviting the entire scientific community to go out and use what we're learning to move the ball forward," Flemings said.

Stored Carbon Staying Put

Marine Geosciences

A carbon capture and storage site off the coast of Tomakomai, Japan, has been keeping carbon dioxide out of the atmosphere by injecting it deep into the seafloor for storage.

But ever since injection began about three years ago, a big question has remained: Was the greenhouse gas trapped for good? Or could it quietly be leaking back into the atmosphere where it could contribute to climate change?

Researchers from The University of Texas at Austin have answered that question, finding that the carbon dioxide is stored safely and securely. Their work relied on a pioneering 3D seismic technology that renders the subterranean seafloor in fine detail.

"This is the first time that high-resolution 3D seismic technology has been deployed over an active offshore injection site," said Tip Meckel, a geologist at the Bureau of Economic Geology at the UT Jackson School of Geosciences. "Nobody has done that before. So that's a big success in and of itself."

The findings were published in print in the September issue of *International Journal of Greenhouse Gas Control*.

The Tomakomai site in northern Japan is a large-scale test project that stores carbon from a nearby refinery under the seafloor. Scientists from the bureau's Gulf Coast Carbon Center (GCCC) were brought into the project through a partnership with the U.S. Department of Energy.

The Tomakomai site already has monitoring systems in place, but none that can give a crisp picture of what is going on underground like the method used by Meckel. The P-cable system used

ABOVE: GAS HYDRATES, SHOWN HERE ON THE GULF OF MEXICO FLOOR, ARE AN ICE-LIKE MATERIAL THAT FORM NATURALLY UNDER EXTREME PRESSURE IN LOW TEMPERATURE ENVIRONMENTS WHERE WATER IS ABUNDANT.

PHOTO: NOAA.

by Meckel and other researchers at the GCCC can reveal geologic features, such as large faults that could leak from about a mile under the seabed to the surface. This technology can also help scientists select sites that are best for future carbon capture projects by ensuring that the rock above the injection zone will act as a trap, keeping the fluids contained.

To Meckel's knowledge, UT is the first and only university in North America to conduct research on P-cable technology. The bureau acquired the $2.5 million system with help from a Department of Energy grant in 2012. Meckel tested the technology during several surveys off the shore of Texas before deploying it off the coast of Japan. The near-offshore Gulf of Mexico is geologically similar to that at Tomakomai and has been a target for scientists who study the subsurface to find sites with high potential for safe carbon dioxide storage. The proximity of Texas' oil and gas operations to the Gulf of Mexico also creates a great opportunity for carbon capture and storage.

"The Gulf of Mexico region is a hot spot for potential carbon management, with some of the nation's leading researchers and infrastructure," said Jerry Carr, study project manager at the National Energy Technology Laboratory of the U.S. Department of Energy. "By leveraging the bureau's history of successful international collaboration with Japanese counterparts, and this technology now successfully demonstrated, the Department of Energy has more diagnostic tools available to support the potential of offshore carbon mitigation in the U.S."

Tracking Flat Slabs in Colombia

Solid Earth & Tectonic Processes

A flat slab is a tectonic plate that does subduction a bit differently than usual. It descends to depths of about 30 to 60 miles before flattening out and traveling horizontally for hundreds of miles before descending farther into the Earth's mantle. This is in contrast to standard subduction, which involves a plate diving directly beneath another plate.

A $2.7 million NSF-Frontiers of Earth Science grant has been awarded to a team of researchers including the Jackson School's Brian Horton and Thorsten Becker to study an active flat slab in Colombia. The co-principal investigators include Lara Wagner of Carnegie Mellon University and Christy Till of Arizona State University.

Flat slabs traveling horizontally and directly beneath the overriding continents leads to extensive effects on the continental crust, including mountain building far from plate boundaries, ore formation and geochemical modifications that can affect the long-term stability of the overriding plate. Furthermore, large earthquakes within flat slabs, such as the magnitude 7.1 Mexico City earthquake that occurred in 2017 or the magnitude 8.0 earthquake in Peru that occurred in May 2019, can cause extensive damage in areas where earthquakes are uncommon and local communities less prepared.

Unlike previously studied flat slabs, the Colombian flat slab has broken into two parts, one of which has recently sunk back into the mantle to resume a normal subduction geometry. By comparing the still-existing flat slab region to the newly sunken flat slab region, the researchers will be able to study the initial migration and cessation of volcanism, the development of modern analogues to the Rocky Mountains (called basement cored uplifts), the formation of ore deposits, and ultimately, the return to normal arc volcanism—the complete flat slab cycle.

The grant will fund a 70-station, two-year seismic deployment across much of central Colombia, as well as an education and outreach program that will take teachers from Washington, D.C., Austin and Phoenix into the field, and help them prepare bilingual educational lessons, multimedia and web materials on the Earth sciences.

BELOW: THE FLAT SLAB SUBDUCTION PROCESS, IN WHICH A TECTONIC PLATE FLATTENS AND TRAVELS HORIZONTALLY FOR HUNDREDS OF MILES BEFORE DESCENDING FARTHER INTO EARTH'S MANTLE.

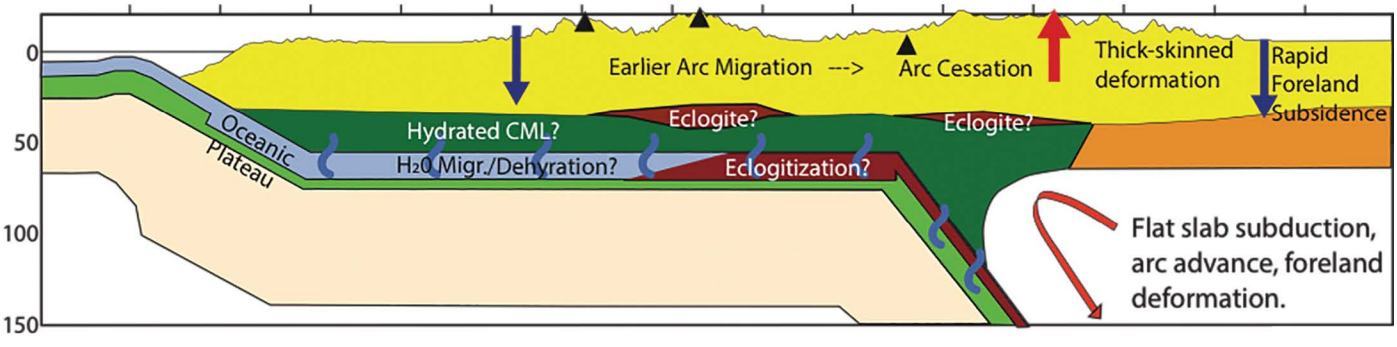


PHOTO: LARA WAGNER/CARNEGIE INSTITUTION FOR SCIENCE.

Drilling Hazard

Energy Geosciences

A study from the UT Jackson School of Geosciences is the first published in a scientific journal to take an in-depth look at the challenging geologic conditions faced by the crew of the Deepwater Horizon drilling rig and the role those conditions played in the 2010 disaster.

The well blowout killed 11 people and spewed oil for three months, spilling about 4 million barrels of oil into the Gulf of Mexico before crews successfully capped the well. Researchers and investigators since then have focused mostly on the engineering decisions and mistakes that led to the blowout and the ecological effects of the oil spill. But researchers from the Jackson School, aided by thousands of pages of documents made public during lawsuits and legal proceedings, have pieced together how the geologic conditions more than 2 miles under the Gulf floor made drilling difficult and drove engineering decisions that contributed to the well's failure and the ensuing blowout.

The study, published May 7, 2019, in *Scientific Reports*, documents, among other things, a significant and steep drop in pore pressure inside the rock near the bottom of the well that influenced the decisions that contributed to the blowout.

"The paper tells the geological story behind the catastrophe," said Will Pinkston, who authored the paper while earning a master's degree at the Jackson School. "It is high impact science, and I'm excited to reach a wider audience."

In the case of the Transocean Deepwater Horizon drilling rig, which was operated by the BP energy company at the time, the pore pressure was very high throughout the well, but dropped abruptly by about 1,200 pounds per square inch near the bottom. Most of the pore pressure drop occurred in the 100 feet above the reservoir target of 18,000 feet below sea level.

BP planned to temporarily abandon the oil, plugging the well base with steel and cement until it could be produced at a later date. However, the sharp drop in pore pressure, and an associated decline in stress, drastically narrowed the range of options to seal off the well. This led to the decision to use a controversial low-density foam cement that failed to set properly. This was a key cause of the blowout.

"The bottom line is that the geological conditions led to a decision to use a specialized cement that failed," said Peter Flemings, a Jackson School professor and senior research scientist at the Institute for Geophysics and study author. "This decision was a root cause of the ultimate blowout."

Flemings was a member of the Deepwater Horizon well integrity team assembled to help respond to the disaster by then-U.S. Energy Secretary Steven Chu.

The paper also maps geologic conditions across the entire subterranean basin to show that the pressure drop was not a unique event in that area. And although the paper does not pinpoint any single reason for the catastrophe, Flemings said it offers important information for the larger drilling community.

"One of the significant things about this paper is to get all the data on the table so that the general community can understand the decisions that were made," he said.

ABOVE: A NEW STUDY FROM THE UT JACKSON SCHOOL OF GEOSCIENCES LOOKS AT THE COMPLEX GEOLOGY THAT CONTRIBUTED TO THE DEEPWATER HORIZON DISASTER.

PHOTO: U.S. COAST GUARD.

Sediment Accelerates Plates

Solid Earth & Tectonic Processes

A new study by The University of Texas at Austin has demonstrated a possible link between life on Earth and the movement of continents. The findings show that sediment, which is often composed from pieces of dead organisms, could play a key role in determining the speed of continental drift. In addition to challenging existing ideas about how plates interact, the findings are important because they describe potential feedback mechanisms between tectonic movement, climate and life on Earth.

The study, published Nov. 15, 2018, in *Earth and Planetary Science Letters*, describes how sediment subducting beneath tectonic plates could regulate the movement of the plates and may even play a role in the rapid rise of mountain ranges and growth of continental crust.

The research was led by Whitney Behr, a research fellow at the Jackson School and professor at ETH Zurich in Switzerland, and co-authored by Thorsten Becker, a professor and Shell Chair in Geophysics in the Department of Geological Sciences and the Institute for Geophysics (UTIG).

Sediment entering subduction zones has long been known to influence geological activity such as the frequency of earthquakes, but until now, it was thought to have little influence on continental movement. That's because the speed of subduction was thought to be dependent on the strength of the subducting plate as it bends and slides into the viscous mantle. However, prior research involving UTIG scientists had shown the subducting plates may be weaker and more sensitive to other influences than previously thought. Subsequent modelling showed that rock made of sediment can create a lubricating effect between plates, accelerating subduction and plate velocity.

This mechanism could set in motion a complex feedback loop. As plate velocity increases, sediment would have less time to accumulate. This would lead to slower subduction, which might allow for mountains to grow at plate boundaries as the force of the two plates running into each other causes uplift. In turn, erosion of those mountains by wind, water and other forces would produce more sediments, which could restart the cycle by increasing the speed of subduction.

Behr and Becker's new model also offers a compelling explanation for variations found in plate speed, such as India's dramatic northward acceleration some 70 million years ago. The authors propose that as India moved through equatorial seas teeming with life, an abundance of sedimentary rock formed by organic matter settling on the seafloor created a lubricating effect. India's march north accelerated from 5 centimeters per year (about 2 inches) to 16 centimeters per year (about 6 inches). As the continent accelerated, the amount of sediment being subducted decreased, and India slowed before finally colliding with Asia.

Indian Ocean Disrupts Climate

Climate & Environment

Today, the Indian Ocean has a predictable rainfall pattern. The prevailing winds blow from west to east, keeping warm waters over the eastern side of the region and bringing rains to Thailand and Indonesia.

However, according to research led by The University of Texas at Austin, it was a different story during the last ice age. The prevailing winds reversed, and the ocean temperatures changed—disrupting the climate as we know it.

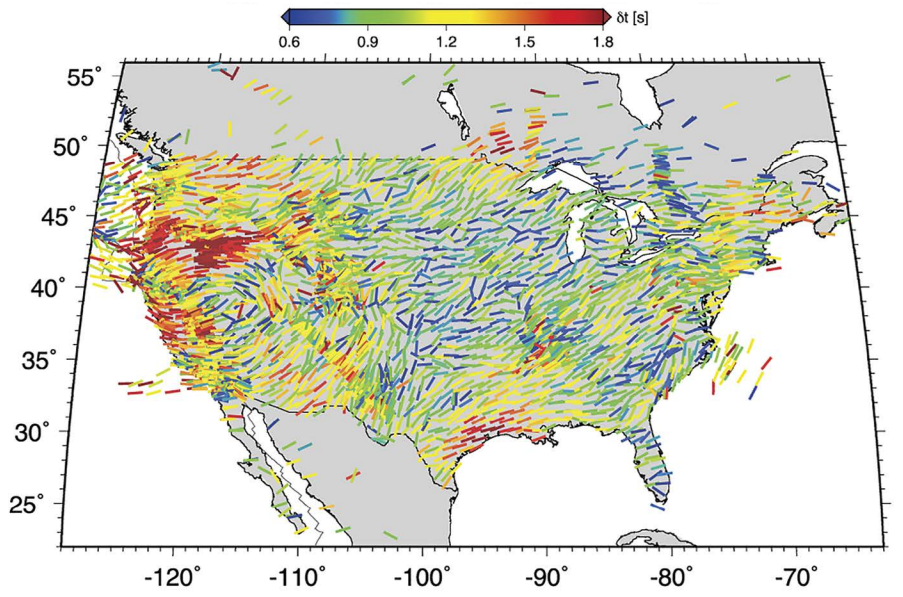
The findings could rewrite established Pacific-centric theories about tropical climate change, said Pedro DiNezio, a research associate at the University of Texas Institute for Geophysics (UTIG) who led the team conducting the study.

"The processes we have uncovered are particularly important for predicting future impacts of climate change," he said. "If such a climate shift were to happen again, the disruption to rainfall patterns would have serious implications for predicting water availability over the heavily populated Indian Ocean rim."

The study was published Dec. 12, 2018, in *Science Advances*. UTIG is a unit of the University of Texas Jackson School of Geosciences.

The scientists investigated changes in the climate of the tropics during the Last Glacial Maximum (LGM), a period of the ice age 21,000 years ago when ice sheets covered much of North America, Europe and Asia. During the LGM, the tropics were struck by dramatic changes, including a reversal of prevailing winds and uncharacteristic changes in ocean temperatures. To find what drove these changes, researchers used a climate model to simulate how various glacial conditions affected climate. They compared simulated outcomes with paleoclimate data, chemical signatures about our past climate stored in rocks and ocean sediments.

"Now that we have reproduced glacial climate conditions for the Indo-Pacific region, we are more confident that the same climate model can be used to predict our planet's future," said co-author Bette Otto-Bliesner, a climate modeler at the National Center for Atmospheric Research.



Parts of Mantle Stuck to Plate

Solid Earth & Tectonic Processes

The North American plate is a medley of geological parts that protrude into Earth's mantle like tree branches frozen into the surface of an iced-over lake. Research from the Jackson School of Geosciences has proposed a new method to map these "frozen-in" layers of the tectonic plate and reveal how it interacts with the upper mantle.

The study, which was published in May 2019 in *Earth and Planetary Science Letters,* is the first scientific paper from Wanying Wang, a graduate research assistant at the University of Texas Institute for Geophysics and doctoral candidate at the Jackson School of Geosciences. Wang said her work is important because it describes the fundamental rules that govern the Earth's internal dynamics and will help scientists better understand the tectonic processes that have shaped North America.

"If you want to understand basic plate tectonics, it is important to understand how mantle dynamics and the lithosphere work together," Wang said.

The paper focuses on a property of the Earth's interior called seismic anisotropy. This property gives the upper mantle, when imaged with seismic waves, a certain "grain" that reveals the mantle's internal flow. The grain is determined by the alignment of a mineral called olivine. The details of how olivine aligns in the mantle were explored in early laboratory work by Jackson School research engineer James Buttles.

Wang and co-author Thorsten Becker, a Jackson School professor, tested several computer simulations of mantle flow and found a match with observations from USArray, a massive cross-continental effort to map the interior of the Earth beneath North America, but only when their models included a previously theorized frozen-in layer of old mantle.

"This is important because this layer contains information about past tectonic events and interactions between lithosphere and upper mantle," Wang said.

According to the paper, the bottom of the North American plate is like the underside of a frozen lake with remnants from the mantle—some new, some ancient—cemented into the lithosphere. Frozen into these remnants are mineral "branches" carrying information about ancient tectonic events.

Wang said that although this frozen-in layer had been theorized and partly studied before, this is the first time it has been demonstrated on a continental scale using models of the upper mantle. By matching their models with observations, their work also supports existing theories about the geological evolution of the North American plate.

Rocks Record First Day of Dino Extinction Event

Marine Geosciences

When the asteroid that wiped out the dinosaurs slammed into the planet, the impact set wildfires, triggered tsunamis and blasted so much sulfur into the atmosphere that it blocked out the sun, triggering the global cooling that ultimately did in the dinos.

That's the scenario scientists have hypothesized. Now, a new study led by The University of Texas at Austin has confirmed it by finding hard evidence in the hundreds of feet of rocks that filled the impact crater within the first 24 hours after impact.

This evidence includes bits of charcoal, jumbles of rock brought in by the tsunami's backflow and conspicuously absent sulfur. They're all part of a rock record that offers the most detailed look yet into the aftermath of the catastrophe that ended the Age of Dinosaurs, said Sean Gulick, a research professor at the University of Texas Institute for Geophysics at the Jackson School of Geosciences.

PHOTOS: JACKSON SCHOOL.

"It's an expanded record of events that we were able to recover from within ground zero," said Gulick, who led the study and co-led the 2016 International Ocean Discovery Program scientific drilling mission that retrieved the rocks from the impact site offshore of the Yucatán Peninsula.

The research was published in the *Proceedings of the National Academy of Sciences* on Sept. 9, 2019, and builds on earlier work led and co-led by the Jackson School that described how the crater formed and how life quickly recovered at the impact site. An international team of more than two dozen scientists contributed to this study.

Most of the material that filled the crater within hours of impact was produced at the impact site or was swept in by seawater pouring back into the crater from the surrounding Gulf of Mexico. Just one day deposited about 425 feet of material—a rate that's among the highest ever encountered in the geologic record.

Researchers found charcoal and a chemical biomarker associated with soil fungi within or just above layers of sand that shows signs of being deposited by resurging waters. This suggests that the charred landscape was pulled into the crater with the receding tsunami. However, one of the most important takeaways is what was missing from the core samples. The area surrounding the impact crater is full of sulfur-rich rocks. But there was no sulfur in the core.

That finding supports a theory that the asteroid impact vaporized the sulfur-bearing minerals present at the impact site and released it into the atmosphere where it wreaked havoc on the Earth's climate, reflecting sunlight away from the planet and causing global cooling.

OPPOSITE PAGE, LEFT: A VISUALIZATION OF SEISMIC MEASUREMENTS OF THE NORTH AMERICAN PLATE COMBINED THEM WITH MODELS OF MANTLE FLOW. THE COLORED STICKS INDICATE ORIENTATION AND SHEAR-WAVE DELAY MEASUREMENTS OF THE UPPER MANTLE. **OPPOSITE PAGE, RIGHT:** A SAMPLE OF ROCKS THAT FILLED THE CRATER LEFT BY THE ASTEROID IMPACT THAT WIPED OUT THE DINOSAURS. THE ROCKS WERE EXTRACTED AS DRILLED CORES DURING A 2016 EXPEDITION CO-LED BY THE JACKSON SCHOOL.

PHOTO: JACKSON SCHOOL.

Dragon Defense

Planetary Sciences & Geobiology

Just beneath their scales, Komodo dragons wear a suit of armor made of tiny bones. These bones cover the dragons from head to tail, creating a "chain mail" that protects the giant predators. However, the armor raises a question: What does the world's largest lizard—the dominant predator in its natural habitat—need protection from?

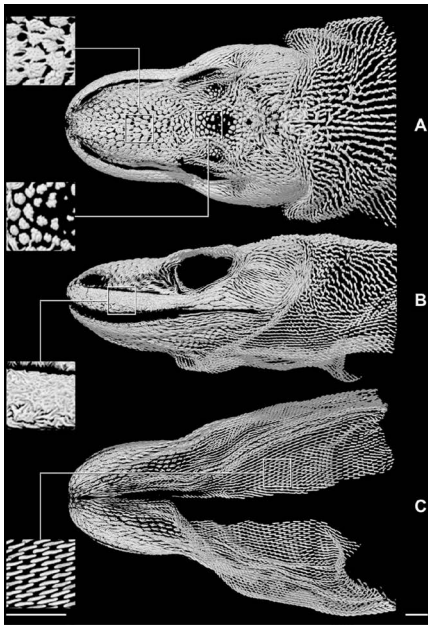
After scanning Komodo dragon specimens with high-powered X-rays, researchers at The University of Texas at Austin think they have an answer: other Komodo dragons.

Jessica Maisano, a scientist at the Jackson School of Geosciences, led the research, which was published on Sept. 10, 2019, in the journal *The Anatomical Record*. The study's co-authors are Christopher Bell, a professor in the Jackson School's Department of Geological Sciences; Travis Laduc, an assistant professor in the UT College of Natural Sciences; and Diane Barber, a curator at the Fort Worth Zoo.

The scientists came to their conclusion by using computed tomography (CT) technology to look inside and digitally reconstruct the skeletons of two deceased dragon specimens—one adult and one baby. The adult was well-equipped with armor, but armor was completely absent in the baby. It's a finding that suggests that the bony plates do not appear until adulthood. And the only thing adult dragons need protection from is other dragons.

"Young Komodo dragons spend quite a bit of time in trees, and when they're large enough to come out of the trees, that's when they start getting in arguments with members of their own species," said Bell, a reptile expert. "That would be a time when extra armor would help."

Many groups of lizards have bones embedded in their skin called osteoderms. Due to their tricky



placement, scientists do not have much information about how the bony plates are shaped or arranged inside the skin.

The researchers were able to overcome this issue by examining the dragons at the University of Texas High-Resolution X-ray Computed Tomography Facility, which is managed by Maisano. Due to size constraints of the scanner, the researchers scanned only the head of the nearly 9-foot-long, adult Komodo dragon.

The CT scans revealed that the osteoderms in the adult Komodo dragon were unique among lizards in both their diversity of shapes and sheer coverage.

"We were really blown away when we saw it," Maisano said. "Most monitor lizards just have these vermiform (worm-shaped) osteoderms, but this guy has four very distinct morphologies, which is very unusual across lizards."

The adult dragon that the researchers examined was among the oldest known Komodo dragons living in captivity when it died. Maisano said that the advanced age may partially explain its extreme armor; as lizards age, their bones may continue to ossify, adding more and more layers of material, until death. She said that more research on Komodo dragons of different ages can help reveal how their armor develops over time—and may help pinpoint when Komodos first start to prepare for battle with other dragons.

The National Science Foundation funded the research.

ABOVE: THE KOMODO DRAGON HAS FOUR DISTINCT TYPES OF OSTEODERMS ON ITS HEAD.

NEWSMAKERS

Jackson School researchers made science news headlines and served as expert sources for news stories across the state and the world. Check out a few of the highlights.

RIGHT: A REPORTER FROM THE BRAZILIAN TV PROGRAM "COMO SERÁ?" INTERVIEWS PH.D. STUDENT AND PALEONTOLOGIST SARAH DAVIS IN THE FIELD DURING A FOSSIL HUNTING TRIP IN PATAGONIA IN MARCH 2019.

OPPOSITE PAGE: IN MAY 2019, FOX 7 AUSTIN INVITED PROFESSOR PETER FLEMINGS (RIGHT) TO TALK ABOUT HIS LATEST RESEARCH ON THE UNDERLYING GEOLOGY OF THE DEEPWATER HORIZON DISASTER.

IN THE NEWS

Methane in Sea Bed Cores a Potential New Source of Energy

"We know this is a pretty ubiquitous substance. It exists all over in the deep-water oceans, it occurs in the permafrost at the northern latitudes. What we don't know is how much is economically viable."

Peter Polito
Research Engineering/Scientist Associate,
University of Texas Institute for Geophysics
The Science Show, ABC Australia, July 28, 2018

NASA's Next Mars Rover Will Look for Signs of Life on an Ancient Crater Lake

"Sedimentary rocks tell us the history of what's been happening at a site ... It's recorded in the layers, and you can read them like a book."

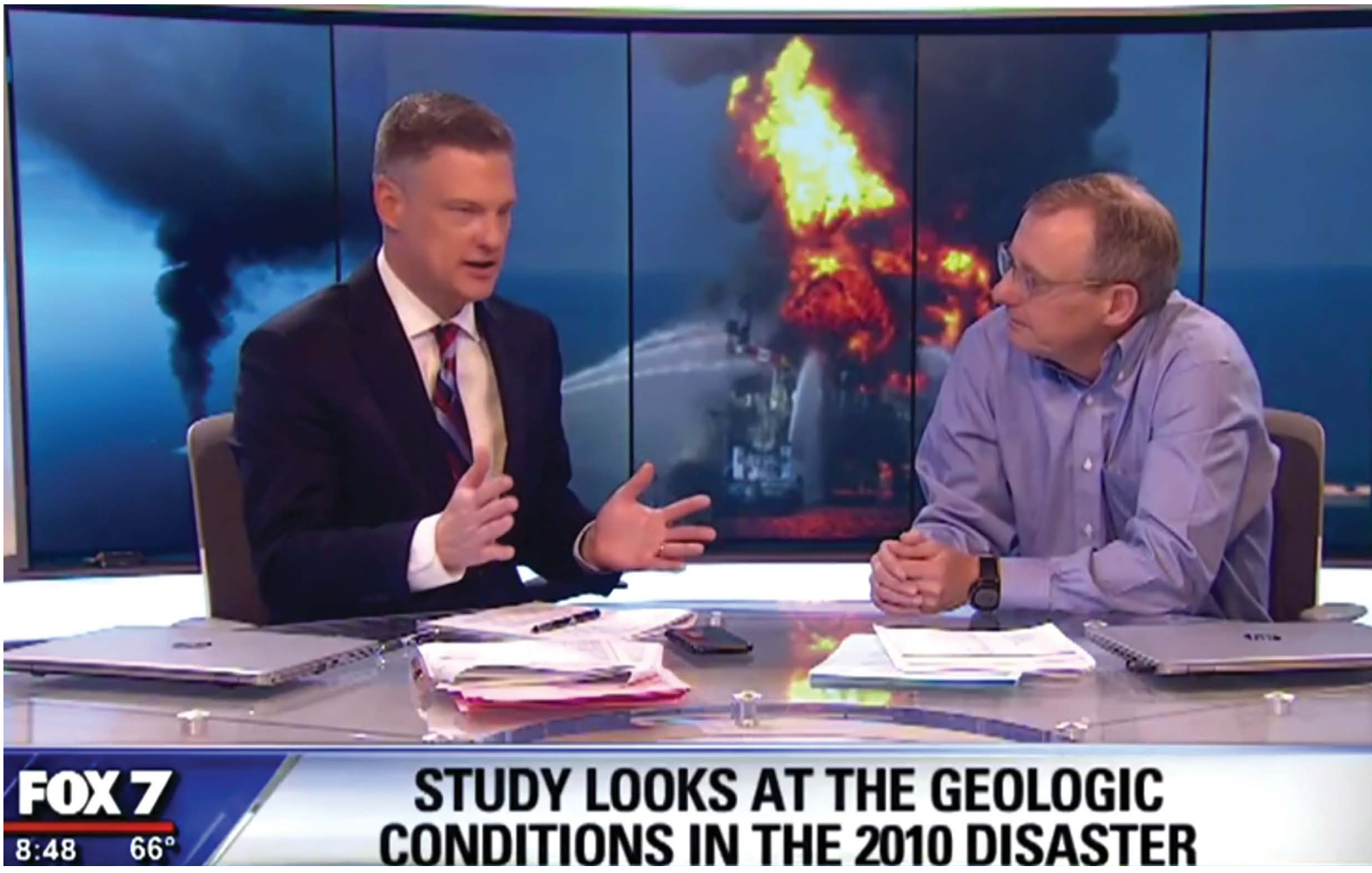
Tim Goudge
Assistant Professor,
Department of Geological Sciences
The Washington Post, Nov. 19, 2018

It Took 10 Million Years for Biodiversity to Recover from Dino-killing Impact

"It's a fundamental speed limit on evolution ... This is just how long evolution takes to develop these niches."

Christopher Lowery
Research Associate,
University of Texas
Institute for Geophysics
Discover Magazine, April 9, 2019

PHOTO: SARAH DAVIS.



UT: Oil and Gas Water Disposal Linked to More Earthquakes

"The issue is injecting water and creating this pressure."

Bridget Scanlon
Senior Research Scientist,
Bureau of Economic Geology
Houston Chronicle, Nov. 12, 2018

KXAN NEWS TALKED WITH BUREAU OF ECONOMIC GEOLOGY RESEARCH ASSOCIATE QIAN YANG (RIGHT) AND SENIOR RESEARCH SCIENTIST BRIDGET SCANLON IN MAY 2019 ABOUT THEIR RESEARCH THAT INVESTIGATED THE FEASIBILITY OF DIVERTING TEXAS FLOOD WATERS INTO UNDERGROUND AQUIFERS FOR STORAGE.

Demian Saffer

By Constantino Panagopulos

According to Demian Saffer, geophysics is more than a scientific pursuit. It's a solution.

"If you want to know whether there's going to be enough water to irrigate crops in the Texas Panhandle next year, that's geophysics," said Saffer. "If you want to know where the next big earthquake's going to hit, or how to safely extract oil and gas, that's geophysics."

Saffer is an internationally known geophysicist who studies how fluids influence tectonic processes, and he has a background in leading scientific missions. On Jan. 1, 2020, Saffer will apply his acumen in both areas to a new venture: serving as the director of the University of Texas Institute for Geophysics (UTIG).

UTIG already has a reputation for applying geophysics to investigate big issues that affect society—from the mechanics of subduction zones where the world's biggest earthquakes are born, to studying past periods of climate change so scientists can better understand the climate of today. It's a reputation that aligns with Saffer's perspective on geophysics as a problem-solving tool applicable across the Earth sciences, said Jackson School of Geosciences Dean Sharon Mosher.

PHOTO: DEMIAN SAFFER.

"UTIG is a unique institution with global reach and a reputation for working on big science that matters," said Mosher. "In Demian, I believe we have found the leader who can help take us to the next level."

Saffer comes to UTIG from Penn State University, where he was a professor and the head of its Department of Geosciences. During his 20-year career he has published over 120 articles in peer-reviewed journals including *Nature, Science, Geophysical Research Letters, Geology,* and the *Journal of Geophysical Research*. He has secured funding from the National Science Foundation, ExxonMobil, Shell, the U.S. Science Support Program, the Consortium for Ocean Leadership, and a host of other funding agencies. And, far from the confines of the office, he has been co-chief scientist on five large expeditions with the International Ocean Discovery Program (IODP) to study subduction zones and slow earthquakes through scientific drilling and borehole monitoring.

But before he was a geophysicist, Saffer was a kid with a rock collection growing up along the rugged coast of Portland, Maine.

"I've always loved the ocean and I've always had a thing for rocks," he said.

However, he said what really fascinated him was taking things apart to learn how they worked. Much to his mother's despair, this meant taking apart the vacuum cleaner at age 5. All in the name of science, of course.

These early experiences eventually led to a degree in geology at Williams College in Massachusetts and then a Ph.D. in Earth sciences at the University of California, Santa Cruz. He then joined the University of Wyoming in 2001, before accepting a position at Penn State in 2005. That was soon followed by leadership positions: first, becoming the head of graduate programs, and then head of Penn State's Department of Geosciences.

Saffer said that his time at Penn State taught him the power of diversity, inclusion and mentoring.

"I learned that if you want to cultivate an environment that embraces diversity, empowers people and retains talent, you need to understand individual perspectives and the challenges people face," he said. "It's not enough to just focus on recruitment; you need to focus on mentorship and counseling across the whole life cycle of people while they are here."

Now entering into the top job at UTIG, Saffer said that building a culture of diversity and inclusivity, student mentorship, and public engagement while advancing interdisciplinary science is a priority for him.

"In many ways, UTIG is already all of these things," he said, "but we need to provide the sustained effort and investment to make UTIG the standard that others will seek to emulate."

Saffer expects a proactive approach will work at UTIG because the Jackson School already has a strong culture of inclusion. He points to the school's GeoFORCE program, a STEM outreach and college prep program that takes kids from underserved areas in Texas on geology field trips across the country.

According to Saffer, the GeoFORCE program works because it takes the whole student life cycle into account, with trips and support changing between the time the students enter middle school and graduate from high school.

"That's the kind of model we can use at UTIG for mentoring graduate students, postdocs and even mid-career scientists," he said. "Creating an effective system of mentorship could really contribute a lot to making scientists at all levels more visible in their community."

When it comes to the science itself, Saffer said that UTIG's designation as a research unit within a college puts it in an advantageous position when it comes to research flexibility, freedom and access to decision makers.

An important aspect of that potential is the intellectual footprint and reach of the institute. Saffer said that when he first arrived at UTIG, he was struck by the breadth of the research.

"From Texas to our planetary neighbors, research at UTIG and the Jackson School really spans from the core to the cosmos," he said.

As director, Saffer said he wants to see more cross-over initiatives in areas that he thinks could significantly advance UTIG's impact in research, education and community. He plans to help the process by creating cross-disciplinary partnerships between units and colleges across campus. This includes hiring, and he has already secured funds for unit-bridging fellowships to bring new graduate students and a new cohort of undergraduate students to UTIG.

Saffer said that building a strong, diverse community is the first step in cultivating a vibrant environment where people —and their research—can thrive. He saw this happening in his hometown of Portland, Maine, where the strong community spirit helped the industrious port town of his childhood mature into a cultural hot spot.

With the people in place, the geophysics-driven solutions will follow.

"With the right incentives and freedom, this is where high-risk, high-reward projects can happen," he said.

BOTH PHOTOS: SAFFER ABOARD THE JOIDES RESOLUTION DURING IODP EXPEDITION 375, WHICH HE CO-LED WITH UTIG RESEARCH SCIENTIST LAURA WALLACE IN MAY 2018.

PHOTO: DEMIAN SAFFER.

Claudio Faccenna

By Monica Kortsha

Claudio Faccenna, the Jackson School's newest structural geology professor, has spent his career studying mountain ranges from across the world. His research has taken him from the Apennines of Italy—the locale that first peaked his interest in geology as a child—to the Andes of Colombia and the Highlands of Ethiopia, among other places.

Spending time in the field is an essential part of his research, Faccenna said.

"In the field, you get ideas, you are inspired," he said.

Now at the Jackson School, one of his ongoing research projects involves bringing the mountains to him, leveraging the expertise and equipment at the school to make a mountain range in a box.

Faccenna has long combined intensive field study with experimental models that attempt to re-create geological processes in miniature. For example, some of his past research includes simulating tectonic-mantle interactions around trenches using a mixture of silicone putty, honey and crystalized honey enclosed in a tank. But he said that the Jackson School's morphodynamics lab has the ability

PHOTOS: CLAUDIO FACCENNA.

and experience to take his modeling experiments further. He is now working with the lab to build a model that can account for all aspects of the mountain building process—from the deformation of the Earth's mantle to the stripping away of sediments by raindrops.

"This will be a unique device, a completely original model that's never been done because we need big expertise from different people working together and a huge space," said Faccenna, who holds the John F. and Carolyn C. Bookout Endowed Chair in Structural Geology.

In the age of supercomputing and big data, constructing a mountain out of household materials can seem quaint. But even the most state-of-the-art super-computers can run into roadblocks trying to realistically model the complex and intertwined processes that build and shape mountains over time, Faccenna said. In fact, he said he thinks the difficulty in theoretically and computationally capturing the relationship between deep mantle processes and surface ones has kept research on what is an interrelated system in its own distinct silos. Laboratory experiments can help bridge that divide, he said.

"The geosciences is kind of split into people who are interested in the deep mantle and people who are interested in the shallow surface deformation, but we've all realized that's just because of the difficulty to couple this process," Faccenna said. "In the laboratory, it's a bit easier. And this brings the community together to really interact."

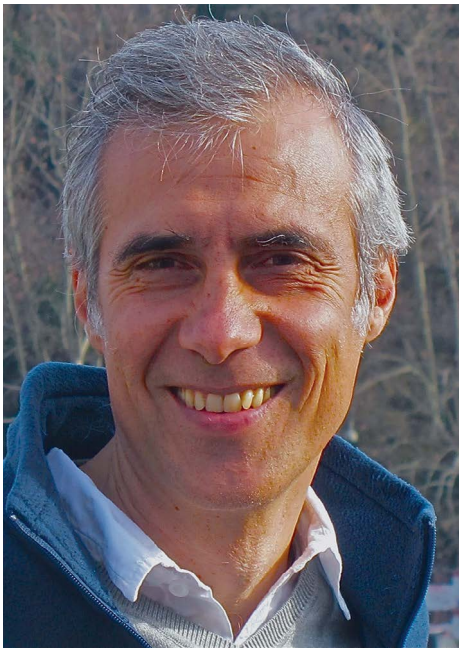
What computers can't do, the morphodynamics lab can. Located in a large warehouse at the J.J. Pickle Research Campus, research engineers in the lab specialize in creating miniature geologic environments. That encompasses building the containers where experiments are run and helping select materials that can serve as realistic stand-ins for geologic phenomena that usually happen in nature at much larger and slower scales. For example, the lab's staff has found that ground walnut shells are great for studying how river deltas shape landscapes, with the shells packing together to form escarpments while still being able to be swept along in the river currents—just like real sediments.

Faccenna said that seeing the lab and talking with its manager James Buttles, a research engineering scientist with 18 years of experience building geological models, cinched the deal to join the Jackson School when he was interviewing for the Bookout Chair position.

"I had the idea [for the mountain model] and said, 'this is crazy,'" Faccenna said. "But look at this. This is the place where you can do it."

A big Plexiglas box, 4 meters long by 4 meters wide by 2 meters high, has been set aside for the work on the laboratory's floor. It's currently filled with water and holds a smaller tank for studying how sinuous channels transport sediment and carve landscapes. But Buttles said that, in short order, the river environment will be traded for mountain-building ingredients. And although creating a mountain model that combines both deep earth and surface processes is very ambitious, he's game to make it happen.

"There's not a thought in my mind that we can't do it," Buttles said. "We'll find a way to move forward."



Faccenna considers the integrative mountain model as the next step in a scientific career that's prioritized a systems approach to studying structural geology, always keeping in mind the interplay between the Earth's different layers. He is a member of the Academia Europaea and a fellow of the American Geophysical Union, with his work leading to important insights on the formation of the Mediterranean during the past 35 million years and the connection between different tectonic processes and the resulting geologic formations. And as the editor-in-chief of the journal *Geochemistry, Geophysics, Geosystems*, or G-cubed, which focuses on understanding the Earth at the systems scale, he is helping to create a research space for boundary-breaking geology.

Jackson School Professor Thorsten Becker, a geophysicist and collaborator of Faccenna's, said that he thinks the Jackson School community will benefit from Faccenna's integrative and collaborative approach. For example, he has plans to work with Faccenna to revamp the PLATES program, a 30-year-old project out of the Jackson School's Institute for Geophysics dedicated to research on plate tectonics and geological reconstructions, and to foster more communication and collaboration among geoscientists across fields of expertise. As a geophysicist, Becker said that his understanding of geology has improved immensely by spending time with Faccenna in both the lab and the field.

"Throughout my career, I've always worked with geologists to basically interpret the Earth for me," Becker said. "And Claudio has been the best interpreter."

Now settling into Central Texas, Faccenna said he is getting used to the new landscape where the closest mountains are about a seven-hour drive west. But he said that he doesn't expect to be away from the mountains for long. He is still keeping up global field work, and spent time this summer teaching field geology to Jackson School students in GEO 660 in New Mexico. And if his grand mountain model goes to plan, it will be just a matter of time until new peaks start to rise.

OPPOSITE PAGE: FACCENNA IN THE SIERRA NEVADA DEL COCUY OF COLOMBIA, A UNIQUE SITE FOR GEOLOGY AND A PROTECTED REGION FOR THE INDIGENOUS POPULATION.

PHOTOS: CLAUDIO FACCENNA.

Core Research Facility

The Bureau of Economic Geology officially opened the doors to its new core research facility in October 2019, bringing two years of construction and facility renovations to a close.

The facility includes a new 10,000-square-foot building, the Stoneburner Family Rock Garden, and renovated labs in the existing Austin Core Research Center. The entire complex is adjacent to the bureau's main offices at UT's J.J. Pickle Research Campus.

In addition to the existing core viewing facilities available to the public, the new building houses a core viewing room for use by students and bureau research staff members, and state-of-the-art scientific equipment, including two scanning electron microscopes. The building is topped off with the Chuck Williamson Family Terrace, a gathering space that offers a bird's-eye view of the Stoneburner Family Rock Garden. Viewed from above, the garden is designed to match the geologic map of Texas with 11 massive rock specimens, with each specimen located in its relative area of origin.

The garden also includes an audio tour option. Listen online at: ***www.beg.utexas.edu/rockgarden***

The core research renovation project also includes new rolling-top viewing tables in the main core warehouse. The refurbished interior design of the building housing the labs puts Texas geology front and center, with the main lobby staircase climbing alongside a wall-size print of West Texas' Guadalupe Mountains.

"Everything we do here is underpinned by rocks, so this is an investment in our own future."

-Scott Tinker, Bureau Director

Stoneburner Family Rock Garden

Core Viewing Room

Chuck Williamson Family Terrace

PHOTOS: BRIAN BIRZER.

Dean Leads Summit on Geosciences Skills

Students enrolling in geosciences graduate programs will spend several years in the halls of academia, but it's unlikely most are going to stay there. Most graduates apply what they learn in school to careers outside of the university, in industry, government or other organizations—so it's imperative that graduate programs make sure they are prepared.

That was the driving force behind a summit at the Jackson School of Geosciences sponsored by the National Science Foundation on May 11-13, 2019, for department heads and chairs. The summit is part of a national effort led by Dean Sharon Mosher to improve the preparedness of geosciences graduate students for the future workforce. Overall, 75 people attended, representing 64 universities from across the country, plus panelists from government, industry and professional geosciences organizations.

According to the American Geosciences Institute, about half of the students who receive doctorates in geosciences will go into a career other than academics. That number shoots to about 96% with master's students. Given those statistics, Mosher said that graduate programs need to start providing students a broader education in terms of skills and experiences—rather than focusing solely on academic research.

"There's a mismatch in graduate education and what they go on to do," she said.

That doesn't mean job training or replacing research. Instead, it means cultivating transferable skills that will help students succeed no matter where their careers take them.

Previously, Mosher led a 2018 workshop for employers of doctoral and master's students in earth, ocean and atmospheric sciences, which identified skills and competencies that cross all geosciences disciplines. There, 52 employers from industry, nonprofits, government agencies and research labs represented interests of a broad spectrum of the geosciences. Employers agreed that, overall, graduate students are coming out with very strong technical skills, including knowledge in their field of geosciences, and research and field skills. Key skills that need more emphasis included: problem solving and critical thinking, the ability to communicate effectively, capacity for learning and being able to adapt skills to new situations, project and time management skills, and systems thinking. Employers also emphasized the importance of being able to work with large datasets (data analytics), higher level math, programing, and computational skills. In addition, the Council of Graduate Schools and National Academy of Sciences issued reports on key competencies needed for graduate students in STEM and found similar results.

PHOTOS: JACKSON SCHOOL.

With these findings in mind, the summit focused on panel sessions where nonacademic employers and representatives from professional organizations shared insights on the workplace skills graduate students need—and the general strengths and weaknesses they currently have. The summit included breakout sessions where small groups reflected on identifying and cultivating key skills in their own programs.

Panelist Alex Martinez, the geoscience staffing and development manager for ExxonMobil, said the company is looking for new hires who can grow into a career, not just meet a job description. Martinez recommended graduate students build their skills by meeting with employers through professional events, internships and research consortia. Panelist Bruce Nocita, the principal environmental geologist at S&ME Inc. and an adjunct professor at the University of Florida, suggested addressing workplace skills head on in the classroom. His graduate-level class Introduction to Professional Geosciences includes lessons in project management, communications, ethics and other topics, and invites speakers from across industry into the classroom.

"We'll be revamping [the course] based on ideas from this weekend," Nocita said.

Nocita's focus gels with what Claudia Hackbarth, Shell International's vice president of unconventional technology, had to say. She said the Dutch-based company no longer screens for technical aptitude during its hiring process. You need a degree from a rigorous program at a good school and a good grade point average to be considered, with the interview process including a number of tests that assess overall intelligence, ethics and the ability to work in teams and make good decisions in situations where you don't have all the information.

Panelist Abhishek Chatterjee, a group lead at the NASA Goddard Space Flight Center, said one of the weaknesses he found from students was the inability to understand or articulate the societal relevance of their work, which is very important at NASA.

"They really struggle with making that connection," he said.

The summit also reflected on the forces driving changes in the geosciences. These include an emphasis on interdisciplinary and transformative science—where scientists take into account how parts of a system interact to influence the whole system, and how science intersects with issues of societal concern. There's also a commitment to growing diversity in the field, which means that geoscientists have to build skills that allow them to navigate outside of their own areas of expertise and collaborate with people who may have backgrounds different from their own.

Doing that involves more than just teaching students skills, Mosher said. It requires a culture change guided by well-informed leaders, one that fosters an academic culture that rewards innovative teaching and mentoring, that develops professional technical and nontechnical skills and competencies and is inclusive, equitable and diverse.

"Those to me are the things we should all be trying to do as academic leaders," Mosher told the group. "You do have the ability to stimulate change."

All attendees left with an action plan for building skills in graduate students at their own institution. The summit attendees also discussed organizing sessions to discuss progress at professional geosciences meetings in the coming months, and for sharing preliminary results in spring 2020.

For more information on this summit and others, visit: ***www.jsg.utexas.edu*** and click on "Future of Geosciences Education."

OPPOSITE PAGE, TOP: MAX DANILLER-VARGHESE AT SPRING 2019 COMMENCEMENT. **OPPOSITE PAGE, BOTTOM:** A PRESENTATION FROM THE SUMMIT ON GRADUATE STUDENTS SKILLS.

ABOVE: THE "EXPLORING THE ARCTIC OCEAN" EXHIBIT AT THE UT VISUAL ARTS CENTER.

Research Hits the Art Gallery

Climate science led by the Jackson School of Geosciences' Patrick Heimbach was turned into a work of art for an exhibit at The University of Texas at Austin's Visual Arts Center.

The exhibit, "Exploring the Arctic Ocean," centered around a data visualization created by Heimbach, an associate professor in the Department of Geological Sciences and a research professor at the University of Texas Institute for Geophysics; and An T. Nguyen, a research scientist at UT's Oden Institute for Computational Engineering and Sciences, where Heimbach is also a faculty member.

Heimbach's research focuses on the role of ocean circulation and how it affects polar ice sheets and the Earth's climate as a whole. The visualization displayed in the gallery used observational data and numerical models to show the process of "Arctic Atlantification"—or how the Arctic Ocean is coming to resemble the Atlantic because of the influx of warm water flowing into it from the subtropical Atlantic. The visualization illuminates the pathways by which the phenomenon is affecting the Arctic environment—including shrinking sea ice—and how it is spreading throughout the Arctic Ocean.

The visualization won the Scientific Visualization and Data Analytics Award at the International Supercomputing Conference in 2018.

In the gallery, it was displayed alongside other works of art inspired by the Arctic Ocean and its changing landscape. The exhibit ran Sept. 21–Dec. 7, 2018. During that time, Heimbach, Nguyen and others participated in a number of community outreach events that explained how data visualization and art can work together to communicate important concepts in science.

A HEALTHY CORAL REEF FROM "CORAL REEF ADVENTURE," AN IMAX FILM.

Gulf Reef Gathering

An impromptu meeting between Jackson School of Geosciences Assistant Professor Rowan Martindale and Rice University Assistant Professor Adrienne Correa may pay big dividends for future research on reefs in the Gulf of Mexico. What started as a conversation between the two after a presentation given by Correa at The University of Texas at Austin morphed into a gathering of researchers working on reef systems throughout the Gulf in October 2018.

The two-day meeting—"Gulf of Mexico Reefs: Past, Present, Future"—brought nearly 40 scientists from throughout the region together at Rice University. Most were from universities in Texas and Louisiana, but there were also participants from Florida, Mexico and the Flower Garden Banks National Marine Sanctuary located off the Louisiana-Texas border. The purpose was to bring local scientists studying reefs in the Gulf together to foster new ideas and collaborations.

The gathering was organized by Martindale, Correa and then-Jackson School doctoral candidate Anna Weiss (Weiss earned her doctorate in 2019). It has already prompted an upcoming special topics section in the journal *Frontiers in Marine Science* and an agreement that the gathering should take place regularly, probably every two years.

Martindale said the need to foster communication among reef researchers in the region became clear after attending Correa's February 2019 Hot Science-Cool Talks presentation at UT titled "Texas' Own Coral Reefs: Weathering the Storm," which explored how Hurricane Harvey affected the coral reefs of the Flower Garden Banks National Marine Sanctuary, which is located 100 nautical miles offshore of Galveston.

Like many in the diverse field, Martindale and Correa share a common research interest but come about it from different directions or, in this case, time scales. Whereas Correa specializes in the ecology and evolutionary biology of modern reefs, Martindale studies reefs and mass extinctions in the ancient world. Bringing together different approaches and disciplines was one of the themes of the meeting.

"It ended up being quite a diverse group of people, a little more biologically inclined than we had originally thought," Martindale said.

Paleo on Screen

The Jackson School of Geosciences Museum of Earth History Vertebrate Paleontology Collections is always on the lookout for opportunities to present geosciences to the public. Hollywood, with its penchant for bringing dinosaurs and prehistoric-looking monsters to the screen, often offers a perfect backdrop.

That's why paleontologists with the collection partnered with the Alamo Drafthouse movie theaters on events during screenings of "Jurassic World: Fallen Kingdom," "The Meg," "Boneyard: Alaska," and "Godzilla: King of the Monsters." They also partnered with the City of Wimberley Parks Department for an event during a showing of "Jurassic Park."

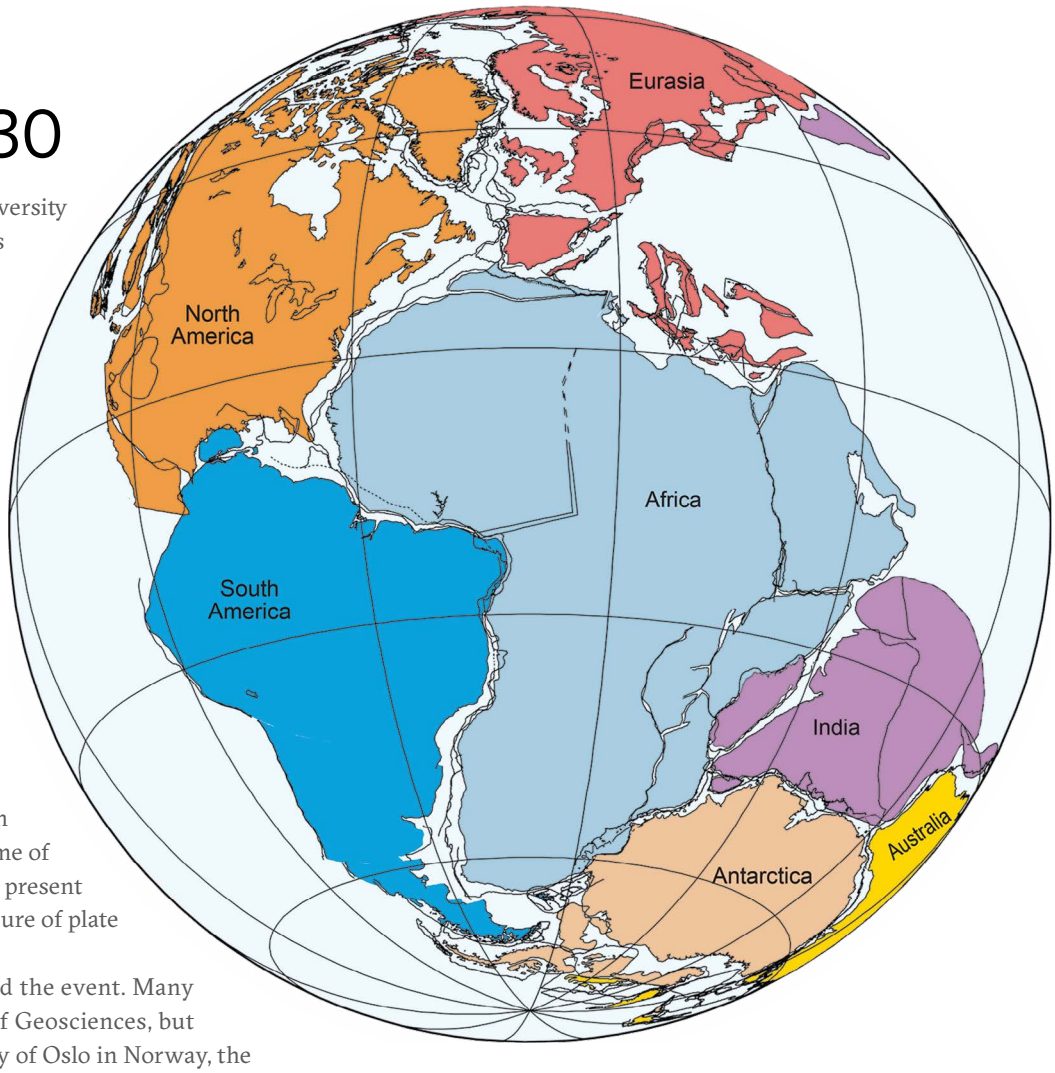
Events usually included fossil exhibits before the shows and question-and-answer sessions with the audience after. Matthew Brown, director of museum operations for the Vertebrate Paleontology Collections, said events such as these are a great way to make connections with people who might not ordinarily visit museums.

"Bringing fossils (and our graduate students and faculty members) to venues like the Alamo Drafthouse allows us to reach audiences that might not otherwise be aware that Texas has such a rich and important paleontological history, or even that fossils can sometimes be found in their own Austin neighborhoods," he said.

A FOSSIL EXHIBIT AT BLUE HOLE REGIONAL PARK IN WIMBERLEY, TEXAS.

REEF: MACGILLIVRAY FREEMAN FILMS. PALEO: JACKSON SCHOOL.

PLATES at 30



The PLATES program at the University of Texas Institute for Geophysics (UTIG) has spent 30 years studying how tectonic plates move around the Earth and creating reconstructions of how the planet's continents have changed over time. The animations, databases and tools developed by the project have been used for diverse purposes, from oil and gas exploration to tracking animal migration in the Earth's distant past.

The program marked the three-decade milestone with a symposium in March 2019 that brought together colleagues from across the world to reflect on some of the program's key achievements, present new research and discuss the future of plate tectonics research.

Nearly 100 scientists attended the event. Many were from the Jackson School of Geosciences, but visitors came from the University of Oslo in Norway, the University of Exeter in England, the University of Lyons in France, Caltech University, Tulane University and Rice University. Industry was also well represented with attendees from Shell, BHP Billiton, Total, Actus Veritas, Hess, ExxonMobil and Chevron.

PLATES co-investigator and UTIG research professor Ian Dalziel said the symposium served three purposes: to assess how far plate reconstructions have progressed since the days before plate tectonics were discovered, understand where the field is heading, and explore how PLATES might be relevant within other Earth sciences.

One such area is biology—in particular, evolutionary biology. Speaking on the morning of day one, Jackson School Professor Julia Clarke described how plate reconstructions are changing how we think about biodiversity dynamics and the origins of species. Among other highlights, Joann Stock, a professor of geology and geophysics at Caltech, gave a presentation on the origins of the Altiplano plateau, an unusually broad section of the central Andes.

Other talks looked at recent applications of machine learning in plate modeling, how new satellite data has improved plate reconstructions, whether plate tectonics is driving the global carbon cycle and a lively debate on the role of paleomagnetism in understanding Earth evolution.

All talks were recorded and are available on ***www.ig.utexas.edu.***

MAP: PLATES PROJECT. BIRD CLAW: SARAH DAVIS.

Big Bird Goes Viral

On Jan. 15, 2019, Jackson School of Geosciences doctoral candidate Sarah Davis shared this picture of a male southern cassowary's claws on Twitter and caught the internet's attention—garnering nearly 15,000 likes and dozens of questions about the origins of the claw and whether it belonged to a bird or a dinosaur. Davis' response? "Both."

TOP: A PLATE RECONSTRUCTION OF THE SUPERCONTINENT PANGEA DURING THE LATE TRIASSIC. **BOTTOM:** CASSOWARY CLAW.

Laser Research Returns to JSG

The Jackson School of Geosciences hosted the 2019 North American Workshop on Laser Ablation May 29-31, 2019, with a pre-meeting on May 28. Close to 150 people from 15 countries gathered to learn about the latest advances in the powerful analytical technology. This was the third time the Jackson School hosted the biennial event. The three-day workshop was spearheaded by a small group that includes Jackson School Laser Ablation and ICP-MS Lab Manager Nate Miller, who wanted to help create a workshop environment where scientists and instrument vendors could exchange information about a rapidly changing field. The event has been held at the Jackson School since its inception in 2015.

TOP: GROUP SHOT OF WORKSHOP ATTENDEES.
LEFT: (L TO R) THE JACKSON SCHOOL'S LISA STOCKLI, CICI CRUZ-URIBE OF THE UNIVERSITY OF MAINE AND THE JACKSON SCHOOL'S DANIEL STOCKLI AT A WORKSHOP SOCIAL HOUR.
MIDDLE: "THE DUDE" ABLATES.
RIGHT: WORKSHOP ORGANIZER NATE MILLER (RIGHT) WITH ATTENDEE JARED WESLEY SINGER FROM THE RENSSELAER POLYTECHNIC INSTITUTE.

PHOTOS: JACKSON SCHOOL.

“Switch On” Shines Light on Energy Poverty

One billion people around the world live without electricity. Billions more live “under the grid” unable to afford access to a reliable supply of energy. And there are about 2 billion people—primarily women—who cook indoors using wood, coal or dung, a practice that exposes them to harmful soot and smoke day after day, with particulate matter killing some 3 million people a year, more than malaria and AIDS combined.

This lack of access to dependable and safe energy is known as “energy poverty.” In the new film “Switch On,” Scott Tinker, the director of the Jackson School of Geosciences Bureau of Economic Geology and professor in the Department of Geological Sciences, explores how it affects the lives of people around the world and examines different strategies that can help communities overcome it.

“We’re so used to energy in our life. But for one-third of the world, it’s not like that,” Tinker said. “That has impacts on all of us in areas like education, health and human services, immigration and migration, and much more.”

Tinker has spent the past two years filming “Switch On,” with the project taking him to the crowded streets of Kenya and Vietnam, to rural villages in Ethiopia, Nepal and Colombia, among other places, to witness how energy poverty affects communities in different ways.

In the case of the small Colombian village of Gunchukwa, Tinker and the rest of the “Switch On” crew were able to bring first electricity to the village. The leaders in the community invited the small solar microgrid—and the lights, fans and refrigerators they powered—that was installed by the team, who then taught residents of the village how to run and maintain it.

“Switch On” is a follow-on to “Switch,” a film produced by Tinker and director Harry Lynch that explores the costs and benefits of different energy sources. “Switch” has been viewed in more than 50 countries by more than 15 million people and still plays in thousands of universities and high schools. “Switch On” is a production of the Switch Energy Alliance, a 501(c)(3) nonprofit started by Tinker to promote energy education and public engagement through videos and educator training.

Tinker said that “Switch On” is in the final stages of production and should be ready for debut in October 2019. However, that’s hardly the end of filming for Tinker. He and Lynch are currently working on two other movies: One is “Making the Switch,” which explores how different energy economies are navigating the current energy landscape. The other is a short movie for museum exhibits, including the Wiess Energy Hall in the Houston Museum of Natural Science, about the role of energy in everyday life.

“These films are my books and they reach millions,” Tinker said. “It takes a team to make this happen, and I would like to acknowledge all the companies, individuals and foundations for their support, the remarkable folks at the Switch Energy Alliance, Dean Mosher, and people at the bureau who cover for me while filming. Without them, this doesn’t happen.”

ABOVE: BUREAU OF ECONOMIC GEOLOGY DIRECTOR SCOTT TINKER WITH SCHOOL KIDS IN KIBERA, THE LARGEST SLUM IN AFRICA, ON THE OUTSKIRTS OF NAIROBI, KENYA.
BELOW: AN EXPLOSIVE EXPERIMENT FROM A HOT SCIENCE-COOL TALKS LECTURE.

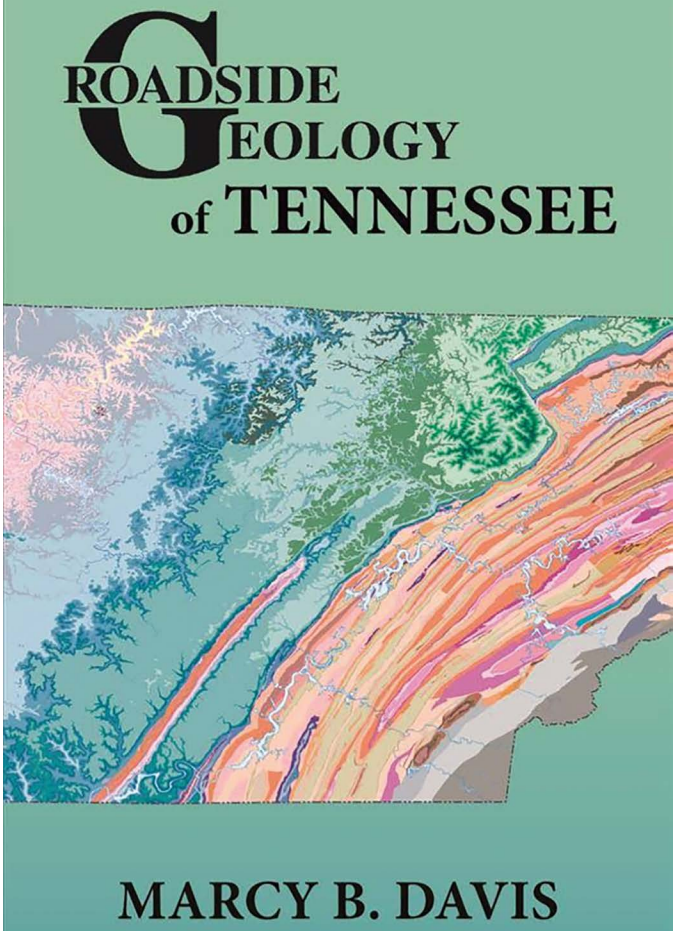
KIDS: TINKER. HOT SCIENCE: JACKSON SCHOOL.

Hot Science on TV

Hot Science-Cool Talks has been engaging and educating the public for 20 years. Now the nationally recognized speaker series from the University of Texas Environmental Science Institute (ESI) is looking to take the next step by developing an accessible and compelling documentary series called “Hot Science.”

“Science education and outreach are cornerstones for addressing the environmental challenges that our society faces,” said Jackson School Professor and ESI Director Jay Banner. “We’re very excited by the potential to reach a new audience with an intriguing, quick and slick slice of science.”

The new series will feature nationally recognized scientists, their passion for discovery and their groundbreaking work. The series is being produced and directed by Scott Rice, a professor at The University of Texas at Austin Moody College of Communication. The goal is to air the episodes in spring 2020 on public television stations and online.



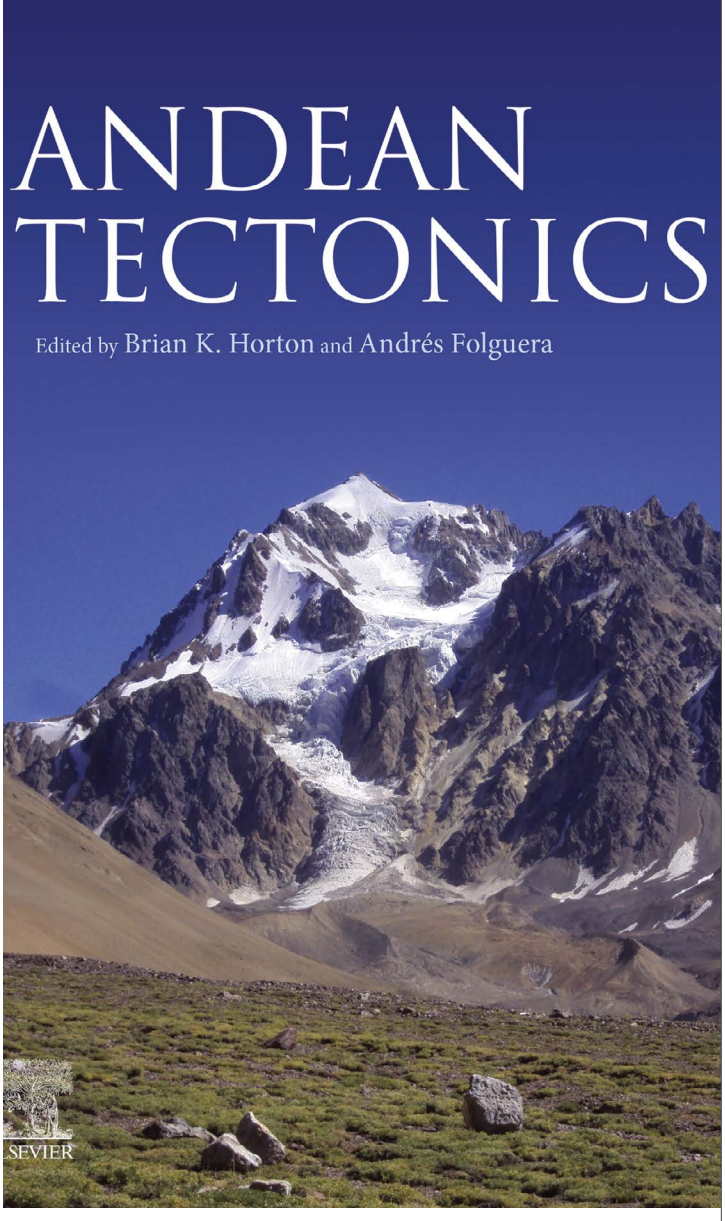
Davis Writes Guidebook to Roadside Geology of Tennessee

Marcy Davis, an engineering scientist at the University of Texas Institute for Geophysics, is the author of the book "Roadside Geology of Tennessee," which was published in April 2019 by Mountain Press Publishing.

The book explores the state's more than 1 billion years of geologic history, from the continental collisions that built enormous mountains to the rifting forces that almost split an ancient continent apart. The book is organized at three levels: an introduction that explains important geologic concepts; an overview of Tennessee's geologic history; and three subsequent chapters that delve into Tennessee's three grand divisions (East, Middle and West Tennessee). Each chapter contains an introduction to the area that provides geologic context for the road guides.

Davis said the book is intended for anyone who has wondered why the Tennessee landscape looks the way it does. Academic and professional geologists will recognize the many sources she cites—including field trip guidebooks, peer-reviewed publications, special papers and maps from the United States and Tennessee Geological Surveys, student theses and dissertations, and books on Tennessee's geologic history.

ON THE COVER: A GEOLOGIC MAP OF EASTERN TENNESSEE.



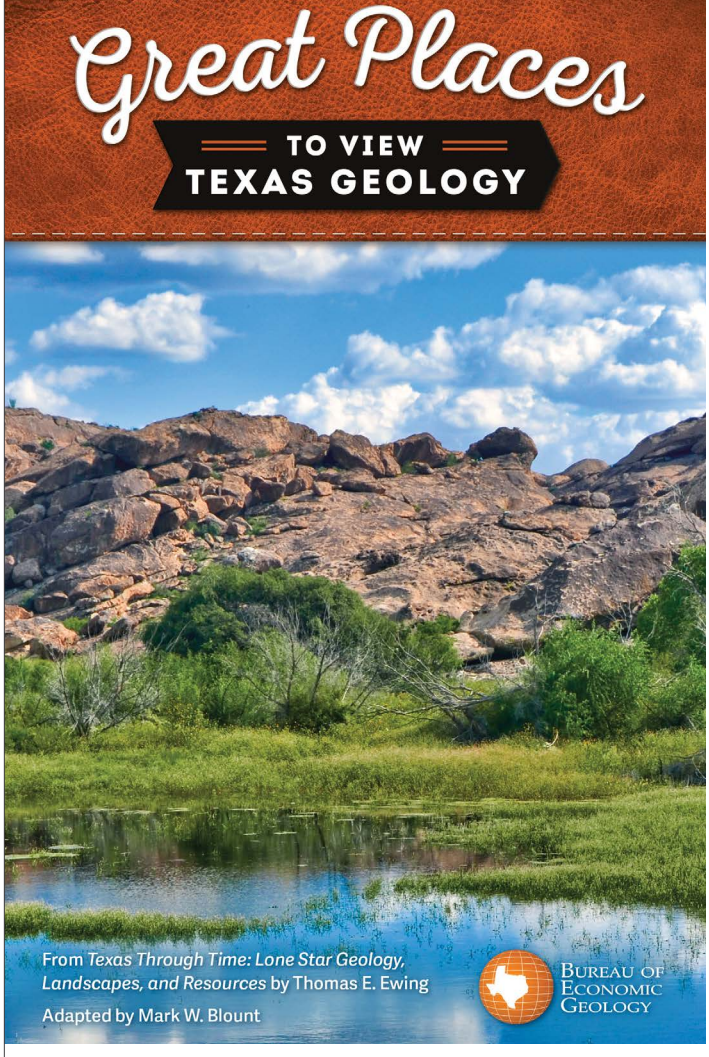
Horton Examines Andes Evolution in New Book

The Jackson School of Geosciences' Brian Horton, a professor in the Department of Geological Sciences and a research professor at the Institute for Geophysics, is the editor of a new book, "Andean Tectonics." The book addresses the geologic evolution of the Andes Mountains, the prime global example of subduction-related mountain building. It is co-edited by Andrés Folguera, a professor at the University of Buenos Aires.

The Andes form one of the most extensive orogenic belts on Earth, spanning about 8,000 kilometers along the western edge of South America. The tectonic history of the Andes involves a rich record of diverse geological processes, including crustal deformation, magmatism, sedimentary basin evolution, and climatic interactions. This book addresses the range of Andean tectonic processes and their temporal and spatial variations during the past 300 million years.

ON THE COVER: THE CENTRAL ANDES PEAK GEMELO ESTE.

TENNESSEE GEOLOGY: MOUNTAIN PRESS. ANDEAN TECTONICS: ANDRÉS FOLGUERA.



Bureau Shares Top Sites for Texas Geology

From the craggy peaks of Big Bend to the sandy shores of the Gulf of Mexico, Texas has some of the most spectacular geologic sites to explore in the U.S. In the new travel booklet "Great Places to View Texas Geology," readers can learn about 50 of the most unique and interesting of these sites, and hear the fascinating story of their underlying rocks.

The convenient travel booklet is published by the Bureau of Economic Geology and is adapted from the comprehensive book "Texas Through Time: Lone Star Geology, Landscapes and Resources." The booklet shares brief descriptions of the state's beautiful vistas and impressive features from a geological perspective, giving the reader a better understanding of the Earth's processes that created them over millions of years.

The book includes maps of Texas illustrating changes through geologic history, when seas covered the land, mountain ranges were built, and rivers carved deep canyons.

"Great Places to View Texas Geology" can be purchased in the bureau bookstore at ***store.beg.utexas.edu.***

ON THE COVER: HUECO TANKS, WEST TEXAS

Reaching Out on Campus

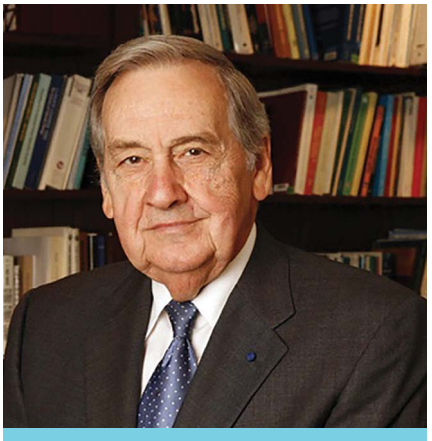
PHOTOS: JACKSON SCHOOL

CLOCKWISE: HIGH SCHOOL TEACHERS IN UT ONRAMPS LEARN HOW TO CONDUCT A CLASSROOM ACTIVITY THAT DEMONSTRATES HOW THE BUILD-UP OF GASES AND MAGMA INSIDE VOLCANOES CAN INFLUENCE THEIR SLOPE. THE TEACHERS PROGRAMMED THEIR OWN TILTMETERS. THE VOLCANO WAS CONSTRUCTED FROM A BEACH BALL; GOOD SPORTS FROM THE "PIE A JACKSONIAN" BOOTH AT THE GEOFAIR, A STUDENT-RUN EVENT THAT RAISED MONEY FOR GEOFORCE; DEPARTMENT OFFICE MANAGER PATRICK STAFFORD PIES ASSOCIATE PROFESSOR JOEL JOHNSON AT THE GEOFAIR.

AWARDS & HONORS

Hall of Distinction

The Jackson School of Geosciences Hall of Distinction is reserved for people who have achieved exceptional standing within the geosciences in industry, government or academia. Professor Emeritus William L. Fisher was inducted during a ceremony at his retirement event in November 2018. Three additional members were inducted at the Evening of Thanks in April 2019: Martin P.A. Jackson, Paul L. Stoffa and Leslie P. White.



William L. Fisher, Fall 2018

In November 2018, the Jackson School of Geosciences held a retirement event to honor the remarkable achievements of Professor Emeritus Bill Fisher. During his nearly 60-year career, Fisher has played an integral part of the geosciences community at The University of Texas at Austin and beyond. So it only made sense that the retirement party also doubled as a surprise induction ceremony into the Jackson School's Hall of Distinction.

"I can think of no other person who is more deserving of this honor than Bill," Dean Sharon Mosher told the crowd at the retirement event. "For nearly six decades, Bill Fisher has been a driving force in geology in Texas and beyond, helping turn the Bureau of Economic Geology into a world-class research institution, launching the Jackson School of Geosciences, educating generations of geoscience leaders and shaping policy across the nation."

Fisher retired after an amazing run at UT. He played a pivotal role in building the Jackson School of Geosciences, helping launch the school and serving as its inaugural dean. He led the Bureau of Economic Geology for 24 years. He was chairman of the Department of Geological Sciences from 1984 to 1990 and director of the Geology Foundation from 1984 to 2006. His only break from UT was when he served the Ford administration as deputy assistant secretary for energy and assistant secretary for energy and minerals. Under Fisher's vision and leadership, the bureau expanded from a small, well-respected organization to a research powerhouse. He inherited a bureau with a budget of $384,000. That grew to more than $20 million by the end of his tenure.

"If forming the Jackson School was Bill's crowning achievement, most certainly the transformation of the Bureau of Economic Geology over a quarter century was his most important body of work," said bureau Director Scott Tinker.

During his time at the university, Fisher also developed a strong friendship with businessman and philanthropist Jack Jackson and played an instrumental role in building a level of trust with Jackson that eventually led to the remarkable gift that founded the school. When university leadership needed a leader for the newly formed school, they turned to Fisher, who was named the school's inaugural dean. Larry Faulkner, who served as university president at the time, said he didn't seriously consider anyone else.

Fisher is credited with foundational discoveries in the geosciences. In 1967, he and colleague Joe McGowen introduced the concept of depositional systems, a fundamental part of modern stratigraphy and sedimentology. Fisher, along with colleague Frank Brown, introduced the concept of systems tracts, which linked contemporaneous depositional systems from source to sink. Fisher also led a 1987 assessment for the Department of Energy that turned around the then-prevalent view of natural gas scarcity. Fisher is among the founders of the field of seismic stratigraphy — a technique that revolutionized how energy companies search for hydrocarbons. It was developed in the late 1960s and early 1970s simultaneously by Exxon researchers and Fisher, who was working with colleagues at the Petrobras Brazilian oil corporation.

As an educator, Fisher was among the best, bringing his unsurpassed knowledge and unbridled energy to the classroom and field, and supervising 30 doctoral candidates and 153 master's students.

Fisher also served as president for numerous professional organizations for geoscientists. During his career, he was president of the American Association of Petroleum Geologists, the Association of American State Geologists, the American Institute of Professional Geologists, the American

PHOTOS: JACKSON SCHOOL.

Geological Institute, the Gulf Coast Association of Geological Societies and the Austin Geological Society.

"I can think of no one more appropriate to be in our hall," Mosher said.

Martin P.A. Jackson, Spring 2019

The late Martin P.A. Jackson was a world-renowned geoscientist and esteemed researcher at the Bureau of Economic Geology who was recognized globally for his groundbreaking work in the field of salt tectonics, with over 100 papers and three books on the subject.

"He's the number one person in the world by a goodly margin," said colleague Michael Hudec. "You cannot work effectively in salt tectonics without reading Martin's work."

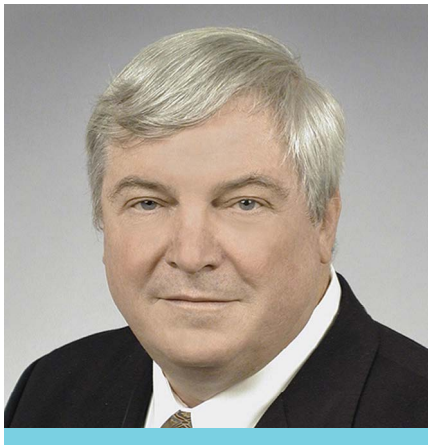
In recent years, Jackson had been exploring signs of salt-tectonic activity on other planetary bodies, including Mars and Neptune's moon Triton.

Born in Rhodesia (today Zimbabwe), Jackson initially studied old, hard Precambrian gneisses before moving to Texas and eventually becoming immersed in, as he called it, "a subsurface world of very young, soft rocks." He came to the bureau in 1980 and in 1988 was instrumental in creating the bureau's first industrial associates program, the Applied Geodynamics Laboratory (AGL).

Jackson's new consortium became a model for those that followed. The AGL now maintains over 30 participating companies and is widely considered the world's preeminent salt-tectonics research laboratory.

Jackson's numerous major career honors include the 2010 American Association of Petroleum Geologists' Robert R. Berg Outstanding Research Award in recognition of outstanding innovation in petroleum geoscience research and the Geological Society of London's 2013 William Smith Medal for outstanding research in applied geology. According to AAPG records, no one has won more AAPG technical awards, nor has anyone won in as many technical categories.

In addition to his preeminence as a research scientist, Jackson is equally regarded for his strength of character, gracious demeanor and unfailing humor. His friends and peers recall his kindness, humility, insightfulness and remarkable equanimity.



Paul L. Stoffa, Spring 2019

Paul L. Stoffa served as the director of the University of Texas Institute for Geophysics from 1994 to 2009 and Shell Distinguished Chair in Geophysics in the Department of Geological Sciences from 1997 to 2009. He is currently Shell Chair Emeritus.

Stoffa's expertise is in multichannel seismic acquisition, signal processing, acoustic and elastic wave propagation, modeling and inversion of geophysical data, along with parallel computing. His research focuses on developing new seismic data acquisition and processing methods that can be used to address complex geologic problems.

"Paul has a wonderful imagination and is able to create new methods to acquire and process geophysical data," stated his Society of Exploration Geophysicists (SEG) citation for honorary membership. "He has developed major acquisition and processing techniques in exploration geophysics that have made a huge contribution to our understanding of how to investigate the Earth's interior."

Stoffa received a B.S. in physics from Rensselaer Polytechnic Institute in 1970 and a Ph.D. in geophysics from Columbia University's Lamont-Doherty Earth Observatory in 1974. He has published over 100 research articles in refereed journals and co-authored "Global Optimization Methods in Geophysical Inversion" as part of the Elsevier Advances in Exploration Geophysics book series.

Stoffa served as a member of the Board of Governors of the Integrated Ocean Drilling Program Management International Inc. and served as chairman from 2005 to 2007. He was also a member representative (alternate) for The University of Texas at Austin to the Consortium for Ocean Leadership and is a member of SEG, the American Geophysical Union and the European Association of Geoscientists and Engineers.

Leslie P. White, Spring 2019

Leslie P. White thumbed a ride from Waco to Austin more than six decades ago looking for an education that would afford him a good career. He got it. But something else happened along the way.

White, who graduated from The University of Texas at Austin with a degree in geology in 1956, fell in love with the science and the university that educated him. The connections and relationships he made at UT are something he never forgot.

They are what prompted White and his wife, Dianne, to make a game-changing gift to the Jackson School of Geosciences in 2018. They donated the family's 266-acre Hill Country ranch to act as a living classroom for future generations of geoscientists and the first in a series of long-term scientific observatories that the school plans to set up around the state of Texas.

"Fieldwork is foundational for geosciences education at every level," said Jackson School Dean Sharon Mosher. "I can't stress how important Les and Dianne's donation is to the school and the opportunities it affords us to educate young geoscientists. Their foresight and generosity will pay dividends for Texas and beyond for generations to come."

White, who spent a career with Humble Oil and Exxon, began buying the property that would make up the ranch in 1995 and enjoyed it with family and friends throughout the years. The property — about an hour's drive southwest of campus outside of Dripping Springs — will have a tremendous impact on the Jackson School, particularly for hydrogeology research and education.

"Geologists need to be outside," White said. "They need to see geology where it lives. It thrills me to think about all the young people that will be out here."

Lavier Wins Evgueni Burov Medal

Luc Lavier, an associate professor in the Department of Geological Sciences and research scientist at the University of Texas Institute for Geophysics, was awarded the Evgueni Burov Medal by the International Lithosphere Program (ILP). The medal recognizes exceptional scientific work in combination with community services for midcareer achievements and serves to honor and recognize individuals who are enthusiastic researchers, scientists, teachers and contributors to ILP and the wider science community.

"I feel very happy to be recognized not just for my science but at the same time for being a positive influence on the community," Lavier said. "I think this is important for the visibility of the university and for the international reputation of the Jackson School."

Lavier's research group works to understand the fundamental laws controlling how the Earth deforms and changes over different timescales.

Hovorka Wins Greenman Award

Susan Hovorka, a senior research scientist at the Bureau of Economic Geology, has won the Greenman Award for her significant contributions to the development of greenhouse gas control technologies.

"I am honored to receive this award in recognition of my team's work," Hovorka said. "Joining the ranks of the prestigious individuals who have won this in the past illustrates the overall success of our work in greenhouse gas mitigation."

She received the award in October 2018 at the 14th annual Greenhouse Gas Control Technologies conference in Melbourne, Australia.

The award was presented to Hovorka by Kelly Thambimuthu, a scientist who worked on the fourth assessment report of the Intergovernmental Panel on Climate Change. The panel, along with former Vice President Al Gore, was awarded the 2007 Nobel Peace Prize.

"Hovorka's work in carbon dioxide storage has advanced the field of carbon capture and storage (CCS) immeasurably," said Thambimuthu. "Most priceless of all, she has been a mentor and inspiration to the CCS students she's advised and an internationally influential leader to many technical research teams."

Only 12 people have received the Greenman Award since its inception in 1996, including the 2018 winners.

Hovorka and her team at the Gulf Coast Carbon Center have worked on CCS since 1998 and identified potential sites for storage around the U.S. and abroad.

Piñón Receives LAS Lifetime Achievement Award

Jorge Piñón, an expert at the Jackson School on energy policy in Mexico and Latin America, was awarded the 2019 Lifetime Achievement Award from the Center for Latin American Studies (LAS) at the University of Florida, his alma mater.

The award is given by the alumni board of the LAS center and recognizes alumni whose achievements over the course of a number of years positively reflect the goals, principles and philosophy of the center.

Piñón is the director of institutional relations between UT and Mexico and the director of the Latin America and Caribbean Energy Program. During his time at UT, Piñón has been instrumental in strengthening the relationship between the Jackson School, and UT as a whole, and Mexican government and research institutions, in particular the National Autonomous University of Mexico.

Greenbaum Receives Fulbright

Jamin Greenbaum, a research associate at the University of Texas Institute for Geophysics, received a Fulbright U.S. Scholar Award to study coastal ice melting in East Antarctica.

"The award means a great deal to me because I see it as a platform to enhance the interdisciplinary and intercultural linkages that began with our earlier projects," he said.

A veteran of 12 Antarctic expeditions, Greenbaum will spend the 2019-2020 academic year in Shanghai, where he hopes to grow Antarctic research programs between China and the U.S.

Pierce Inaugural Recipient of AWG's Kent Award

Jackson School of Geosciences Lecturer Suzanne Pierce has won the inaugural Mavis D. Kent Award for Mid- Career Excellence from the Association for Women Geoscientists (AWG). The award is named for Kent, a founding member of the AWG, and the first woman to serve as president of the Association of Engineering Geologists.

In addition to being a lecturer at the Jackson School, Pierce is an alumna, graduating with a Ph.D. in hydrogeology from the Jackson School in 2006. She is also a research faculty member at the Jackson School's Environmental Science Institute and a research scientist at the Texas Advanced Computing Center. Pierce leads a community of researchers funded by the National Science Foundation who use intelligent systems to understand Earth, including water, energy, urbanization and the ecosystem. Her research helps develop tools and techniques that aid integrated computer modeling.

Behr Wins Presidential Early Career Award

Whitney Behr, a research fellow at the Jackson School of Geosciences, received a Presidential Early Career Award for Scientists and Engineers. The award is the highest honor given by the United States government to engineers and scientists beginning their independent research careers and who show exceptional promise for leadership in science and technology.

In addition to her UT appointment, Behr is a professor at ETH Zürich, a university in Switzerland. She studies the mechanics and deformation of plate boundaries and faults.

Awards

Common Abbreviations:

AAPG..... American Association of Petroleum Geologists

AGS..... Austin Geological Society

AGU ..... American Geophysical Union

BEG..... Bureau of Economic Geology

DGS ..... Dept. of Geological Sciences

EERI.....Earthquake Engineering Research Institute

GSA.....Geological Society of America

GSEC .....Graduate Student Executive Committee

IAS ..... International Association of Sedimentologists

JSG ..... Jackson School of Geosciences

SEG... Society of Exploration Geophysicists

SEPM... Society for Sedimentary Geology

SSA.....Seismological Society of America

UTIG ..... Institute for Geophysics

Faculty and Researchers

WILLIAM AMBROSE
J. C. "Cam" Sproule Memorial Award, AAPG

ADRIEN ARNULF
Director's Circle of Excellence, UTIG

WHITNEY BEHR
Presidential Early Career Award for Scientists and Engineers, U.S. Government

DAN BREECKER
Knebel Teaching Award, Introductory Course, DGS

SAHAR BAKHSHIAN
Best Poster Award, Texas Advanced Computing Center

JULIA CLARKE
Fellow, Royal Society of Biology

TIM DOOLEY
Tinker Family Publication Award, BEG

OLIVER DUFFY
Tinker Family Publication Award, BEG

PEDRO DI NEZIO
Director's Circle of Excellence, UTIG

NAIARA FERNANDEZ
Tinker Family Publication Award, BEG

ANDRAS FALL
Tinker Family Publication Award, Runner-up, BEG

SERGEY FOMEL
Best Paper in Interpretation Journal Award, SEG/AAPG

Best Paper in Geophysics Honorable Mention, SEG

JULIA GALE
Best Recent Publication, AAPG

JOHN GOFF
Director's Circle of Excellence, UTIG

TIMOTHY GOUDGE
Knebel Teaching Award, Graduate Course, DGS

JAMIN GREENBAUM
Fulbright Scholar, Department of State

MAHDI HADDAD
Future Leader, American Rock Mechanics Association

SCOTT HAMLIN
Monroe G. Cheney Science Award, AAPG

BRIAN HORTON
Outstanding Researcher Award, UTIG

SUSAN HOVORKA
Greenman Award, Greenhouse Gas Control Technologies Conference

MIKE HUDEC
Tinker Family Publication Award, BEG

MARTIN P.A. JACKSON (POSTHUMOUS)
Tinker Family Publication Award, BEG

WONSUCK KIM
Knebel Teaching Award, Undergraduate Course, DGS

LUCY KO
Tinker Family Publication Award, Runner-up, BEG

TOTI ERIK LARSON
Jules Braunstein Memorial Award, AAPG

LUC LAVIER
Evgueni Burov Medal, International Lithosphere Program

STEVE LAUBACH
Best Recent Publication, AAPG

BOB LOUCKS
Tinker Family Publication Award, Runner-up, BEG

CHRISTOPHER LOWERY
Outstanding Young Researcher Award, UTIG

TIP MECKEL
Outstanding Educator Award, JSG

YUKO OKUMURA
Director's Circle of Excellence, UTIG

JEFFREY PAINE
Fellow, GSA

SUZANNE PIERCE
Mavis Kent Award, Association for Women Geoscientists

STEPHEN PHILLIPS
Outstanding Postdoc Award, UTIG

STEVE RUPPEL
Tinker Family Publication Award, Runner-up, BEG

REINALDO SABBAGH
Best Poster Award, AAPG

BRIDGET SCANLON
O.E. Meinzer Award, GSA

JOHN SNEDDEN
Director's Circle of Excellence, UTIG

DANIEL STOCKLI
Outstanding Research Award, JSG

ALEXANDER SUN
Tinker Family Publication Award, Runner-up, BEG

XINMING WU
Honorary Lecturer, SEG
Best Paper in Geophysics Honorable Mention. SEG

DUNCAN YOUNG
Director's Circle of Excellence, UTIG

TONGWEI ZHANG
Tinker Family Publication Award, Runner-up, BEG

Promotions

GINNY CATANIA
Professor, DGS

PEDRO DI NEZIO
Research Scientist, UTIG

ANDRAS FALL
Research Scientist, BEG

PETER FLAIG
Research Scientist, BEG

AFU LIN
Professor, DGS

KRISTA SODERLUND
Research Scientist, UTIG

BRAD WOLAVER
Research Scientist, BEG

Students

DOUGLAS BARBER
Best Talk Fall Seminar, DGS

LAKIN BEAL
Graduate Groundwater Field Methods Award, DGS
Outstanding Teaching Assistant, Spring, DGS

GRACE BEAUDOIN
2nd Place Graduate Folk-McBride-Cloos Petrography Contest, DGS

KERI LEIGH BELCHER
Technical Sessions Best Speaker, Fall M.S., DGS

CHANCE BOLDUC
Undergraduate Groundwater Field Methods Award, DGS

KRISTINA BUTLER
Student Travel Grant, SEPM
Travel Grant, GSA South-Central Section
Grants-in-Aid, AAPG
Postgraduate Grant, IAS

TOMAS CAPALDI
Outstanding Teaching Assistant, Fall, DGS

MAX S DANILLER-VARGHESE
Glenn and Martha Vargas Endowed Presidential Scholarship, UT

CANSU DEMIR
Research Grant, GSA

THOMAS ETZEL
GSEC Student Service Award, JSG
1st Place Graduate Folk-McBride-Cloos Petrography Contest, DGS

STEPHEN FERENCZ
Outstanding Teaching Assistant, Fall, DGS

SUYU FU
John C. Jamieson Student Paper Award, AGU

OMAR RAMIREZ GARCIA
Director's Award, Earth and Energy Resources Graduate Program

KIARA GOMEZ
Grants-In-Aid, AAPG
Travel Award, GSA

HIMA J HASSENRUCK-GUDIPATI
Outstanding Student Presentation Awards, AGU

EVA HOFFMAN
Best Graduate Paper, JSG

MARY HOFFMANN
2nd Place Undergraduate Folk-McBride-Cloos Petrography Contest, DGS

JAIME HIRTZ
Internship, USGS/NAGT

SCARLETTE HSIA
Graduate Student Research Grant, GSA
Graduate Research Fellowship, NSF

ESTEFANIA SALGADO-JAUREGUI
Graduate Student Research Grant, GSA
Fulbright Scholar, Department of State

AARON R JONES
Repsol Student Innovation Award
Environmental Fellowship, University of Michigan

SEAN KACUR
Internship, USGS/NAGT

DOMINIK KARDELL
Pre-Drilling Activity Award, IODP

LANDON LOCKHART
3rd place Earth Model Award, Halliburton

JACOB MAKIS
Technical Sessions Best Speaker, Spring M.S., DGS

NAOMA MCCALL
Endowed Presidential Scholarship, UT

STEFANO NEROZZI
Best Talk Spring Seminar, DGS

MATTHEW NIX
Estwing Hammer Award, DGS

MICHAEL O'CONNOR
Best Talk Spring Seminar, DGS

MARGO ODLUM
Technical Sessions Best Speaker, Spring Ph.D., DGS

KELLY OLSEN
Outstanding Graduate Student, UTIG

EMILY CAMILLE PEASE
Ed Archuleta Desalter Scholarship, Texas Desalination Association
Outstanding Student Presentation, AGU

ESBEN PEDERSEN
2nd Place Imperial Barrel Award, AAPG

FERNANDO APANGO PEREZ
Director's Award, Earth and Energy Resources Graduate Program

NATALLIA PIATRUNIA
Outstanding Teaching Assistant, Fall, DGS

SEBASTIAN RAMIRO RAMIREZ
Research Fellowship, Equinor (Statoil)

EVAN J RAMOS
Student Geoscience Grant, GSA
Honorable Mention, Ford Foundation Predoctoral Fellowship

MARK REID
2nd Place Imperial Barrel Award, AAPG

SAM ROBBINS
2nd Place Imperial Barrel Award, AAPG

HEATHER ROSE
Green Fund Grant, UT

ADDISON SAVAGE
Undergraduate Prize, Mineralogical Society of America

COLIN SCHROEDER
Distinguished Speaker, Society of Petrophysicists and Well Log Analysts

SINJINI SINHA
Professional Development Award, GSA and University of Arkansas

BEN SMITH
Best Talk Spring Seminar, DGS
Jules Braunstein Memorial Award, AAPG

CHIJUN SUN
1st Prize Best Poster Presentation, Urbino Summer School in Paleoclimatology

COLE SPEED
The Institut Français du Pétrole Grant, AAPG
2nd Place Imperial Barrel Award, AAPG
Seed Grant, National Center for Airborne Laser Mapping

BRANDON SHUCK
Honorable Mention Award for GeoPRISMS Student Prize, AGU

GABRIEL TAGLIARO
Outstanding Graduate Student, UTIG

DIMITRI P VOYTAN
Travel Grant, SSA

MATTHEW WADE
Endowed Scholarship, AGS
1st Place Undergraduate Folk-McBride-Cloos Petrography Contest, DGS

ANNA WEISS
Currano Scholarship, The Bearded Lady Project and Paleontological Society
Student Research Grant, GSA
Technical Sessions Best Speaker, Fall Ph.D., DGS

KATHLEEN WILSON
Foundation Grants-in-Aid, AAPG
Student Travel Grant, SEPM

NATALIE WOLFENBARGER:
2020 Zonta International Amelia Earhart Fellowship
2019 Travel Award, International Glaciological Society

WEN-YING WU
Outstanding Teaching Assistant, Spring, DGS

LEO ZENG
2nd Place Imperial Barrel Award, AAPG

XIAFEI ZHAO
Endowed Scholarship, AGS

Staff

ROSALIND GAMBLE
Eleanor Picard Excellence Award, UTIG

BIRCH GRIESSE
Guion Library Staff Honors, DGS

NANCY HARD
Career Award, UTIG

KIM LAVALLEY
Outstanding Service Award, JSG

LUISANA LOPEZ
Guion Library Staff Honors, DGS

MELINDA MCGLAUN
Staff Excellence Award, DGS

SARAH MCKAY
James W. Vick Texas Excellence Awards for Academic Advising, Texas Exes

DAVID MELANSON
Guion Library Staff Honors, DGS

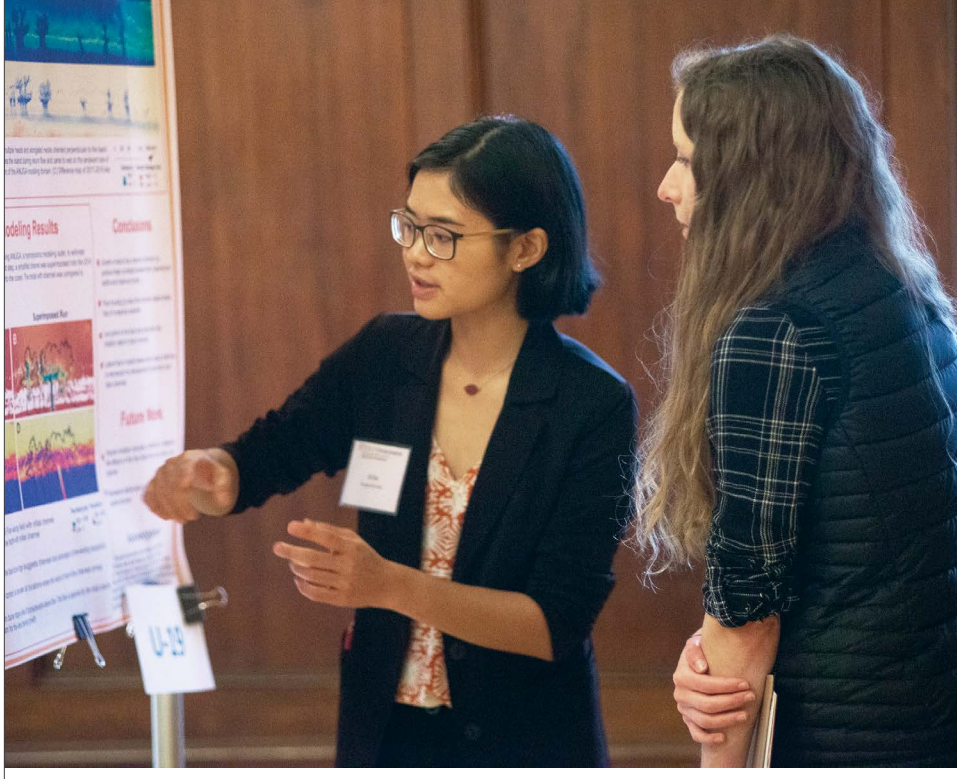
JOSH O'CONNELL
Outstanding Support Staff, UTIG

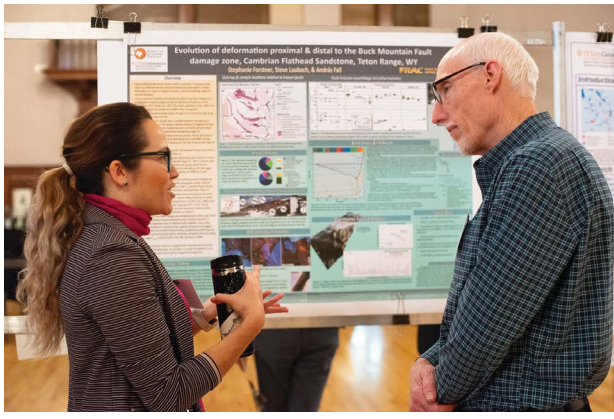
PAMELA PEREZ
Guion Library Staff Honors, DGS

JORGE PIÑÓN
Lifetime Achievement Award, Center for Latin American Studies at the University of Florida

SARA SIEBERATH
Staff Excellence Award, JSG

DENNIS TROMBATORE
Joseph C. Walter, Jr. Excellence Award, JSG





Student Research Symposium Awards

In February 2019, the Jackson School's Graduate Student Executive Committee organized its 8th Annual Research Symposium. Winners and honorable mentions are as follows:

LATE-CAREER PH.D. STUDENT

1st Place: Ken Ikeda: Numerical and Laboratory Study of Low-Frequency Elastic Properties of Limestone

2nd Place: Tomas Capaldi: Cordillera Evolution Along the Southern Central Andean Margin Recorded by Detrital Zircon U-Pb and Hf Isotopes

Honorable Mention: Brandon Shuck: From Rifting to Subduction: Evidence for the Role of Past Tectonics Influencing Subduction Initiation at the Puysegur Trench, New Zealand

LATE-CAREER MASTER'S STUDENT

1st Place: Skyler Dong: Pore-Scale Methane Hydrate Formation Under Pressure and Temperature Conditions of Natural Reservoirs

2nd Place: Gabriel Giacomone: Paleogeographic Reconstruction and Characteristic Trends of a Basin Floor Fan in Los Molles Fm, Neuquén Basin, Argentina

Honorable Mention: Fernando Apango: Top Seal Evaluation of Miocene Deep-Water Reservoirs, Southern Gulf of Mexico

EARLY-CAREER GRADUATE STUDENT

1st Place: Andrew Gase: Crustal Structure of the Northern Hikurangi Margin from Marine Seismic Reflection Imaging and Onshore-Offshore Seismic Tomography: Implications for Megathrust Heterogeneity and Overpressure in a Region of Shallow Slow

2nd Place: Scott Eckley: Isotopically Light Carbon (δ13C-31 to -24 ‰) in the Mantle by at Least 3.2 Ga: Insights from Carbonado Diamond

Honorable Mention: Natalie Wolfenbarger: Can Radar Attenuation Serve as a Signal of Ice Shell Salinity on Europa?

UNDERGRADUATE STUDENT

1st Place: Arisa Ruangsirikulchai: Evolution of Return-Flow Channels Cut Into San Jose Island, Texas, Caused by Hurricane Harvey

2nd Place: Brooke Kopecky: Reconstructing Paleo-ENSO Variability During the Holocene Using Geochemical Proxies from Corals

Honorable Mention: Matthew Nix: Controls on the Sedimentation and Morphology of an Oxbow Lake Along the Trinity River, Texas, USA

BEST REPRESENTED RESEARCH GROUP

1st Place: David Mohrig Research Group

2nd Place: Harm Van Avendonk Research Group

CLOCKWISE FROM LEFT: UNDERGRADUATE ARISA RUANGSIRIKULCHAI SHARES HER POSTER ABOUT CHANNELS CUT INTO SAN JOSE ISLAND BY THE BACKFLOW OF HURRICANE HARVEY'S STORM SURGE; A GROUP SHOT OF THE STUDENT RESEARCH SYMPOSIUM AWARD WINNERS; GRADUATE STUDENT STEPHANIE FORSTNER EXPLAINS HER RESEARCH ON EVOLUTION OF DEFORMATION IN THE BUCK MOUNTAIN FAULT DAMAGE ZONE IN THE CAMBRIAN FLATHEAD SANDSTONE IN THE TETON MOUNTAINS.

PHOTOS: JACKSON SCHOOL.

GEO660

Students spent six weeks in the field conducting geology at classic sites across West Texas, New Mexico, Colorado, Wyoming, Montana, Idaho and Utah.

ABOVE: RESEARCH SCIENTIST PETER HENNINGS SHARING THE SURFACE AND SUBSURFACE GEOLOGY OF THE SAWTOOTH MOUNTAINS OF MONTANA.

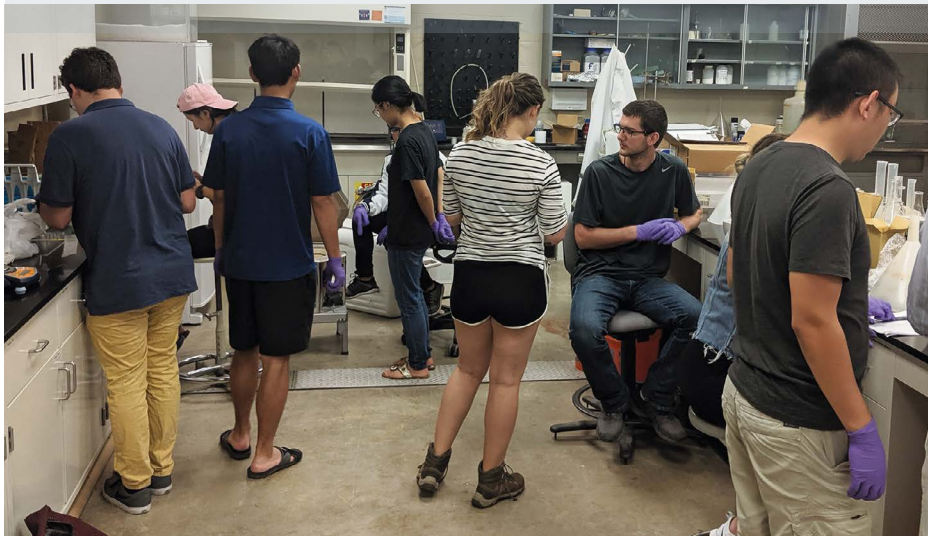
CLOCKWISE: STUDENTS WORK ON A MAPPING PROJECT IN ALCOVA, WYOMING; PROFESSOR DAVID MOHRIG AND GROUP STUDY MODERN SAND DUNES AT WHITE SANDS, NEW MEXICO; A GROUP HOOK 'EM IN THE GUADALUPE MOUNTAINS OF NEW MEXICO.

PHOTOS: JACKSON SCHOOL.

MG&G

The class travelled to Port Aransas where they learned about the geologic history of the Gulf Coast by collecting and analyzing their own marine data.

CLOCKWISE: ABOARD THE R/V SCOTT PETTY AFTER COMPLETING THE LAST DAY OF MULTIBEAM MEASUREMENTS; STUDENTS EXTRACT A SEDIMENT CORE FROM A BOX CORER FROM THE DECK OF THE R/V BROOKS MCCALL; CELEBRATING A SUCCESSFUL DAY OF SEDIMENT CORING; STUDENTS PARTICIPATING IN THE GRAIN SIZE ANALYSIS LAB IN THE SED LAB ON THE J.J. PICKLE RESEARCH CAMPUS; STUDENT NIKKI BRETTING UNLOADING CORES FROM THE R/V BROOKS MCCALL.



PHOTOS: JACKSON SCHOOL.

hydro

Students in the hydrogeology field course travelled near and far. Their field sites included Austin's own Hornsby Bend, the Jackson School's White Family Outdoor Learning Center and the Jemez River in the Valles Caldera, New Mexico.

CLOCKWISE: STUDENTS USE AN ACOUSTIC DOPPLER VELOCIMETER TO MEASURE FLOW OF THE JEMEZ RIVER IN THE VALLES CALDERA, NEW MEXICO; STUDENTS (LEFT TO RIGHT) JACKSON TRCKA, ANTHONY EDGINGTON, LAUREL HE, BALEY JONES AND SUVAN CABRAAL; STUDENTS MEASURE FLOW IN SOUTH ONION CREEK AT THE WHITE FAMILY OUTDOOR LEARNING CENTER IN DRIPPING SPRINGS; ANDREW DENHAM (LEFT) AND CHRISTIAN ROUMELIS MEASURE STREAM FLOW IN THE VALLES CALDERA.

PHOTOS: JACKSON SCHOOL.

Walter Geology Library 2018–19 Annual Report

This year's big event came late last summer, when we were contacted by members of the local caving community to review the library of Bill Mixon. Bill, who has since passed away, was a long time collector of caving materials, and the book review editor for the National Speleological Society. His library was a treasure of international, national and regional scope. Over a compressed period of time last summer, we reviewed the materials, finding over 1,000 books and another 1,000 periodical issues that represented new materials for our already strong cave and karst collections. Large gifts put a strain on our current staffing levels, but as this year closes, with concerted efforts by our student workers and processing staff, this extraordinary collection is almost all available. Since about one-third of the material is only owned here, and due to the non-commercial nature of many caving publications, we are already seeing interlibrary loan requests. We are profoundly grateful to Bill and the Austin caving community for their partnership and generosity.

All that new material creates space issues, and with Library Storage facility #3 open, we have begun transferring a great deal of little used material and material replaced by online access to storage. We are also creating space to take down some shelving in the area where we have had repeated water incursions to reduce risk. This will also create another quiet study area.

This year's major purchases included more quads of the China 1:250K Geologic Atlas, a number of new maps from Germany, and several globes—Mars topography, world geology, and three paleogeography globes from various eras. Based on strong performance, we have renewed our access to EarthDoc, the full-text online database of EAGE publications, covering a broad spectrum of earth science topics. We have also signed a site license to the Blakey Deep-Time Maps, but there have been some technical issues with finding a proper platform to serve up the third-party data that have delayed the usefulness of this acquisition. The convenience of digital resources sometimes masks their back-office complexity.

UT Library's efforts to develop a library GIS portal are bearing fruit. Michael Shensky, the Libraries GIS coordinator, has been working hard and is about to launch our portal after a year of infrastructure development. It will be modest initially, with hopes of advances over time. In other e-services news, we continue to add legacy theses to our online repository, averaging five per month. We completed a pilot project with the Vertebrate Paleontology Lab to digitize a small number of their WPA surveys. You can see them here: ***repositories.lib.utexas.edu/handle/2152/65659***. The Jackson School continues to add materials to our Scholarworks repository, as well as our newer Texas Data Repository, adding more "open" materials for public access.

Our social media presence is strong, with more than 900 people following our Facebook page ***www.facebook.com/UTGeoLib*** (you should too!). Nicola Tisato and GSEC continue to sponsor ROKAFE, the Monday coffee klatch, in the library, and we continue to sponsor the new grad student pizza lunch during orientation. Inside the library space, the periodicals room near the entrance is almost emptied out as our subscriptions have mostly transitioned to digital access. We have added another white board, and we are currently using the space as a group study and conference area. There have been continuing discussions of converting that space by moving the gem and mineral displays upstairs where we can offer more space, better security, and more available open hours. Those discussions are getting more concrete as we investigate design and cost issues and look for funding, so watch this space!

In staff news, Stacy Ogilvie has transitioned to be the new cartographic materials cataloger at PCL, where she is working with all the map collections to reduce our processing backlog. James Galloway has taken her place as the Unit Manager, and is working on a number of projects to enhance operations. Melissa Van Ostran, long our night supervisor, has relocated as night supervisor at the new Engineering Library, and Alice Dewberry, after many years working half-time in the afternoons has decided to retire at the end of the summer. We thank Melissa, Alice and Stacy for their years of service. Aubrey Stark-Miller, previously of PCL and Course Management Services, has joined us working afternoons and evenings. Aubrey has been a great addition to our staff, and has spent her first few months learning our routines and settling in.

Three student workers graduated over the course of this year after many semesters of service with us: our GRA Birch Griesse, Yushan Li, and Stephen Scaglione. We wish them well in their future endeavors. This year's winners of the Guion service award were recognized for their extra efforts in processing our new caving gift: Birch Griesse, Pamela Perez, Luisana Lopez and David Melanson. I presented on library and information topics to GEO 298T, and several courses, and continued to serve as chair of the AGI GeoRef advisory committee.

Dennis Trombatore, Librarian

YUSHAN LI, AN EXCHANGE STUDENT FROM CHINA, AND GLOBE. LI WORKED IN THE LIBRARY DURING HER TIME AT UT. PHOTO: JACKSON SCHOOL.

In summer 2019, Jackson School of Geosciences Professor Bayani Cardenas led members of his lab on field work in Alaska. The team studied groundwater within subsea permafrost at the bottom of Arctic lagoons, and they explored how soils store and transmit water. Graduate students Micaela Pedrazas Hinojos, Cansu Demir and Michael O'Connor wrote about the experience.

Science at the Arctic Circle

Arctic lagoons along the Beaufort Sea coast of Alaska are sensitive systems hosting vast amounts of ecological life and are home to native Alaskan coastal communities. Subsurface geologic understanding and delineation of the groundwater-lagoon connectivity is necessary to understand the contribution of thawing ice-rich permafrost to lagoon systems in terms of organic carbon, greenhouse gases, petrophysical properties and potential impacts to coastal communities, infrastructure and ecosystems. There emerges the need of subsea permafrost distribution investigation across the lagoons. To study this phenomenon outside the comfort of our office, we set on an adventure to acquire data in Kaktovik, Alaska. Micaela Pedrazas Hinojos, M.S. student, used electrical geophysics to infer the petrophysical properties deep in the subsurface both along and across the coast of Kaktovik Lagoon. This method was used to reveal the spatial extent of permafrost thawing and the interplay between saltwater from the Beaufort Sea and freshwater from thawed permafrost. Cansu Demir, Ph.D student, seeks to build on this petrophysical model to model groundwater flow beneath the Arctic lagoon and predict concomitant changes in Arctic coastal areas based on field observations. During the campaign, we acquired electrical resistivity data, groundwater samples, temperature and salinity data. To understand the community's perspective on these issues, we were able to share ideas, meals, and partake in the native Iñupiat culture, and go polar bear watching.

Cansu Demir, *Doctoral Candidate, and* ***Micaela Pedrazas Hinojos,*** *Master's Student*

ABOVE, LEFT: GRADUATE STUDENTS MICAELA PEDRAZAS (LEFT) AND CANSU DEMIR EXAMINE PERMAFROST ON AN ERODED CLIFF SIDE. **ABOVE, RIGHT:** (L TO R) GRADUATE STUDENTS MICHAEL O'CONNOR, STEPHEN FERENCZ AND PROFESSOR BAYANI CARDENAS ABOUT TO LIFT OFF FOR THE NORTH SLOPE OF ALASKA FOR THE FIRST-EVER SOIL STRATIGRAPHY MAPPING MISSION.

Alaska: The Final Frontier

The goal of our summer 2019 field campaign was to expand our understanding of how Arctic soils store and transmit water and how much carbon is stored within them. Our research is motivated by estimates that about half of the soil carbon on Earth is stored in the Arctic, and as the Arctic warms (which it's currently doing, rapidly), that carbon can be released into the atmosphere and exacerbate global warming. Understanding how much carbon is in these soils and how water is stored and flows in them will help to more accurately predict how these soils will respond to changing climate. Much of the previous work in Alaska has been based on data collected in a very small area of the Arctic in the vicinity of the permanent Toolik research station. Our aim this year was to expand beyond that small area —from the local to the regional scale. Thanks to NSF and NASA funding, we had the incredible opportunity to use a helicopter to access remote and otherwise inaccessible locations. It was more successful than we hoped for! In total, we collected approximately 100 soil samples distributed over hundreds of square miles. These observations represent the first ever documented data in this region and will undoubtedly improve our understanding of Arctic soils.

Michael O'Connor
Doctoral Candidate

PHOTOS: BAYANI CARDENAS.

Searching for Fossils in Patagonia

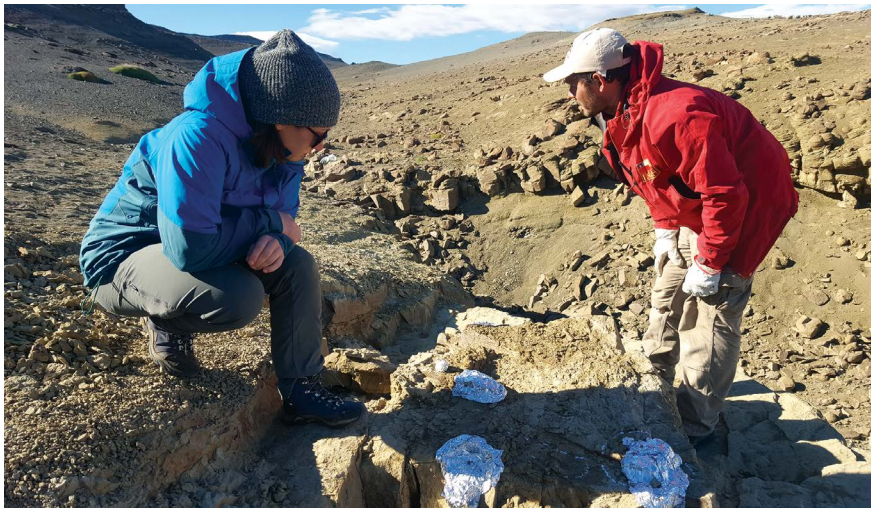
North of the town of Puerto Natales, Chile, near Torres del Paine National Park, an international group of scientists from across South America, Germany, Japan and, most recently, Texas has been working to uncover fossils in Patagonia. The field work is part of a multidisciplinary project of geologists and paleontologists studying biotic connections between South America and Antarctica.

Julia Clarke, Wilson Professor of Paleontology at The University of Texas at Austin, and Ph.D. student Sarah Davis have been working with scientists at the Instituto Antártico Chileno (INACH) and the University of Chile for the last three years. The team, co-led by Director of INACH Dr. Marcelo Leppe, is looking for fossils and studying the geology of the Las Chinas field site. The site records the time interval just before, during and after the Earth experienced the last of its "Big Five" mass extinctions, which resulted in the demise of non-bird dinosaurs. Recently, Clarke and Davis collaborated with Jackson School Professor Brian Horton and Ph.D. student Sarah George to demonstrate the presence of this key time interval in a paper published in the *Journal of South American Earth Sciences.* Clarke and Davis study the evolution of birds, the only group of dinosaurs that survived this catastrophic event; their work with the field site focuses on finding bird and other small theropod dinosaur fossils to better understand their diversity and evolution before and after the extinction event.

In February 2019, during the Chilean summer, the team returned to the field to continue the search for signs of ancient life. After a seven-mile hike through grassy foothills, the researchers set up camp near fossil bearing outcrops, where they stayed and worked for two weeks. The site presented several challenges: steep climbs up to outcrops, populations of pumas that roam the area and the ever-changing Patagonian weather. This year the team faced a new obstacle after the entire valley was covered in a foot of snow during the middle of the field season, covering the fossiliferous rocks. Despite this, the group had a successful season, recovering the remains of several dinosaur groups including birds, as well as reptiles, amphibians and mammals. These fossils were excavated and brought to the University of Chile and INACH.

Clarke, Davis and the team plan to return to the field in February 2020. Work at the site has included several members of the Clarke lab, including graduate students Chris Torres and Grace Musser and undergraduates Hector Garza and Sarah Hood. This field work is made possible by funding from the Jackson School and the National Science Foundation.

Sarah Davis
Doctoral Candidate



TOP: MEMBERS OF THE 2019 FIELD TEAM CARRYING A JACKETED FOSSIL THROUGH THE SNOW BACK TO CAMP. **CENTER:** DAVIS (LEFT) AND ARGENTINE FOSSIL PREPARATOR JONATAN KALUZ WITH A DINOSAUR SKELETON DISCOVERED BY CLARKE. **BOTTOM:** THE TEAM STANDING NEXT TO THE TAIL OF A TITANOSAUR (THE LARGEST GROUP OF DINOSAURS) DISCOVERED BY JACKSON SCHOOL PROFESSOR BRIAN HORTON.

TOP: SARAH DAVIS; CENTER: ROY FERNÁNDEZ JIMENEZ; BOTTOM: SARAH DAVIS.

TOP: THE GROUP AMONG THE CAMPANIAN GROWTH STRATA OF THE NORTH HORN FORMATION, UTAH. **BOTTOM:** DRONE PHOTO OF STUDENTS AND TRIP INSTRUCTORS ON THE TOP OF CAMPANIAN NESLEN FORMATION (FLUVIAL-TIDAL CHANNELS) AMONG THE BOOK CLIFFS OF UTAH.

Sediment and Structure in the Cordilleran Foreland Basin System

The fall 2018 field trip for the courses GEO 383S (Foreland Basins) and GEO 383 (Clastic Depositional Systems) at The University of Texas at Austin explored the diverse stratigraphic and sedimentologic record of the Cordilleran foreland basin system in Utah and western Colorado. The marine and nonmarine depositional systems form important analogues for foreland reservoir units around the world. The 14 UT graduate students in the two courses worked with professors and researchers Ron Steel, Cornel Olariu and Brian Horton to assess the long-term sedimentary and structural evolution of the foreland basin system, with consideration of regional sea level, climate and tectonics in the development of varied stratigraphic systems.

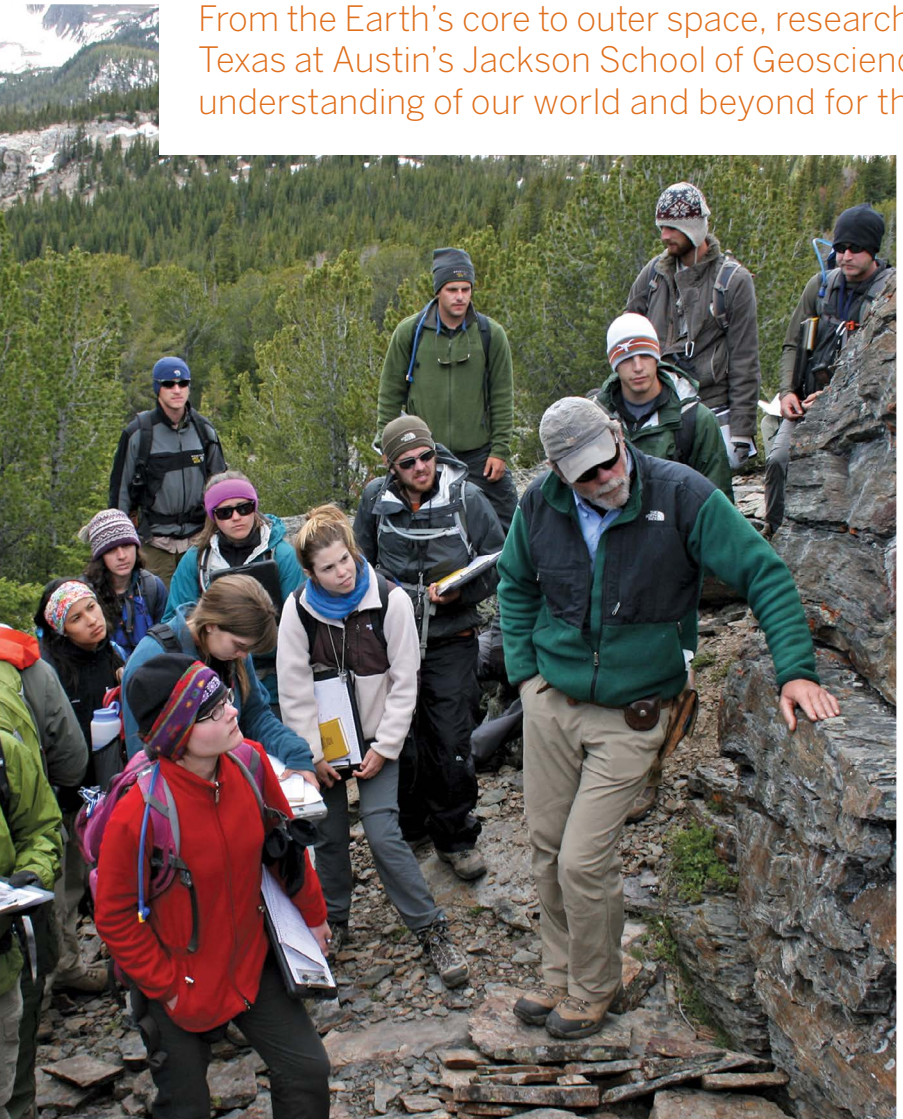
The trip was funded by Chevron.

Brian Horton
Professor, Department of Geological Sciences
Research Professor, Institute for Geophysics

PHOTOS: BRIAN HORTON.

TAKING ON 21ST CENTURY CHALLENGES CREATING 21ST CENTURY LEADERS

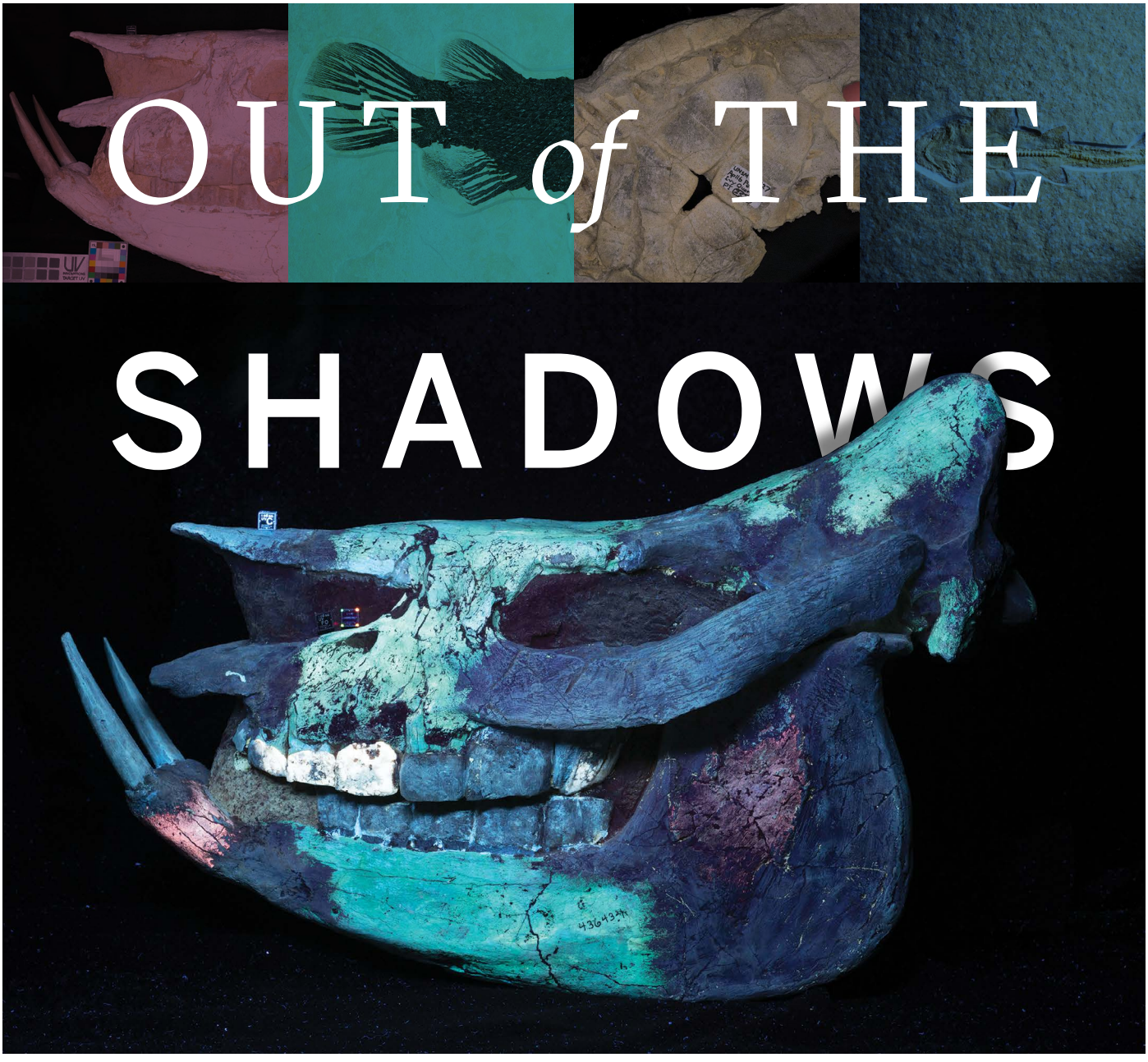
From the Earth's core to outer space, research at The University of Texas at Austin's Jackson School of Geosciences is advancing the understanding of our world and beyond for the benefit of humankind.



TEXAS Geosciences

The University of Texas at Austin
Jackson School of Geosciences

OUT of THE SHADOWS



A new fossil photography technique developed at the Jackson School of Geosciences is revealing scales, hair and other soft tissues, as well as signs of repair.

BY MONICA KORTSHA

Enter any natural history museum around the country, and it probably won't be long until you encounter a cache of fossils—almost certainly big dinosaurs—posed and lit so they look nearly lifelike, not a single tooth or tailbone out of place.

These specimens are meant to inspire wonder, to light a spark that can lead to or strengthen a lifelong interest in science. But the truth is that fossilization is not pretty process. A carcass could have been gnawed upon and scattered by ancient scavengers, bones crushed or distorted by the piling on of millions of years' worth of rock. And when a skeleton does happen to show up on the surface, weathering and erosion start to whittle everything away.

ABOVE: AN ASIAN RHINO SKULL UNDER UV C LIGHT. THE DIFFERENT COLORS INDICATE A MOSAIC OF MATERIAL, INCLUDING BONES FROM OTHER UNKNOWN FOSSIL SPECIMENS (PINK) AND PLASTER OR PAINT (DARK PURPLE). THE GREEN COLOR IS FROM THE ORIGINAL BONE.

PHOTO: MIKE EKLUND.

Making dinosaurs and other fossils look good comes down to the dedication and skill of fossil preparators.

However, the preparation process includes techniques that can sometimes lead to scientifically important features, such as soft tissues or fine structures, being unknowingly damaged or stripped away. And sometimes the reconstruction work on fossil specimens is so good that the prepared specimens can fool the very scientists who are studying them. What looks like an actual attribute can turn out to be the result of repair. Biological remains may lurk in places where it looks like nothing is there.

ABOVE: THE SAME ASIAN RHINO SKULL AS ON THE PREVIOUS PAGE BUT IN VISIBLE LIGHT. BONE AND PLASTER BLEND PERFECTLY TOGETHER — MAKING FOR AN ATTRACTIVE SKULL, BUT A LOUSY SCIENTIFIC SPECIMEN. **BELOW:** MIKE EKLUND, A JACKSON SCHOOL FOSSIL PREPARATOR AND THE DRIVING FORCE BEHIND A NEW FOSSIL PHOTOGRAPHY TECHNIQUE, SHINES A LIGHT ON THE SKULL OF A RHINO-LIKE *BRONTOTHERIUM* KEPT IN THE JACKSON SCHOOL'S VERTEBRATE PALEONTOLOGY COLLECTIONS. MATTHEW BROWN, THE DIRECTOR OF THE COLLECTIONS, STANDS NEARBY.

RHINO HEAD, NORMAL LIGHTING: MIKE EKLUND. EKLUND WITH LIGHT: JACKSON SCHOOL.

Mike Eklund, a fossil preparator and research associate at the Jackson School of Geosciences, has spent years preparing fossils for scientific study and display. The experience inspired him to take the lead in developing a new photography technique that does not seek to just put fossils in their best light, but under a whole sequence of lights—17, to be exact—that can illuminate a host of features, including those that would have otherwise remained hidden.

"This is the shortest path to getting the most complete story," Eklund said.

He calls the technique Progressive Photonics, a nod to the stepwise nature of the approach and its potential for growth as more photographic techniques are incorporated. The approach is starting discussions about how fossils should be researched and prepared. It also has Eklund and others making the case that it's not just scientists who can benefit from seeing fossils outside of their exhibit-ready looks. Developing the technique has made him an advocate for fossils as not just wow-worthy specimens but as tools to teach how the science of paleontology is done.

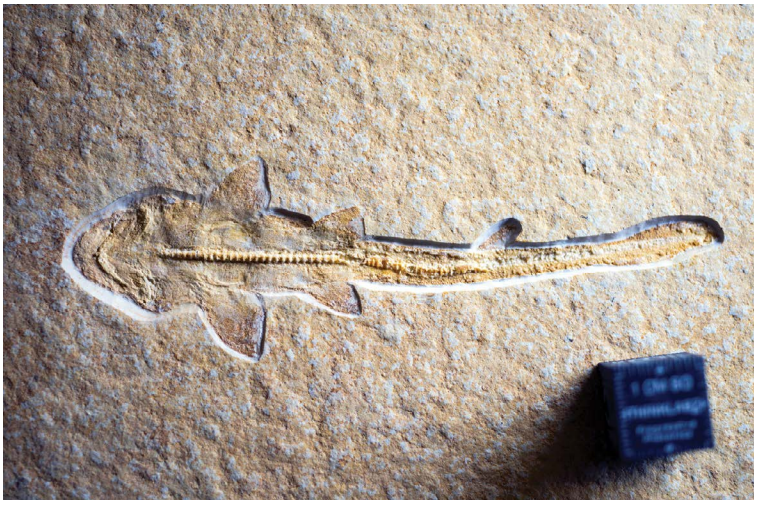
MAKE IT PRETTY

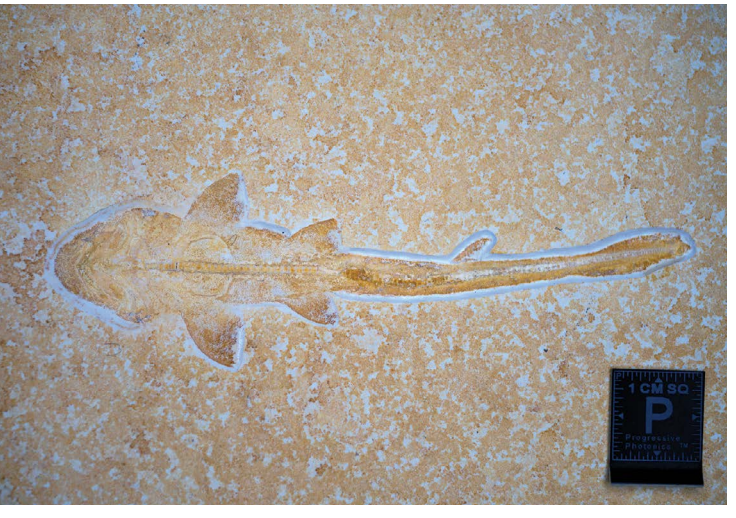
When fossils come in from the field, they get shipped off to "beauty school," Eklund's term for the preparation process that gets a specimen ready for research or display. At its most basic, the process involves removing enough rock from around the specimen so the fossil can be examined. Depending on the fossil and its envisioned purpose, the preparator then performs a range of interventions. Gluing pieces together, adding missing parts shaped from plaster—or covering sections in protective sealant or even paint in the case of exhibit specimens—are common treatments.

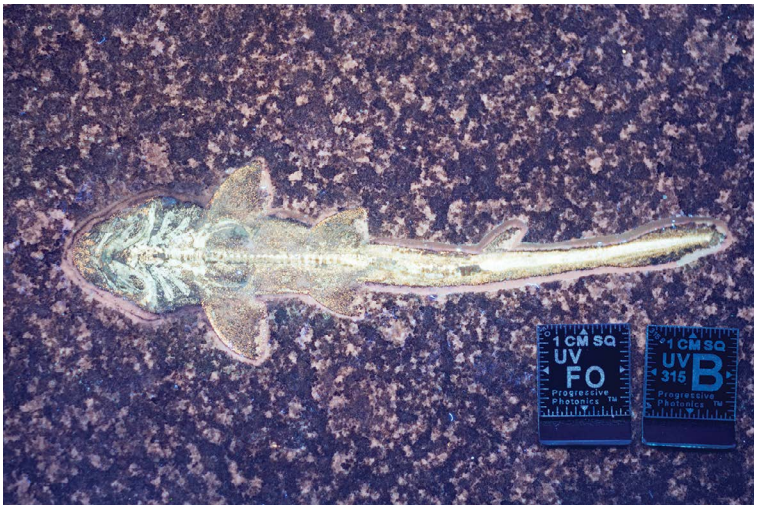
Preparation and repair are a necessary part of putting fossils in a state where people can learn from them. The alternative would be paleontologists going cross-eyed trying to mentally piece together drawers of bone fragments, and much less impressive fossil exhibits.

But there are many challenges connected to the preparation and

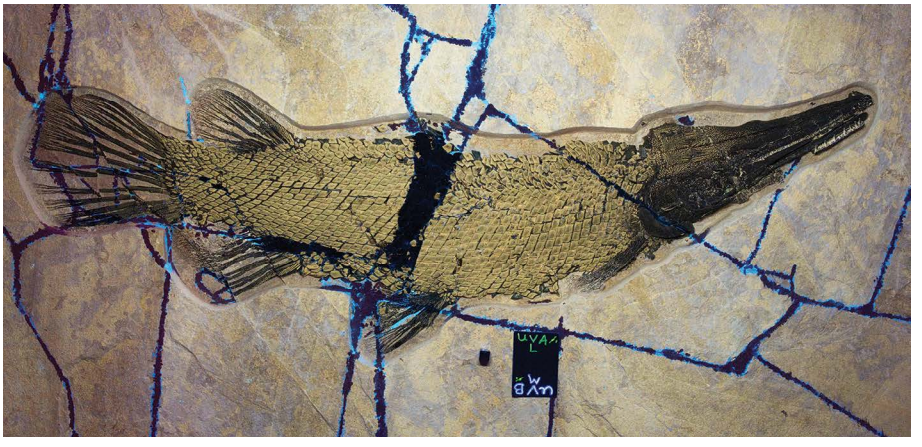
DIFFERENT LIGHTING CONDITIONS REVEAL NEW DETAILS ABOUT THE ANATOMY OF A TINY FOSSILIZED SHARK HELD BY THE LAUER FOUNDATION FOR PALEONTOLOGY, SCIENCE AND EDUCATION (SPECIMEN #LF1657P). NO ONE KNEW THAT THE SHARK'S GILL ANATOMY WAS PRESERVED UNTIL IT WAS EXAMINED WITH PROGRESSIVE PHOTONICS. **LIGHTING CONDITIONS CLOCKWISE:** OBLIQUE, UV B, POLARIZED, AMBIENT.







PHOTOS: MIKE EKLUND.



repair process. For one, it can be hard to distinguish where rock stops and bone begins. If you scrape away just a bit of bone, any remnants of soft tissue are blasted away with it.

Then there's the issue of how—or even whether—to distinguish actual fossil from repair materials. That's a debate that's been happening practically since paleontology was first practiced as a science in the early 1800s. For example, 19th-century paleontologist Erwin Hinckley Barbour wrote through gritted teeth about how O.C. Marsh, a contemporary of Barbour's and a famed fossil hunter at Yale University, preferred to display specimens in a coat of black paint—a practice that prioritized looks over substance and forced Marsh to use a damp sponge to distinguish between the porous plaster and mineralized bone. Blacked-out bones have fallen out of vogue now, with most fossil preparators going for a natural look. Nevertheless, the preference for natural-looking specimens combined with advanced repair techniques has caused its own problems. Namely, they can make it difficult to distinguish which fossil features are natural and which are due to getting some work done.

"It's all being interpreted through the prep process," said Matthew Brown, the director of museum operations at the Jackson School Museum of Earth History Vertebrate Paleontology Collections. "You take someone and give them hard tools, and they will be shaping the data. People will be looking at the bone, but what you really have is a reconstruction."

The prepared and repaired fossil affects all research that follows. But the details of what was done to the specimen can be essentially invisible.

TOP TWO: THE SCALES OF A FOSSILIZED GAR UNDER DIFFERENT CONDITIONS. SMALL FRACTURES APPEAR ON THE SCALES UNDER POLARIZED LIGHT (TOP). WHILE OBLIQUE LIGHTING (BOTTOM) SHOWS DIFFERENCES IN SCALE HEIGHT AND ARRANGEMENT. **BOTTOM TWO:** THE ADHESIVE HOLDING TOGETHER A FOSSILIZED GAR FLUORESCES IN BRIGHT BLUE STREAKS UNDER UV A LIGHT (TOP). THAT SAME ADHESIVE IS INVISIBLE UNDER NORMAL VIEWING CONDITIONS (BOTTOM).

PHOTOS: MIKE EKLUND.

LET THERE BE LIGHT

Progressive Photonics can help address the issues inherent to the beauty school process by making different materials in a specimen easier to distinguish. Scientists have experimented with multiple ways of differentiating fossils from their surroundings for decades. O.C. Marsh had his sponge (much to Barbour's annoyance). And, although illuminating hidden features with UV light has been in use since at least the 1920s, it had never been standardized or even used as a regular practice.

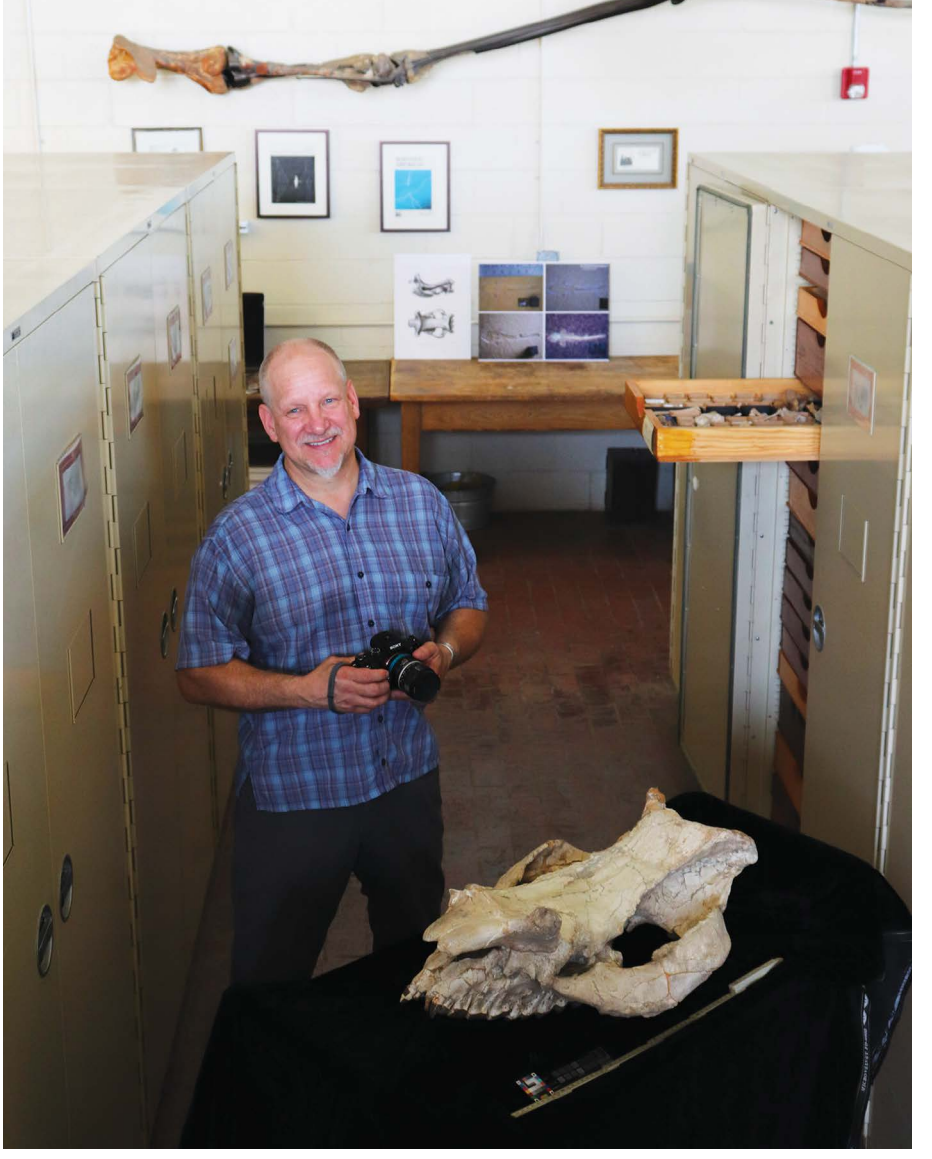
What sets Eklund's technique apart from others is its meticulous and methodical approach.

He is the first author of a paper published in the *Journal of Paleontological Techniques* in fall 2018 that serves as a how-to guide for the Progressive Photonics process and provides examples of the technique's application to various fossils. It covers equipment, safety, and how to shoot the 17-image sequence, which Eklund said takes only about 10 minutes once you have the hang of it. The only thing that changes with each picture is the light source used or the direction of the light.

The resulting photos make it easy for scientists to digitally flip through the images and spot features that appear in some shots and not others. The photos also serve as a comprehensive digital record of a fossil from multiple vantage points. Uploaded into a collection's digital repository, the pictures can be a critical research tool for scientists looking to get to know a specimen from afar.

"You're documenting the history of the specimen while looking for new stuff," said Jackson School Professor Christopher Bell, who co-authored the paper with Eklund.

Eklund said that he has been developing the Progressive Photonics process for about seven years, and he credits the ongoing support of Brown and others at the Jackson School Museum of Earth History Vertebrate Paleontology Collections with helping get the technique ready to debut with the larger research community. But even



JACKSON SCHOOL FOSSIL PREPARATOR MIKE EKLUND AMONG THE COLLECTION CABINETS OF THE JACKSON SCHOOL MUSEUM OF EARTH HISTORY'S VERTEBRATE PALEONTOLOGY COLLECTIONS. THE COLLECTIONS STAFF — AND SPECIMENS — PLAYED AN INTEGRAL ROLE IN HELPING HIM DEVELOP THE PROGRESSIVE PHOTONICS METHOD FOR FOSSIL PHOTOGRAPHY.

before Eklund got into the paleo world proper, he said that his past jobs — first an accountant, then a custom home builder — put him in the Progressive Photonics mindset by helping him hone an eye for detail and making him a stickler for documentation. So, when he started volunteering as a fossil preparator at the Field Museum in Chicago — his first preparator gig — he saw how the precision work of preparing and examining fossils could benefit from a standardized documentation process.

However, the technique's benefits go beyond documentation. The array of lighting types and lighting angles not only helps give a better view than what the naked eye can see, but also helps reveal features that no one expected to find in the first place.

"Fossils are maimed, crushed, distorted," Eklund said. "We need to look for more than what we think our eyes are seeing."

The case of a pinky-finger-size, juvenile shark fossil illustrates this point perfectly ***(see pg. 56)***. In ambient lighting, the shark appears as a delicate etching. Oblique lighting boosts the contrast, bringing the fossil into high relief. But UV light brings a total surprise: preserved gills, tooth-like scales called denticles, and the remnants of whisker-like sensory organs called barbels. All of these features had gone unseen for decades, blending in perfectly with the surrounding limestone.

Allison Bronson, a lecturer at Humboldt State University, met Eklund and examined the juvenile shark fossil

PHOTO: JACKSON SCHOOL.

using Progressive Photonics while she was in graduate school at the American Museum of Natural History. She said she usually relies on CT scanning to get a detailed look at specimens. But the technology falls flat with specimens pressed into the surface of a rock slab, which is how delicate animals, such as insects, birds, cephalopods and sharks are frequently preserved.

"There are a lot of things that are flattened that you just can't scan, and all these things in limestone are like that," Bronson said. "The best way to look at stuff like that, I think, is Mike's technique."

Bronson and Eklund have also examined a different shark specimen. While the juvenile shark was lightly stamped in the surrounding rock, this one was still largely trapped within the rock and still in the process of being exposed by preparators. During the Progressive Photonics workup, the shark's teeth unexpectedly fluoresced under UV light. It's unknown what exactly caused the teeth to glow, Bronson said. It could be signs of preserved tooth enamel or some other coating; regardless, identifying the glow in the first place could be an important starting point for future research.

Historically, it has been exceedingly rare for scientists to find fossils of vertebrates that contain anything but bones. Internal organs and adornments such as feathers, scales and skin are thin and delicate. Even if they make it through the fossilization process, it's not a given preparators or researchers will realize they're there.

But Eklund said that finding soft tissue during a Progressive Photonics workup is not an unusual occurrence. What scientists previously thought was the rarest of the rare could have just been an oversight.

"This is the next big thing. It's the next step towards finding things we've been missing in the past," Eklund said about soft tissue finds. "And we know that it's present way more often than we realized."

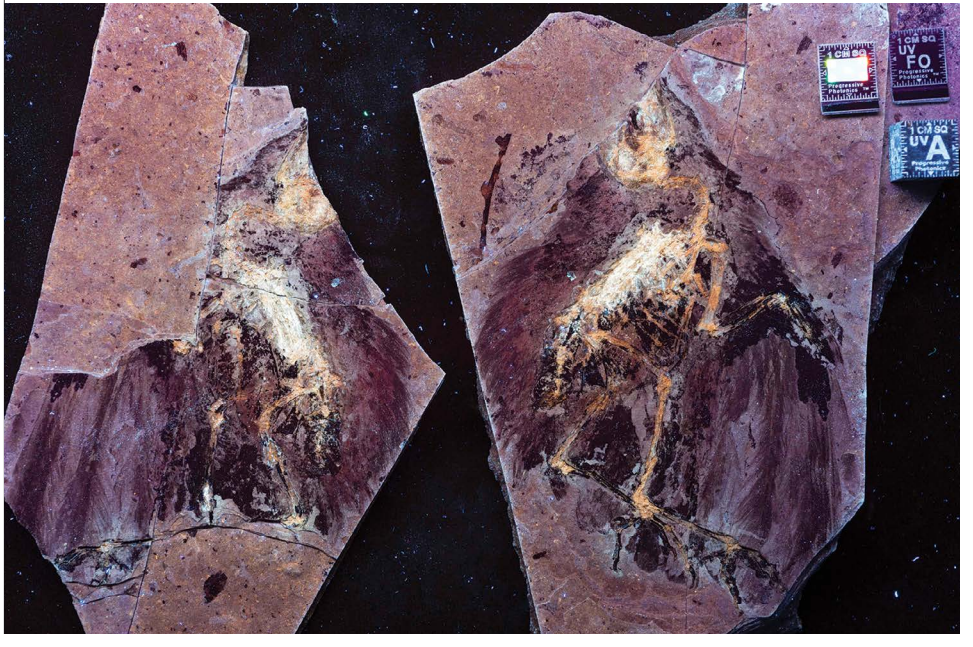
Just as important as the approach's ability to reveal unseen tissue is the power of Progressive Photonics to show which specimens should not be studied — the ones that are more artistry than anatomy. An Asian rhino skull — or what's supposed to be one — in the Jackson School's collections has become a classic example.

It looks like a passable specimen under white light. Shine a UV light on it, though, and the skull is revealed to be a practical mosaic of different materials. Plaster, rhino fossil, and bits of pieces of bone swiped from other unknown fossils all glow with their own distinctive hues ***(see pg. 54)***.

If a researcher wants to know anything about actual ancient rhinos, they should steer clear of this skull.

For most specimens, though, it's not an all-or-nothing situation when it comes to

ABOVE: JACKSON SCHOOL PROFESSOR CHRISTOPHER BELL HELPED DEVELOP THE PROGRESSIVE PHOTONICS METHOD AND CO-AUTHORED A PAPER ON IT WITH EKLUND. **BELOW:** A FOSSIL OF A BIRD UNDER FILTERED UV A LIGHT SHOWS REMNANTS OF BONES, CLAWS AND FEATHERS. EKLUND SAID HE SUSPECTS SOFT TISSUES — SUCH AS FEATHERS — MAY BE MORE COMMON THAN CONVENTIONALLY THOUGHT AND THAT PROGRESSIVE PHOTONICS CAN HELP SCIENTISTS FIND THEM.



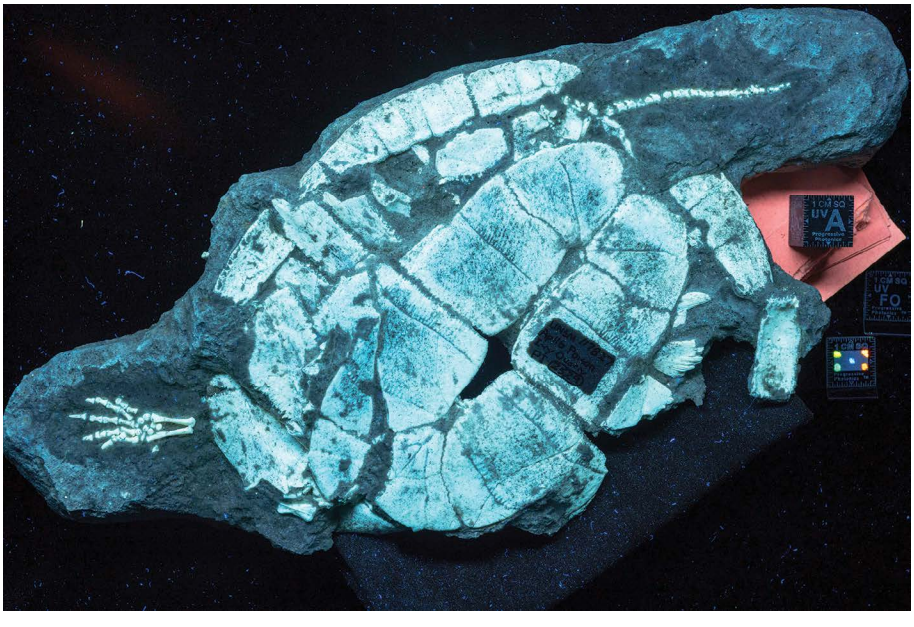
CHRIS BELL: JACKSON SCHOOL. FOSSIL BIRD: MIKE EKLUND.

research. The same Progressive Photonics session that reveals signs of extensive repair can also distinguish which areas of the fossil are good for scientific study. Eklund gives the example of a pterosaur fossil that was put together from 13 pieces. Certain regions of the fossil were lost to globs of glue. But others gave exceptional insight into the anatomy of the winged reptile. Progressive Photonics offers scientists the insight to unequivocally tell such areas apart.

"You have to think about what you're looking at," Eklund said. "And that's where the suite of images gives you the tools to really digest and interpret what's present in the specimen. Close proximity is not enough. Likeness is not the real thing."

Eklund notes that with all the talk of paint, plaster and distinguishing what's natural from constructed, Progressive Photonics can seem like a ready-made fraud detection tool. But he's quick to say that's not the point.

"People look at the system and too quickly jump at associating it with fake, fraud and forgery detection—but those are not relevant terms," he said. "By having the imaging here I can ask, 'Is it viable for my study or research purpose? Can I make a statement about the confidence I have in it? Is it acceptable to my research or education needs?'"



In other words, while Progressive Photonics can't tell you how a fossil came together, it will let you know what's there. From that point, it's up to the researcher what to do next, whether that's write a paper, raise an eyebrow or wave a red flag.

KEEPING IT REAL

Progressive Photonics pulls back the curtain on the preparation history of fossil specimens. That undoubtedly helps scientists analyze their specimens. But Bell said that he thinks the larger public could also benefit from getting to know the work that goes into preparing and displaying fossil specimens. The statuesque skeletons in museums are impressive, but they can give the wrong impression about the science of paleontology: namely, that fossil specimens are much more complete than they actually are.

"That's a form of deception," Bell said. "It's benign deception. It's not done with the intent to deceive or lie. It's an intent to have a visually captivating representation of past life on Earth—but you're ceding the interpretive context."

And when a display isn't forthcoming about what's real and what's not, it can give fodder to those who want to undermine a scientific world view in general, he said. In contrast, exhibits that employ the principles of Progressive Photonics—seeking to highlight unseen features, those left behind by nature and those added in museum prep labs alike—could provide more information about the specimen and the scientific reasoning that informed the display process.

"Why not talk about it?" said Bell. "From my perspective, we're missing out on a really important educational opportunity to talk to people about the confidence we have when reconstructing the past and the places where we do have differing degrees of uncertainty."

TOP: THE BONES AND SHELL OF A TURTLE FOSSIL BLEND IN WITH THE SURROUNDING ROCK UNDER AMBIENT LIGHTING. **BOTTOM:** UNDER FILTERED UVA LIGHT, THE DISTINCTION BETWEEN ROCK AND BONE IS CLEAR.

PHOTOS: MIKE EKLUND.

The Smithsonian Institution has embraced this line of thinking. In June 2019, the National Museum of Natural History reopened its hall of fossils after an extensive five-year renovation, the first one since the fossil hall opened in 1911. The fossil displays include casts of bones articulated into lifelike poses—a dog-size *Stegoceras* dinosaur using its back foot to scratch the top of its domed head, a *Tyrannosaurus rex* chomping on the frilled crest of a *Triceratops*, an extinct species of horse rearing up like a bony replica of Silver, the Lone Ranger's steed. These mounts serve as a reminder of the amazing animals that once walked the Earth. But when it comes to real bones, the distinction is clear. All synthetic materials are painted a shade darker than the surrounding bone, said Steve Jabo, a preparator, researcher and collections assistant in the Smithsonian's Department of Paleobiology. That wasn't always the case. Many of the old mounts gave the illusion of a complete specimen by painting plaster the same shade as bone, or even painting over the bone itself. Part of the renovation process involved removing the illusion of a complete specimen when preparators were just working with parts.

"We need to look for more than what our eyes think we're seeing."

-Mike Eklund, Research Associate

"We made the decision to go back and do that uniformly," Jabo said. "We don't want to trick people, especially the researchers, the people who are doing active research on our research specimens. Because deciding if something is real or not, sometimes that's hard to do."

The new exhibit also features a UV light box. At the push of a button, delicate crab fossils from the famed German Solnhofen Limestone go from blending in with the surrounding rock to popping out in a shade of glow-stick orange. Eklund played a key role in choosing the lightbox specimens, which were selected from among a number of specimens in the Smithsonian collection that got the Progressive Photonics treatment during a research visit.

In addition to helping with the exhibit, Jabo said that seeing Progressive Photonics in action has changed his approach to fossil prep, mainly, to go easy on the consolidant (which can cover small or delicate parts and complicate the chemistry research) and to stop and check for soft tissues.

"It has affected how I do prep," Jabo said. "In the process of doing things, I can stop, get a light on it to look and see if there's anything. If something cleaves along the bone, that's the perfect time to look at it because that's where you're going to find any soft tissue preservation."

The work of fossil preparators sets the stage for a fossil's future—how it's interpreted, how it's displayed, what is seen and what goes overlooked. But just like the many hidden fossil features that Progressive Photonics has helped bring to light, the critical role of preparators in paleontological research usually remains in the shadows. Preparators are frequently volunteers. They come from a variety of backgrounds and don't always work within the usual research spheres, said Brown, whose own career in paleontology started when he was a volunteer fossil preparator while in high school.

"It's a quirk of paleo; the person who discovers a fossil is usually not the preparator," Brown said. "The preparator is the hidden hand."

Progressive Photonics helps reveal the impact of that "hidden hand" and other features that would have otherwise remained hidden to the human eye. By spreading the word and practice of the technique to preparators and scientists alike, Eklund said that he hopes to remove some of the uncertainty that's inherent to studying fossils. You might not know much about how a fossilized animal lived, but you can at least know whether the fossil is a good starting point for asking questions, Bell said.

"When you go back and image these fossils, you can now say 'this part's paint, this part's plaster and now we know,'" said Bell. "We don't have to worry. We don't have to guess."

A SKELETON FROM A CROCODILE-LIKE *SMILOSUCHUS* FROM THE SMITHSONIAN'S NATIONAL MUSEUM OF NATURAL HISTORY'S HALL OF FOSSILS. THE SKULL IS MADE OF PLASTER — AND IS PAINTED A DIFFERENT COLOR THAN THE FOSSILIZED BONES OF THE BODY — SO ONLOOKERS CAN TELL WHAT'S REAL FROM WHAT HAS BEEN RECONSTRUCTED.

PHOTO: NATIONAL MUSEUM OF NATURAL HISTORY.

THE DEAN

Sharon Mosher has led the Jackson School of Geosciences for most of its existence. Now that she's stepping down, she leaves behind a thriving, world-class institution built to last.

BY ANTON CAPUTO

Even as a child, Sharon Mosher knew the path she wanted to take. Whether she was picking up rocks on family vacations or attaching her bicycle pedals to a motor so that she could swirl chemicals to grow geodes, Mosher understood early on that geology would be her life.

The path would take her from her hometown of Freeport, Illinois, to the University of Illinois at Urbana-Champaign for her bachelor's degree, to Brown University for her master's, and back to Illinois for her doctorate. From there, she would launch a career as a structural geologist and academic that would ultimately cast her as a national leader in the field and the head of one of the country's preeminent geosciences schools.

Mosher has been dean of the Jackson School of Geosciences for 10 years, about two-thirds of the school's existence. She took over the institution in its early formative years, building the infrastructure of a modern college and pushing an interdisciplinary and cross-disciplinary approach to research and education that is now synonymous with the school's identity. Along the way, she helped build a juggernaut. The Jackson School is the largest geosciences program in the country. It is ranked No. 1 in geology by the *U.S. News & World Report* 2019 edition of "Best Graduate Schools," and has been regularly ranked among the most scientifically productive academic geosciences institutions in the world by the *Nature Index*.

Mosher's leadership has pushed the Jackson School to new heights, but now it's time for someone else to keep the momentum going. The longest-serving dean in the school's history is getting ready to step down and return to the faculty. To Mosher, it's simply the right time. She's helped build and stabilize the school so her successor is on solid footing to take it to even higher levels. And she has things she wants to do. She can't wait to get back to her research, and she's looking forward to wrapping up the two major national geosciences education initiatives that she is leading for the National Science Foundation. One involves developing and implementing a community vision for the future of undergraduate geosciences education; the other is working to ensure graduate students are prepared for the workforce of the future.

After that, Mosher said there are many possibilities, although she cannot see herself taking a job somewhere else. Ultimately, she said, her next moves will depend on how the chessboard of her life evolves.

"When I was little, my dad taught me to play chess. It teaches you to look in[to] the future and make plans that depend on what the other player does," she said. "You have to have multiple options open. I've lived my life that way, where I always know that there are different options at different steps."

That thoughtful and strategic outlook on life and decision-making is reflected in the institution she has helped build and lead during the past decade. When Mosher steps down, she will leave behind an institution unique in its depth, breadth and quality.

"The Jackson School is truly in a class of its own, and that is due in large part to Sharon Mosher," said Gregory L. Fenves, president of The University of Texas at Austin. "But it is the personal impact Sharon has had as a mentor and champion of her students that defines her leadership."

PHOTOS: JACKSON SCHOOL.

BUILDING A COMMUNITY

When the latest crop of graduate students showed up at the Holland Family Student Center on a scorching day in August 2019 for the field trip that would kick off their Jackson School experience, Mosher was there, as always, welcoming and prepping them for two days in the field. From there, the group loaded up on the bus to see some of the geological wonders of Central Texas—Enchanted Rock, Pedernales Falls, Inks Lake and Inner Space Caverns.

The trip was, as incoming master's student Bethany Rysak described it, "ridiculously hot" and "awesome." She wasn't surprised to see Mosher there every step of the way, explaining the geology and reminding students to hydrate and apply sunscreen. That's because Rysak met Mosher some weeks before at a prospective student weekend. She remembers a nice, unassuming woman introducing herself, welcoming Rysak to the school and chatting before moving on. Rysak realized she had been talking with the school's dean only after her potential adviser informed her.

"I kind of freaked out," Rysak admits.

But she got the idea right away that the dean of the Jackson School was someone who wanted students to feel at home on campus. That was vitally important to Rysak, who did her undergraduate work at Trinity University in San Antonio and was feeling a little lost as she made the transition from a small, private college to a massive, public, flagship university. The field trip, she noted, helped ease the transition considerably.

"This makes the university feel just as small as my undergraduate was," she said. "Getting to know everyone's names and faces and a little bit about them. It really helps."

That's not by accident. That's exactly the type of environment Mosher has worked to build as dean and why she instituted the field trips for new graduate students and a similar trip that incoming undergraduates would undergo a week later. The undergraduates would also be accompanied by the dean and a host of faculty members.

The Jackson School that Rysak and her fellow students are entering has the outgoing dean's fingerprints all over it. Ensuring the school provides a top education that helps build and prepare future generations of geoscientists has been one of her overarching goals.

For instance, Mosher led the fundraising effort to build the bright, airy Holland Family Student Center that is now a mainstay of the Jackson Geological Sciences Building. She established in-house student services and career services. She brought on tutors for calculus, chemistry and physics. She launched the Jackson Scholars Program to provide leadership and study abroad opportunities for undergraduates. She created a writer-in-residence position to help students learn the communication skills needed for the modern geosciences workforce. She increased experiential learning, and undergraduate student opportunities in research and expanded overall field programs and experiences—something of a mantra for a dean who insists geoscientists are built in the field.

"The field is just the best place to see and understand geology," Mosher said. "It's the place where everything you have seen and learned comes together and you have that 'aha' moment. You have to do lab work, geochemistry, geophysics or computer modeling. But if you haven't actually seen it in the field, you don't really understand it."

Mosher has worked hard to build the kind of cohesive, family atmosphere that welcomes new students and keeps alumni connected to the school. It all seems pretty seamless now. But when she took over in 2009, and during the two years before when she served as department chair, there was very little of a schoolwide structure in place.

TOP RIGHT: MOSHER WITH INCOMING GEOSCIENCES STUDENTS AT UT'S GONE TO TEXAS EVENT.**BOTTOM RIGHT:** MOSHER AND AN INCOMING GRADUATE STUDENT DESCEND FROM ENCHANTED ROCK DURING THE INCOMING ORIENTATION TRIP.

OPPOSITE PAGE: MOSHER AT THE JACKSON SCHOOL STUDENT RESEARCH SYMPOSIUM.

PHOTOS: JACKSON SCHOOL.

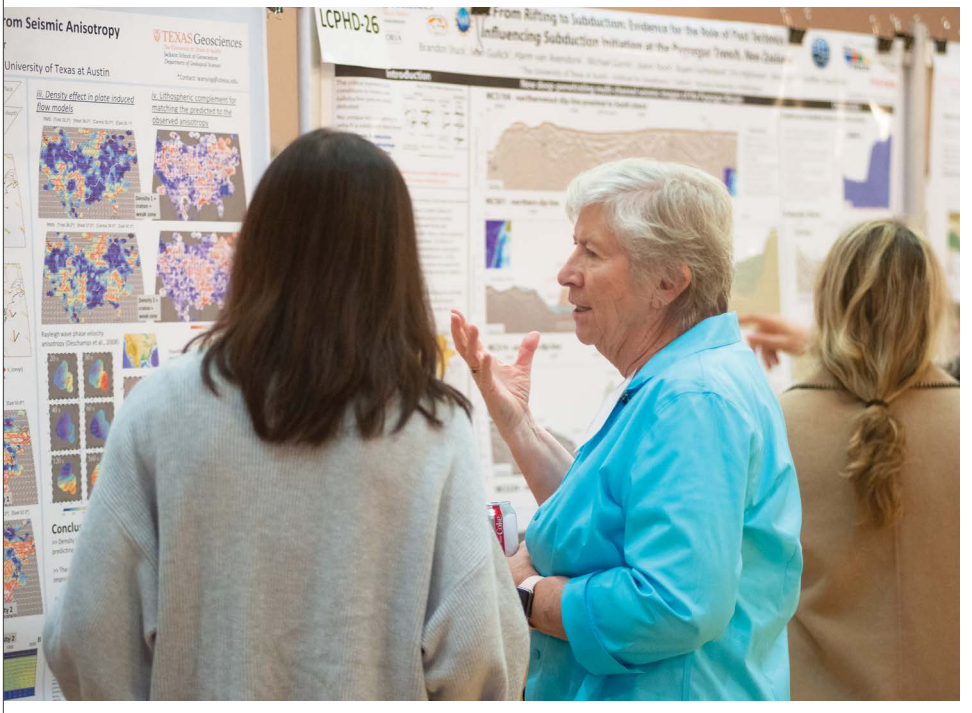


PHOTO: JACKSON SCHOOL.

That's because, prior to the formation of the Jackson School, the UT College of Natural Sciences took care of all of the basics for geosciences students. That ended when geosciences broke off and formed its own school in 2005.

Assistant Dean for Student Affairs and Administration Nicole Evans was there in the early days. She remembers scrambling to find IT support to make sure classes were ready to go for the new school year, or to find facilities staffers to help keep the building functioning. Mosher hired Evans to work in the department as office manager before moving her over to the dean's office. Evans became one of the school's first assistant deans. Mosher also created an assistant dean position for financial affairs and one for student affairs, and associate dean positions for academic affairs and for research.

The operational and administrative issues probably seem utterly mundane to those not involved, but they are vital to keeping a school running, let alone thriving.

"It was under her watch that we became a fully functional university-integrated school," said Associate Dean for Research David Mohrig, who joined the school in 2006. "That's really quite an accomplishment."

Evans and others credit Mosher's ability to keep the big picture crystal clear while working through all the details, and to look several steps ahead as her father's chess lessons had taught her. They also point to an uncanny capacity to understand budgets as key to Mosher's success. This is particularly important at the Jackson School, which has a unique combination of soft money research units and hard money academics, and operates on 270 endowments, all of which have specific requirements on how they can be spent.

Evans recalled meetings about planning and finance in those early years where they were trying to make sense of all the budgetary constraints and needs of the growing school. She said she was consistently astounded by Mosher's mastery of the massive budget spreadsheet and the hundreds of funding sources.

"Sharon was always planning ahead," Evans said. "She would be like, 'no, we can't use that [account]. I'm saving that one because it will earn enough in two years that we can replace all the microscopes, and then when we're doing that, we can fix that classroom the following month.' We would have a list of stuff that people had asked about, and she was thinking about all the stuff they haven't asked about."

BRINGING IT ALL TOGETHER

Mosher is the Jackson School's fourth dean, but she's really the first to serve in the position for any length of time.

When the school launched, William Fisher agreed to act as its inaugural dean. Fisher would serve a year before Eric Barron, who is now president of Penn State University, would come on board after a nationwide search. Mosher, who served under Barron as a department chair, credits him with helping show the fledgling school how to actually be a school. But Barron moved on after serving less than two years, leaving a short but controversial legacy that involved committing much of the school's ready cash on new hires and buying the E.P. Schoch building. After Barron, Chip Groat served as interim dean for a year before the university decided on Mosher.

Mosher took the helm of a school that was rocky in terms of finances, as well as identity and culture. The latter two are foundational and ongoing challenges for the Jackson School that stem from its unique origin.

When Jack and Katie Jackson donated their massive estate to the UT Geology Foundation, it allowed the university to bring together its three main geosciences units—the Bureau of Economic Geology, the Department of Geological Sciences and the Institute for Geophysics (UTIG)—under one umbrella. While great in theory, uniting the units proved challenging. All three had vastly different and strong cultures, identities and business models. There's also the matter of geography to deal with. The department is on the main campus (and in the same building as the dean's offices), and the bureau and UTIG are on the J.J. Pickle Research Campus about 10 miles away.

"We needed new leadership that was going to dig into the program and work flows to bring the three institutions together, while also preserving their unique qualities and contributions," said Annell Bay, a Jackson School Advisory Council member. "Sharon possessed the leadership strength and vision to drive the best decisions for the university, the Jackson School and the students."

Mosher made it a point to break down the barriers created by distance and history. Much of it just boiled down to legwork, she said. She talked to everyone in the school to understand the kind of research they did and how they were funded, and she ran meetings to bring people of similar interests together. She encouraged research scientists to take part on the graduate studies committee and to supervise students. She surveyed all the researchers and faculty members about their scientific interests. And she helped organize the school's research into six themes that helped bring together scientists who wanted to work on similar problems. And she still spends one to two days a week working out of the Pickle campus.

Her goal was simple and is ongoing: to create a transparent environment where people could come together to tackle big scientific issues.

"Once you get people to know what others are doing, you get people who recognize that they could work together on really big science questions rather than the smaller ones they could do by themselves," Mosher said.

Scott Tinker, who has led the bureau since 2000, said that Mosher's success in this area came from strengthening the units' natural connections instead of trying to force connections that weren't there or trying to run the school like some kind of "superdepartment."

He pointed to examples such as the Rapid Response program, the Equinor Fellowships (previously Statoil) and the Shell-UT Unconventional Research program, which tie the units together and strengthen the school's overall mission. He also applauded Mosher for working hard to understand the needs of researchers in the units and advocating for them. This included continuing the practice that Barron had put into place of funding researchers for up to two months a year, and supporting technical job tracks. Mosher also persuaded the university to create an emeritus title for senior research scientists, and said she was extremely proud when UTIG's Cliff Frohlich became the first in UT's history to earn the title.

"Sharon helped make sure researchers were recognized for what they did for the school and the university," Tinker said. "She grew into a very strong dean. And I mean that in the best way. We all bring our own experiences to a job, and Sharon evolved over the decade from professor to dean. We grew together, and I have tremendous respect for her leadership and what the school has accomplished."

THE EARLY PATH

Leading an institution like the Jackson School is full of unique challenges and takes a special set of skills and traits. Mosher learned many along the way, but some were seemingly with her from the beginning.

Mosher describes herself as a "tomboy" growing up, which dovetails well with her persona as a young rock hound. She regularly planned her family's vacations as a kid, showing a propensity for taking charge and charting a course that would characterize much of her career. She would pore over maps, which she loved, and plan routes that maximized the opportunity to collect rocks.

She worked a number of jobs throughout high school, realizing early on that she didn't like waitressing or working in a curtain rod factory. She transitioned to being a Fuller Brush salesperson (door-to-door brush and cleaning product sales) and became so successful that by her senior year, she had six adults working for her.

"I was good at managing people and getting them to work harder," she remembers.

The experience of door-to-door sales helped Mosher develop another skill that would serve her well.

"The idea of asking for money doesn't bother me," she said. "You get the door slammed in your face enough and you get used to it."

The early lessons paid off. During her tenure as dean, Mosher helped create 74 endowments and raised $86 million for endowed chairs, scholarships, graduate fellowships and programmatic support.

> "To put it mildly, when Sharon turned up at field camp, we were absolutely thrilled to be her TAs ... here she was, doing something that perhaps we'd imagined, but never actually seen."
>
> -KITTY MILLIKEN
> Bureau of Economic Geology
> Senior Research Scientist

Although Mosher knew she wanted to be a geologist from a young age, it took her a while to settle on a career path and specialty. Her initial lean was toward industry. Her senior thesis involved designing a rig that deforms thin sections of granite (or for her undergraduate job, cement) while allowing a researcher to study the sections under a microscope to look at crack propagation. After finishing her undergraduate degree, she spent eight months backpacking and camping solo throughout the western United States and Canada, looking at, of course, geology.

Mosher went to Brown University with the idea of becoming an igneous petrologist, but she found her calling on the first field trip. She fell in love with the Pennsylvanian quartzite conglomerates from the Narragansett Basin in Rhode Island and decided her future lay in structural geology. Using the conglomerate, she became the first to demonstrate that pressure solution was an important deformation mechanism —and she was the first to quantify its effects. Although she didn't stay at Brown for long, her love of New England geology led her to continue research there later with her own graduate students, where they proved that New England was affected by a major orogeny in the Pennsylvanian and Permian periods.

PHOTOS: SHARON MOSHER.

Mosher had a number of job offers in both industry and academia before finishing her doctorate, but she settled on UT on the advice of her adviser, Dennis Wood. He told her that if Professor Bob Folk was at UT, it had to be a good school. During the back-and-forth of the job negotiations, UT Professor William Muehlberger contacted Wood to ask whether Mosher would be up to teaching a field camp.

"He told him, 'she could run your field camp,'" Mosher remembered with a laugh.

Ironically, she did run it for 15 years after taking the job and was eventually succeeded in the position by her husband, Distinguished Senior Lecturer Mark Helper, who has been running it ever since.

"You don't realize how challenging it is to organize and run field camps until you have to do it yourself," Helper said. "But field camp is one of the most formative and important experiences in a student's education, and I was proud to take it over."

For that first year, Mosher arrived at The University of Texas at Austin with no time to spare. She finished her thesis in May, defended on June 1, drove to Texas over the weekend, and then took off to teach field camp on Monday.

Her teaching assistants included Kitty Milliken, who is now a senior research scientist at the bureau. Milliken said she realized Mosher was a great field scientist and instructor from the first day she knew her. But it was something else that made a lasting impression on her as a young geoscientist.

"Neither I, nor, I imagine, my co-TA, Vicki Price, had ever had a female science instructor, much less a geology professor," she said. "To put it mildly, when Sharon turned up at field camp, we were absolutely thrilled to be her TAs and to know that when we got home, there would be a woman professor in the department. She wasn't much older than we were, and here she was, doing something that perhaps we'd imagined but never actually seen."

Mosher was the first female faculty member in the department (which has had female lecturers in the early 20th century). Like most female geoscientists of her generation, she was one of the very few in her school or workplace, but Mosher said she never had a problem navigating in the male-dominated profession. That doesn't mean she didn't run into sexism. She has plenty of stories.

When she was an undergrad, for instance, she had a job in a chemical engineering lab. A faculty member complained, telling Mosher's supervisor that he needed to fire her because his students couldn't concentrate with a woman in the lab. Mosher's boss refused, commenting that Mosher had no problem working around the male students and that the faculty member should consider seeking more female students.

Mosher has been active in gender and equity issues as dean, implementing comprehensive workplace guidelines and working to diversify both the student body and faculty. But her advice to budding scientists has always been not to think of themselves as a male or female scientist or to put any other qualifiers on it, but to simply be the best scientist you can be.

TOP: MOSHER (CENTER) CROSSING THE ANDES ON HORSEBACK IN TIERRA DEL FUEGO. **BOTTOM:** MOSHER PICTURED WITH A GAUCHO AND KASEY DALZIEL, THE DAUGHTER OF JACKSON SCHOOL RESEARCH PROFESSOR IAN DALZIEL.

"But the bigger thing is she's someone who's always in there, working just as hard as anybody else to make things go."

-MARK CLOOS
Jackson School Professor

Still, her presence seems to have a major impact on female students around the school. Chris Symons, a master's student of Mosher's who arrived on campus in 1993 and later did a postdoc with Mosher, is a perfect example. Symons had the opportunity to work with Mosher on her research on the evolution of the Pacific-Australian plate boundary in the Macquarie Ridge Complex south of New Zealand, something the two may revisit after Mosher steps down.

Like all of Mosher's students, Symons spent time at Mosher's house, particularly during the weekly get-togethers that Mosher then had for her team, which Symons said were nine or 10 students at the time. She also remembers babysitting Mosher's daughters so her supervisor could review Symons' work. The way Mosher balanced her work and family life, while being an incredibly productive and driven professional, was striking and made a major impression on the young graduate student.

"She certainly was a role model because here's a woman who was, you know, was married with kids, had a successful career, was happy, well-adjusted," Symons said.

ABOVE: MOSHER IN 1981 RECEIVING THE ATLANTIC RICHFIELD COMPANY (ARCO) OUTSTANDING JUNIOR FACULTY AWARD FROM MICHAEL WILEY, A JACKSON SCHOOL ALUMNUS AND SUPPORTER.

TAKING CHARGE

It has been more than 40 years since Mosher first stepped on campus at UT as an assistant professor. In that time, she has taught thousands of students and advised about 70, sometimes taking on as many as 15 graduate students at a time. Advising students allowed Mosher to work on structure and tectonic problems throughout the world, which makes choosing her most exciting field experience difficult.

"Was it riding horseback across the Andes in Tierra del Fuego?" she said, "or trips on fishing boats during storms in the Straits of Magellan? Or navigating around elephant seals and millions of penguins on Macquarie Island? So many great field adventures with students."

In her early years, during the oil boom of the early 1980s, the undergraduate population at the Jackson School shot up to well over 800 students, about triple what it is now, and the department was bursting at the seams. Mosher said it was common back then to have students lined up in the hallways past the elevators during office hours, and she would have to hold office hours in the Boyd Auditorium during exam weeks. One of her goals as dean has been to diversify the education offered by the school so enrollment doesn't balloon and deflate with industry fluctuations.

Professor Mark Cloos has known Mosher longer than most. He served as her undergraduate assistant at the University of Illinois at Urbana-Champaign when she was a graduate student, and then joined her on the faculty at UT when he was hired in 1981.

They alternated teaching the undergraduate and graduate students' structural geology classes into the early 1990s. He estimates that Mosher has personally taught the basics of structural geology to at least 1,000 students. Cloos remembers the two working together in 1985 to persuade the faculty to build a zircon U/Pb geochronology lab. He said Mosher's structural petrology course—ductile structure—which featured microscopic analysis of deformed rocks in thin section, was a mainstay for 30 years for all graduate students interested in understanding how rocks can flow.

Cloos said 10 years serving as a dean is a remarkable accomplishment. He attributes Mosher's success to a combination of attributes.

"She's a really good people person, and she's very engaged," he said.

PHOTO: JACKSON SCHOOL.

"Obviously she's got good national connections, as she was president of GSA (Geological Society of America) and AGI (American Geosciences Institute). But the bigger thing is she's someone who's always in there, working just as hard as anybody else to make things go. Most deans are much more the delegator type."

Many people marvel at the set of skills Mosher has employed as dean, but she didn't get them by accident. Throughout her career she deliberately took on leadership roles and challenges when she saw an opportunity to make positive changes.

"My whole life, I have been building that: that background, the abilities, the knowledge," she said. "And I started young. My first major role was as the first elected chair of GSA's newly formed Structure/Tectonics Division shortly after I arrived at UT."

One of the very formative experiences during her career was taking over the presidency of GSA. She served as its president in 2000–2001. It was a difficult time for the organization, which was in the red and bleeding money. She ran the organization from Austin but would fly to Boulder weekly to continue the work of turning the ship around.

"She put GSA back on a track, and the kinds of techniques that she put into existence are still used today, so that even in the industry downturn, GSA has maintained quite a good budget," said Robbie Gries, a longtime friend of Mosher's and a member of the Jackson School Advisory Council who served as GSA president in 2018–2019.

Many of GSA's well-known programs are part of Mosher's legacy. She credits much of her leadership success at GSA and AGI to what she learned through the Council of Scientific Society Presidents, where she is a longtime member and former leader.

It was also during that time, the early 2000s, that Mosher and Gries, who was then president of the American Association of Petroleum Geologists, started GeoScienceWorld. The service works with societies, institutions and researchers around the world to provide a single source of access to 46 scholarly journals, more than 2,100 e-books, and over 4 million records in the GeoRef database.

Here again, Mosher took direct leadership, running the Washington, D.C.-based organization as CEO for several years after its formation. In addition to being transformational for geoscience researchers, the service has returned more than $38 million to membership societies since it launched in 2005.

Throughout her career, one of the only things that has made Mosher hit the pause button on work, and even excuse herself from meetings, has been a call from one of her daughters, Sarah and Lisa.

Given their parents' love of geology, the two girls nearly grew up in the field. Lisa Helper followed her parents into the geosciences, entering industry after earning a master's from the Jackson School in 2012. Looking back, Helper understands how incredibly busy her mother was while she was growing up, but she said that it didn't get in the way of their relationship. On the contrary, she said her parents' love of geology meant hours upon hours of quality time together, where Mosher, of course, slipped in education. This included taking the girls to field camp nearly every year as they were growing up, as well as taking time to see natural wonders as a family.

"She would always have us stop at road cuts and explain the geology, and during our car trips she'd always ask us questions that now, I realize as an adult, were prompting us to make observations and come up with hypotheses," Helper said. "I thought she was just asking us fun questions about nature. But I think she was kind of formulating our thought process and creativity."

The lessons haven't stopped since the girls grew up.

"Even up to a week ago, I was drilling a well and something unexpected happened—she was there to bounce ideas off of at 3 in the morning," she said. "That's not something that everyone can say. I'm very aware of how unique that is."

LASTING LEGACY

Joe Reese, a professor at Edinburgh University in the Department of Geosciences, studied for his doctorate under Mosher from 1988 to 1993. He worked on metamorphism and ductile deformation in the Llano uplift, an area where Mosher would publish foundational studies on the Precambrian Grenville of Texas.

Like many of her students, Reese has stayed close to Mosher over the years, and said he gets a kick out of people's awed reaction when they realize she was his faculty adviser. Reese raves about her ability as a scientist and educator, but, like many others, said it's her empathy and ability to read people that truly made an impact on his life. He remembers, for instance, rushing back to Austin to defend his thesis after accepting his first faculty position. He was, to say the least, nervous, and Mosher knew it. But she was able to set him at ease with a simple question.

"She said, 'Joe, what kind of beer would you like for your party?'" Reese said. "And once she said that, I thought, you know I might actually get through this."

Now that she's getting ready to step down as dean, Mosher has had some time to reflect on all she's accomplished. It's been gratifying, she said, watching everyone at the school come together to build a strong community and elevate the science and education to the world-class level it now achieves. She particularly loves attending graduation and hearing parents rave about how much their children loved the Jackson School and how they felt like they were part of a very supportive community.

"That didn't happen by accident," Mosher said. "When I became dean, I had goals for this place, and I really feel like I have achieved the goals that I had set. Now there are new goals, but that's for somebody else."

FROM EARTH TO THE MOON

It's been 50 years since astronauts first walked on the moon. UT geoscientists taught them what to look for and helped shape the science of lunar geology and geophysics for decades to come.

BY MONICA KORTSHA

A video recording from the NASA archives starts like this: Apollo 16 astronauts Charles Duke and John Young are ambling across the moon. Young moves about in the background, while Duke takes two little hops toward a gray, lumpy rock near the rim of a crater.

"This one right here?," Duke asks to Mission Control as he approaches the rock, carefully scooting closer and closer to the crater's edge.

"That's it. You got it right there," a voice from Mission Control confirms.

The rock is bulky and easily visible even on the grainy footage. And when Duke bends down to collect it, he audibly heaves as he hoists it up with his one free hand.

"If I fall in the Plum Crater getting this rock, Muehlberger has had it," Duke says in a miffed tone as he walks off with the rock and the clip comes to a close.

(You can watch the scene for yourself at: http://ow.ly/Vs1N50vLnh6)

The Muehlberger he's referring to is UT geology Professor William Muehlberger, who served as the principal investigator for field geology for the Apollo 16 and 17 moon missions. He taught the astronaut crews how to conduct field work on the moon by practicing at sites here on Earth. And for his service—or perhaps insistence that the astronauts lug the rock back to Earth—the sample collected on the Plum Crater's edge was named "Big Muley" in his honor. Weighing in at 26 pounds, it ended up being the heaviest rock brought back from the moon.

But Muehlberger wasn't the only geoscientist from The University of Texas at Austin involved with historic moon missions. And the impact of UT geoscientists on training astronauts didn't end with Apollo. As we honor this year's 50-year milestone of Apollo 11, the first mission to land on the moon, get to know the UT geoscientists who were part of history then,and those who are making it now.

PHOTO: APOLLO 15 ASTRONAUTS DAVE SCOTT (RIGHT) AND JIM IRWIN IN A ROVER ON THE WEST RIM OF NEW MEXICO'S RIO GRANDE GORGE. NASA.

William Muehlberger

Field Geology Lead on Earth and the Moon

For nearly four decades, Jackson School of Geosciences Professor William Muehlberger took geology undergraduates from UT into the dry desert mountains of West Texas as part of the school's annual summer field camp. The cragged formations were a testament to the power of tectonics, while the shifts in stratigraphic layers showed how the geology of different eras built the landscape of today.

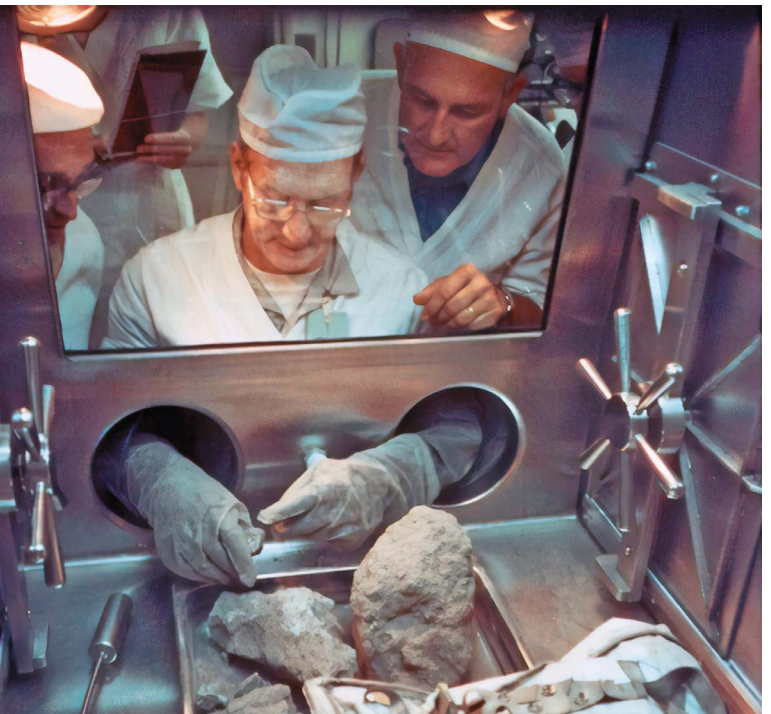
In April 1964, Muehlberger taught similar lessons to a class of a different sort of students: Apollo astronauts. His charges included Buzz Aldrin and Neil Armstrong—the men who would make history as the first humans to walk on the moon.

After planting the American flag, the most important objective of astronauts on the moon was field geology. From the very beginning, astronauts were sent up with seismic sensors and came back laden with rock and soil samples. However, the astronauts of the Apollo program were test pilots, not rock hounds (the only exception being Harrison "Jack" Schmitt, a professional geologist and the only scientist to walk on the moon). To get the astronauts up to speed on the fundamentals of field geology, NASA depended on local experts who taught geology lessons that astronauts could learn on Earth and apply on the moon.

In the Marathon Basin of West Texas, NASA turned to Muehlberger to be that expert. It would be the start of a collaboration with NASA that would outlast the Apollo years and would position the Jackson School as a leader in teaching geology to astronauts.

Muehlberger was known for his work on tectonic processes at the regional and continental scales. In 1968, the year before the moon landing, he directed the production of the U.S. Geological Survey's first edition of its Basement Rock Map of the United States. Although the astronauts were just neophytes when it came to that type of work, Muehlberger said that what the astronauts lacked in formal knowledge they more than made up for in enthusiasm.

"What I found is that teaching geology to astronauts is fun!" Muehlberger wrote in a 2005 article for *Geotimes* magazine



PHOTOS: NASA.

(now *Earth*). "They are smart and interesting people, and while most have little or no knowledge of geology, they all want to learn."

Neil Armstrong, for one, considered the time in the field as time well spent.

"I enjoyed geology, and it was certainly appropriate to understanding what we were seeing on the surface of the moon," he said in a 2002 interview with the Johnson Space Center (JSC) Oral History Project. "Had I been a better geologist, I might have seen some things that were important that I missed ... but in the time that we had available, I think everyone did a credible job of being able to see things that were important and know which samples to pick up and be able to describe to people back on Earth what they were seeing."

After the Marathon Basin field training, Muehlberger returned to UT, where he became chairman of the Department of Geological Sciences in 1966. But he never lost touch with NASA and the Apollo happenings. He got the latest news on lunar geology from fellow UT geology Professor Hoover Mackin, who worked with NASA developing hand tools and sampling procedures, and who covered his office walls in hand-colored copies of geologic maps of the moon. Muehlberger also helped NASA make a moonscape of its own by arranging for a 16-ton dump truck to deliver granite from the Llano Uplift to the Kennedy Space Center in Florida. Then, six years after the Marathon Basin field exercise, Muehlberger found himself teaching astronauts again when NASA asked him in 1970 to serve as the principal investigator for field geology for Apollo 16-20, the final missions.

"Holy Toledo. I knew that the moon was up here on this wall, but that was about it," Muehlberger said in the JSC Oral History Project, recounting his reaction to being offered the job and referring to Mackin's moon maps. "And here I am suddenly the head man."

The Apollo program ended up lasting only through Apollo 17, with Muehlberger serving as principal investigator for the final two missions, as well as for the Apollo 15 backup crew.

In interviews and articles, Muehlberger calls these final three missions the "big science" missions. They involved exploring more complex terrain, using a moon rover to go longer distances, and deploying new sampling technology—such as a coring drill developed by UT alumnus Uel Clanton. Apollo 17 even brought a bona fide geologist, astronaut Jack Schmitt, to the lunar surface.

As principal investigator, it was Muehlberger's job to plan the geological traverses that astronauts would take on the moon and prepare the crew to execute them. Doing that involved taking field trips to lunar analogs on Earth—the lava fields of Hawaii and Iceland and the craters and gorges of the southwestern United States, for instance—but interacting with the astronauts as if they were already on the moon.

Muehlberger and his team would stay out of sight, available only through radio contact, as the men ambled along their traverses carrying packs bulked up with Styrofoam and with tools placed as they would be on the real mission. A local geologist would shadow the crew on their mock missions, providing feedback to both the astronauts and the geology team once the traverse was over and everyone presumed to be back on their home planet.

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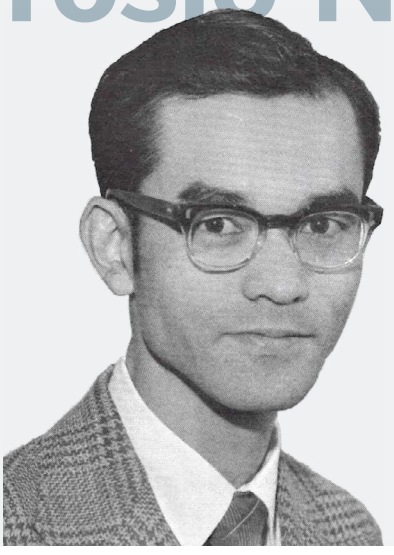
OPPOSITE PAGE, TOP: WILLIAM MUEHLBERGER PLAYING THE ROLE OF ASTRONAUT DURING AN APOLLO FIELD TRAINING.
OPPOSITE PAGE, BOTTOM: MUEHLBERGER (RIGHT) AND JOHN POWERS (CENTER) EXAMINE "BIG MULEY," THE LARGEST MOON ROCK BROUGHT BACK TO EARTH, AT THE LUNAR RECEIVING LABORATORY IN HOUSTON.

ABOVE, LEFT: ASTRONAUT CHARLES DUKE COLLECTING BIG MULEY.
ABOVE, RIGHT: BIG MULEY CLOSE-UP.

PHOTOS: NASA.

Yosio Nakamura



Moon Quake Tracker & Lunar Archivist

It wasn't long after the moon landing in July 1969 that the seismic recorders at Mission Control came to life, their needles scratching the first seismic transmissions from another world.

The zig zagging lines of data served as a signal for Yosio Nakamura, now a Jackson School Professor Emeritus, and the rest of the Apollo Passive Seismic Experiment team to gather at the Manned Spacecraft Center (now the Johnson Space Center). It was their job to learn about the moon's interior by interpreting the seismic data.

"It was such an exciting time," said Nakamura, who is also a researcher at the Institute for Geophysics (UTIG).

Nakamura's involvement with the seismic experiment started in 1967, when he took a one-year leave of absence from his job at General Dynamics in Fort Worth to conduct postdoctoral research with renowned geophysicist Maurice Ewing, the then-director of Columbia University's Lamont-Doherty Geological Observatory. He wasn't expecting to work with Ewing on lunar seismic research, but when Ewing was asked by NASA to take the lead on the project, Nakamura became part of the team, which was led by Ewing's former graduate student Gary Latham.

By the time of the moon landing, Nakamura was back at General Dynamics. During the Apollo years he balanced his day job there with NASA lunar research.

The goal of the first seismometer was to listen to the background noise of the lunar surface, such as meteoroid impacts. This passive listening that gave the experiment its name went on for about 21 Earth days (1½ lunar days) until it shut down due to overheating. But that was just the start of seismic research on the moon. New seismometers—now equipped with heat shields—were installed by astronauts with each following mission that made it to the moon. The seismic experiments became bolder, too. Astronauts set off charges and crashed lunar modules on the moon's surface as they departed for Earth.

Nakamura and other scientists learned about the interior of the moon by studying how the seismic signals that originated on the lunar surface changed as they travelled through the moon's subsurface. But no one expected to record signals coming from within the moon itself.

"Before we went there, just about everyone thought nothing was happening inside the moon," Nakamura said. "But at least signals from meteors hitting the surface could maybe tell us something about the moon's internal structure."

The assumption of a geologically dead moon turned out to be wrong. The seismometers picked up moonquakes—seismic signals generated by rocks shifting and moving within the moon. However, the signals from these quakes were initially a mystery. It took until Apollo 15, in 1971, for the researchers to have enough seismometers on the lunar surface to confirm that the mystery signals were coming from deep inside the moon.

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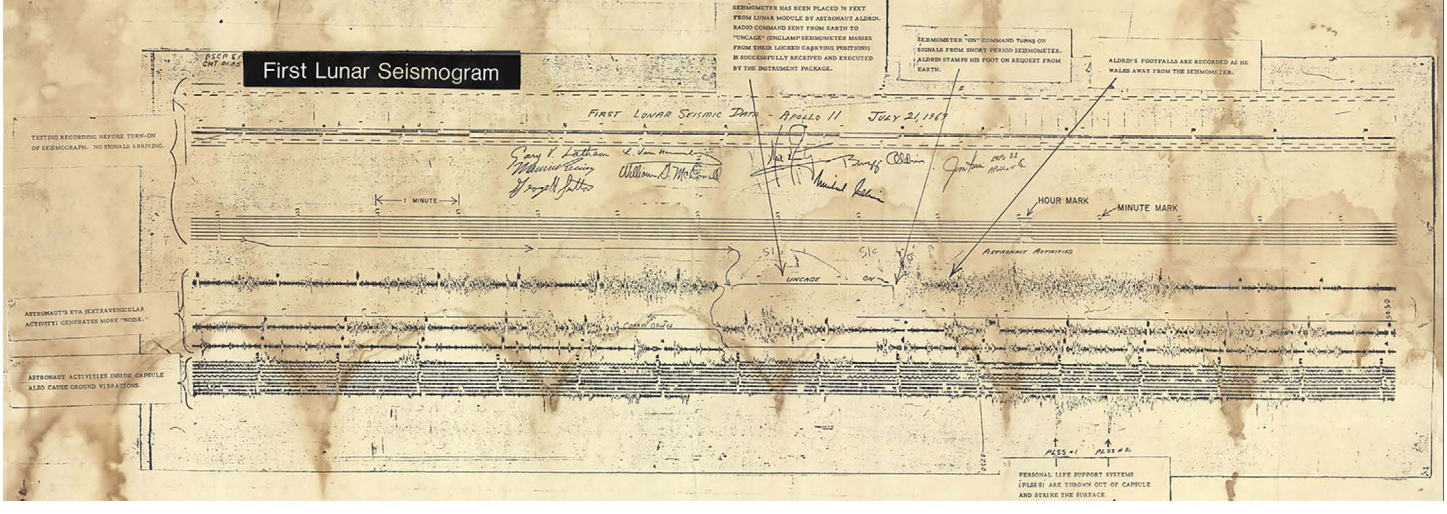
TOP: YOSIO NAKAMURA IN A PHOTO FROM 1974.
BOTTOM: AN ANNOTATED SEISMOGRAM OF THE FIRST SEISMIC SIGNALS FROM THE MOON.



PORTRAIT: YOSIO NAKAMURA. SEISMOGRAM: NASA.

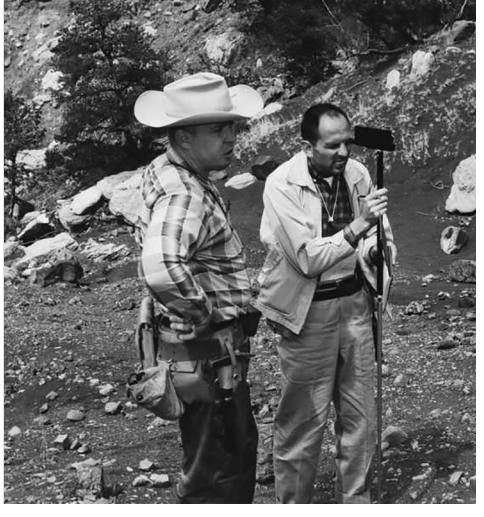
Uel Clanton

Apollo Astronaut Instructor & Moon Gadget Maker

In 1964, 29 Apollo astronauts—all vying for the chance to go to the moon—filled the room of their first geology course. According to a NASA history on Apollo astronaut training, they were asked this question: "Who has, at some time in their education, taken at least an introductory course in geology?"

Not a single person raised his hand.

It was going to take some serious training to get the men ready for the geological field work they were expected to conduct on the moon. In the early days of the Apollo program, UT alumnus Uel Clanton played a primary role in determining what a moon-bound astronaut should know about geology on a world where no human had been before.



PHOTOS: NASA.

Clanton was still a graduate student at UT when he was hired by NASA to develop a geology training program for Apollo astronauts. He was recruited for the position by fellow UT geology graduate and NASA scientist Curtis Mason. But when Clanton arrived at NASA's Manned Spacecraft Center (MSC, for short and now the Johnson Space Center) in Houston in 1963, he found that he and Mason were in the minority when it came to teaching astronauts to do geology—or really any scientific activities.

"There were only two or three people at MSC at the time who were really thinking or planning any sort of a science-type activity on the moon," Clanton recounted in the NASA history. "I rather vividly recall one of the earlier conversations with people really high in the structure where the suggestion was made that one might want to pick up some rocks from the moon and return them. And the question was, 'Why?'"

By the time the first class of Apollo astronauts was selected for training in 1964, Clanton and others had made a convincing case. General geology took up the bulk of training and consisted of six distinct sections. At 58 hours, the first geology section alone outnumbered all other scientific training in terms of time. (The 40 hours of flight mechanics took second place.) The training also included field geology excursions to observe geologic formations in their natural environment. The first of these was a two-day trip to the Grand Canyon.

Clanton had championed the Grand Canyon as the first field experience not because of its direct likeness to lunar geology—no one expected to find a river-eroded gorge on the surface of the moon—but because of the overarching lessons it taught about geology. According to Clanton, the trip was an eye-opening experience for the astronauts, many of whom couldn't quite grasp why geology was taking up so much of their training time.

"After the first field trip their comment was, 'well, we've listened to you for two weeks and not understood. And one field trip has shown us the importance and the reasons for all of the discussion,'" Clanton said in the NASA history.

In addition to classroom lectures, the Apollo missions also included mission-specific training. Due to time constraints, the crew of Apollo 11—the first to land on the moon—had time for only a single trip: a rock-sampling excursion in the Quitman Mountains of West Texas. As with most of the other Apollo field trips, Clanton was there as a geology instructor. But on this trip, he also played enforcer against the news crews that were swarming the usually remote mountains for a chance to chat with the moon-bound astronauts. He stopped the reporters in their tracks by using an ax to draw a line in the ground and warning of serious consequences to anyone who crossed it.

The rock-sampling lessons proved successful, with the Apollo 11 crew bringing home just shy of 50 pounds of rocks. These rocks greatly informed lunar scientific training going forward. But in the years leading up to that mission, Clanton had to decide what the astronauts should know about mineralogy and petrology when no one had ever seen a single verified moon rock. (Meteorites that came from the moon were not positively identified until after the Apollo program.) Based on the moon's reflectivity, scientists expected most moon rocks to be dark, a hypothesis that turned out to be true. But focusing on dark-colored samples could complicate the astronauts' introductory lessons, as features would be difficult to see.

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TOP: UEL CLANTON TESTING A ROCK HAMMER MEANT FOR LUNAR GEOLOGY.
BOTTOM: CLANTON (IN HAT) AT PHILMONT RANCH DURING AN ASTRONAUT FIELD TRIP.

Maurice Ewing

Lunar Seismic Pioneer

In the early days of the Apollo program, NASA needed scientists who were up to the challenge of building scientific instruments and interpreting data from harsh and alien environments.

Maurice Ewing—the founding director of the institutions that would become the University of Texas Institute for Geophysics (UTIG) and Columbia University's Lamont-Doherty Earth Observatory—spent his career exploring the great unknown of Earth's ocean geology. He was the first to conduct explosion seismology at sea; he invented the world's first deep-sea camera (which collected photos of sand ripples and other formations that proved the existence of deep-sea currents); and he was the co-builder of the first mass-produced seismograph, aptly named the Press-Ewing after its two inventors. (Frank Press was a graduate student of Ewing's at Lamont.)

So, it should come as no surprise that when NASA needed a seismometer that would work on the moon, they went to Ewing. The call came in 1965 when Ewing was director of Lamont-Doherty. Ewing accepted the challenge—but gave the role of principal investigator to graduate student Gary Latham. Postdoctoral researcher Yosio Nakamura ***(see pg. 74 for more on his role)*** also joined the research team.

The resulting instrument was about the size of a shoebox and designed for passive listening—recording the sounds of the natural lunar environment, such as meteoroid impacts. The device provided the first look into the moon's internal structure through data beamed back to Mission Control in Houston. But the data were short lived: after 1½ lunar days (21 Earth days) the seismometer overheated and died.

However, that was far from the end of seismic research on the moon. In just a few short months after the Apollo 11 crew returned to Earth, Apollo 12 went to the moon and installed a new seismometer. Ewing served as the co-head of the second seismic experiment. Instead of just passively listening to the sounds of the moon, this experiment involved listening as the departing astronauts intentionally crashed the lunar module into the surface of the moon to create a controlled seismic blast. (The Apollo 12 crew was safely aboard the command-and-service module that would take them back to Earth.)

Nakamura said that the impact of the module created a seismic signal unlike any that he had ever seen. It lingered, reverberating within the interior of the moon. The unusual behavior prompted Ewing to make a statement at an Apollo 12 press conference on Nov. 20, 1969.

"It's as though one had struck a bell, say, in the belfry of a church, a single blow, and found that the reverberation from it continued for 30 minutes," Ewing said.

Except the signal lasted longer than that. The reverberations were ongoing as Ewing gave his statement and ended up lasting for another 25 minutes. The moon had rung for a full 55 minutes. Researchers later linked the ringing effect with the bone-dry geology of the moon, which helped the sound reverberate among the rocks.

In 1972, Ewing moved back to his home state of Texas to found the Earth and Planetary Sciences Division of the Marine Biomedical Institute at the University of Texas Medical Branch in Galveston—a precursor of what would become UTIG. He died just two years later in 1974.

TOP: MAURICE EWING. **BOTTOM:** EWING AT MISSION CONTROL EXAMINING SEISMOGRAMS DURING APOLLO 17.

PORTRAIT: UNIVERSITY OF TEXAS INSTITUTE FOR GEOPHYSICS. SEISMOGRAPH: NASA.

After Apollo

Pat Dickerson & Mark Helper

The legacy of training astronauts in field geology started by Professor William Muehlberger continues at the Jackson School thanks to the effort of researcher Patricia Dickerson and Distinguished Senior Lecturer Mark Helper.

Dickerson was one of the driving forces in forming the Field Exploration Analysis Team, a group dedicated to recruiting experienced field geologists who could help NASA prepare astronauts for future field work on the moon or Mars. She started the program with Muehlberger, who was her Ph.D. adviser, and astronaut geologist Harrison "Jack" Schmitt in 2006. Shortly after its formation, Helper joined as the program's co-chair.

Dickerson personally saw the importance of field training. From 1996 to 2002, she worked at NASA's Johnson Space Center, where part of her job involved co-leading astronaut training field trips with Muehlberger in New Mexico. In collaboration with Muehlberger and astronaut John Young, she initiated instruction in field geophysical methods, including seismic imaging. She recognized that the skill set could prove useful to astronauts who might one day be sent to Mars, a world where much of the bedrock geology is obscured by layers of shifting sand.

Today, Dickerson frequently teaches general audiences about geology on tours organized by the Smithsonian Institution. She said that she was reminded of the synergy between the Jackson School and the Apollo program when, on the week of the 50th anniversary of the first moon landing, she was able to tell a tour group that the Icelandic lava flows that they were visiting had counterparts on the moon, and that her information had come from quite a reliable source: Jack Schmitt, an astronaut who had trained on the very lava flows they were visiting and who had walked among the lunar flows.

Helper, in turn, is lead field geology instructor for NASA's astronaut candidate program. Beginning with the 2009 astronaut class and continuing to the most recent class selected in 2017, he has designed and taught five-day field exercises involving geologic mapping and field data collection in northern and central New Mexico. He has also taken NASA engineers and scientists, particularly those involved in planning or directing lunar or Martian surface science, on similar trips so they can learn about the nature of geologic field work by doing it for themselves. In addition to wearing these field training hats, Helper has played the role of an astronaut on a simulated Mars geology mission as part of NASA's Haughton Mars Project, a program that conducted mock Mars mission exercises on an impact crater in Canada's remote and isolated Devon Island, an analog site for the Red Planet.

Helper said that his experience teaching astronauts has carried over into teaching Jackson School undergraduates in the field. For instance, he tasked students in the 2019 GEO 660 field geology course with the same Rio Grande Gorge field mapping exercise as the 2017 astronaut class. If that sounds intimidating, Helper said that the students did not know they were following in the footsteps of astronauts until later on in the field camp when teaching assistants let it leak. But Helper noted that it's the astronauts who had it easier; the students having to create more detailed maps in less time.

ABOVE: PATRICIA DICKERSON CO-LED NUMEROUS TRAINING FIELD TRIPS FOR SPACE SHUTTLE ASTRONAUTS.
RIGHT: MARK HELPER SIMULATES LUNAR FIELD WORK ON EARTH AT HAUGHTON CRATER IN THE CANADIAN ARCTIC IN 2010.

HELPER: NASA. DICKERSON: JACKSON SCHOOL.

From pg. 73 | Muehlberger

By the time the astronauts on the "big science" missions went to the moon, Muehlberger estimated that they each had the equivalent of a master's degree in geology. Their extensive training was put to the test when the crews of both Apollo 16 and Apollo 17 encountered geology that they were not expecting.

Instead of volcanic rocks, the Apollo 16 crew found that the Descartes Highlands were dominated by beaten-up breccias, the result of meteorites bombarding the moon earlier in its history. During this mission, the astronauts also found Big Muley—the biggest rock ever brought back from the moon, and named by the astronauts in Muehlberger's honor. The geologists at Mission Control spotted the rock on a live-feed that the astronauts set up, and they had high hopes that it was a chunk of the lunar crust. But it was just another breccia.

From their geology training, the astronauts at least knew that the lack of volcanic rock wasn't an oversight on their end. Although it took a minute to convince the geologists in Mission Control.

"We kept looking for ilmenite and all those little crystals in the basalts, but we didn't see any basalts and no ilmenites, and everyone got mad at us," said astronaut John Young in a 1995 interview cited in a NASA document on the history of the science training of the Apollo astronauts.

As for the crew of Apollo 17, they ended up finding some of the oldest rocks sampled on the moon in the place where the NASA geologists thought they would find the youngest. The geologists had interpreted the dark landscape as a sign of youth, the thought being that meteors had not had time yet to pound it into a lighter gray hue. But it turned out to be material forged billions of years ago in the moon's mantle.

The moonscape being so different from what was expected only proved to Muehlberger the importance of conducting geological field work in the first place, he said in an interview with the JSC Oral History Project.

"That's why you go and check. You can't interpret these photographs 100 percent right all the time," he said. "It would be nice if you could," he added, but then quickly took it back. "No, it wouldn't because it's more fun going out and looking ... That's what geology's all about, going to find out what you [were] really supposed to learn there."

The value that Muehlberger put on from-the-ground interpretation is illustrated by how he oversaw field work on the final moon mission, Apollo 17. Instead of sticking to objectives planned 238,000 miles away on Earth, he deferred to Schmitt, the geologist on the moon. Muehlberger knew that NASA would not officially approve a flexible field work schedule, so he kept the official task list for show while the actual objectives were set by Schmitt in the moment.

"In effect, he was running the mission from the moon. I was the official one. But what the heck? I can't see that stuff like he can," Muehlberger said in the JSC Oral History. "All of those within the geological world certainly knew it, and I had a sneaking hunch that the top brass knew it too, but this is a practical way out, and they didn't object."

The return of the Apollo 17 crew ended the era of lunar geology field work by astronauts as NASA shifted its sights toward studying the Earth. Muehlberger's expertise in large-scale tectonic processes made him an asset to astronauts who were now tasked with observing their home planet, first from the space station Skylab, which flew from 1973 to 1979, and then aboard the Soviet spacecraft Soyuz during the Apollo-Soyuz mission of 1975. For these missions, Muehlberger taught global tectonics using aerial photographs of rift valleys, faults and mountain ranges. However, it wasn't long until he was again in the field with astronauts. Before the launch of the first space shuttle in 1981, he met with astronaut Sally Ride, who would become the first American woman in space, and they decided that the crew would benefit from a visit to the geological features that they would be observing from orbit.

That decision led to NASA rebooting field geology training for astronauts under Muehlberger's leadership. He ended up leading most of the space shuttle crews on four-day field trips through the geology of northern New Mexico.

Spending all that time with astronauts may have inspired Muehlberger to see the Earth from orbit himself. In the JSC Oral History, near the closing of a long conversation, he revealed that he applied to be an astronaut during the space shuttle program but was not selected. Nevertheless, he frequently wore a memento of the shuttle's first flight—a bolo tie of New Zealand jadeite that commander John Young brought along into orbit.

Muehlberger died in 2011, the same year the space shuttle program ended. But the training of NASA astronauts by members of the Jackson School continues. Researcher Patricia Dickerson and Distinguished Senior Lecturer Mark Helper have broadened the content and expanded upon the foundation first laid by Muehlberger. Both have guided astronauts in field training exercises and have taken part in organizing a network of geoscientists who are up to the challenge—and excitement—of teaching astronauts how to explore their world and others.

From pg. 74 | Nakamura

Once the geophysics team knew what to look for in a moonquake signal, they were able to pick them out on the earliest readings from the Apollo 11 seismometer and even distinguish between different types of quakes. They found deep events occurring just about half way to the center of the moon. They also detected much larger events occurring close to the surface but far from the seismic stations.

"We called these high frequency teleseismic events, now called shallow moonquakes," Nakamura said.

Still, today little is known about shallow moonquakes and why they occur, Nakamura said. An idea he developed with UTIG colleague Cliff Frohlich, a research scientist emeritus, was that they may be triggered by something coming from outside our solar system.

"They seemed to occur at certain times when the moon was facing a certain direction, not relative to the sun, but the stars," Nakamura said. "This is only our guess, but maybe shallow moonquakes are caused by particles hitting the moon from some far away star."

Deeper moonquakes have less mysterious origins. Scientists have linked them to changes in the gravitational pull on the moon as it orbits the Earth and sun.

During Apollo, all the data from scientific instruments on the moon was transmitted live to Earth and recorded on large, seven-track digital tape reels. Each reel stored about 800 bits per inch —about the same amount of data as a JPEG image file. NASA struggled for years to manage the thousands of reels generated by the lunar experiments until, in 1976, NASA eventually decided it had had enough.

Officials reached out to researchers at the Galveston Geophysics Laboratory at the University of Texas Marine Sciences Institute, the precursor of UTIG and where Nakamura was now working, to see whether the university could serve as the scientific home for the last leg of incoming lunar data. For the final 19 months of lunar readings, Nakamura took part in receiving, processing and recording of not just the seismic data, but data from all scientific instruments making measurements on the moon.

Since then, Nakamura has become a lunar archivist who not only is analyzing seismic data, but saving it. Thanks to his efforts, UTIG maintains copies of the Apollo program's seismic data, along with the final 19 months of lunar instrument readings. Nakamura has also led the charge in keeping the data accessible. In the early 1990s, Nakamura hired a team of undergraduate UT geosciences students to copy all 12,000 tapes onto just 80 cassette tapes—an effort that took about a year and a half. And he has since ensured that all the Apollo lunar data are safely stored in an online and public-access database so that a new generation of scientists—and a new generation of data-analysis technology—can continue to mine them for new discoveries.

The effort has already resulted in amazing new finds. For example, Nakamura and Texas Tech Associate Professor Seiichi Nagihara, who earned a Ph.D. from the Jackson School, uncovered and incorporated an additional 440 reels of scientific data covering a three-month period from April to June 1975. It took many years to find funding and equipment to extract the data from the reels, but finally, in 2018, Nagihara published a remarkable paper in the *Journal of Geophysical Research: Planets* showing that dark moon dust kicked up by astronauts walking on the moon had actually warmed the moon's surface several degrees.

Nakamura said that he is hopeful that future generations will return to the moon and uncover more of its secrets using seismology.

"I think eventually an international team will go there and put seismometers on the moon again," Nakamura said. "In this kind of thing, there is no boundary between countries."

In honor of his many lunar accomplishments, Nakamura was inducted into the Jackson School's Hall of Distinction in 2013.

Additional reporting by:
Constantino Panagopulos

From pg. 75 | Clanton

To avoid these issues, Clanton opted to train the astronauts in geology foundations, teaching basically the same mineralogy and petrology course that he had given to sophomore geology students as a teaching assistant while in graduate school at UT. He even repurposed the old lab manual and persuaded the UT geology department to donate a hand specimen tray used in the class to the Apollo program. This tray served as a reference for 100 more trays put together by NASA.

Clanton also saw to it that the collection represented the landscapes the astronauts were learning from, typically bringing back 30 to 40 pounds of rocks from each field excursion locale to have cracked into hand specimens for teaching.

"If a question came up during the classes about rock types from the localities that had been visited on field trips, one could go to the reference collection and pull out a specimen of whatever weird and wonderful rock that you wanted to talk about," Clanton said in the NASA history.

With the success of Apollo 11 and subsequent missions, knowledge about lunar geology sprang forward. Astronauts no longer had to depend entirely on suspected Earth analogs for moon rocks when they could learn from the real things. This prompted NASA to reorient incoming astronauts' geology training toward mission-specific information and skills. Classroom training was cut from about 225 hours to just 35, with astronauts spending more time in the field conducting dry-runs of lunar traverses.

Clanton stayed involved with the astronaut training by taking part on mission field trips. He also continued to play an important role in the Apollo program by helping develop geologic tools that astronauts could properly wield while suited up on the lunar surface, including a coring drill, rake and scoop. Clanton would test the tools himself by donning a space suit and trying them out on the infamous "vomit comet"—the KC-135 Stratotanker airplane used to simulate low gravity environments. The tools eventually made their way to the moon on various Apollo missions, where astronauts put them to work collecting moon rocks to bring home.

EL NIÑO LA NIÑA RISING

THESE SEASONAL CLIMATE PATTERNS ARE RESPONSIBLE FOR FAR-REACHING AND DAMAGING WEATHER EVENTS THAT AFFECT THE ENTIRE WORLD. THE UNIVERSITY OF TEXAS INSTITUTE FOR GEOPHYSICS IS LEADING THE WAY TO UNDERSTAND HOW GLOBAL CLIMATE CHANGE COULD BE AFFECTING THEM.

BY CONSTANTINO PANAGOPULOS

Allison Lawman is in The University of Texas at Austin paleoclimate archive, laying out pieces of featureless, bleached white coral beneath a glistening medical scanner. Around her, the warehouse is a medley of coral, tools, machinery and a line of shelves housing one of the most significant collections of coral cores held by a university.

"What many people don't know is that corals have growth bands, just like tree rings," she said.

"To see the banding, we carefully slice a thin slab from the core and take an X-ray."

Lawman is a Jackson School of Geosciences graduate student working at the University of Texas Institute for Geophysics (UTIG), where she is part of a group of scientists who are solving some of the most pressing questions about our enigmatic climate.

The corals, according to Lawman, are important because they tell us, month by month, what the ocean was like when the coral was alive, which was often long before humans were around.

"Each one of these is like looking at a thermometer from the past," she said.

"We can also tell how salty the ocean was, which is often related to how much rain there was."

Lawman and her colleagues at UTIG are studying corals to find traces of two recurring climate events in the Pacific Ocean known as El Niño and La Niña. The goal is to learn how to better predict when they will happen and their impacts on the world.

El Niño begins as a bulge of warm water that drifts below the ocean surface across the equator in the Pacific Ocean. When it reaches the eastern Pacific, it bursts to the surface, warming the atmosphere and triggering a cascade of weather disruptions across the world. El Niño carries the seed of its own destruction, however; about a year later, a slower blob of cold water arrives, putting an end to the warming and initiating La Niña, the opposite, equally disruptive cold phase. Typically, each phase runs its course within a year. Sometimes, however, El Niño or La Niña will continue for a second or third year. The prolonged effects of these back-to-back events cost billions of dollars in ecological damage, including fish stock crashes in Peru, crop failure in China and cataclysmic flooding in Australia.

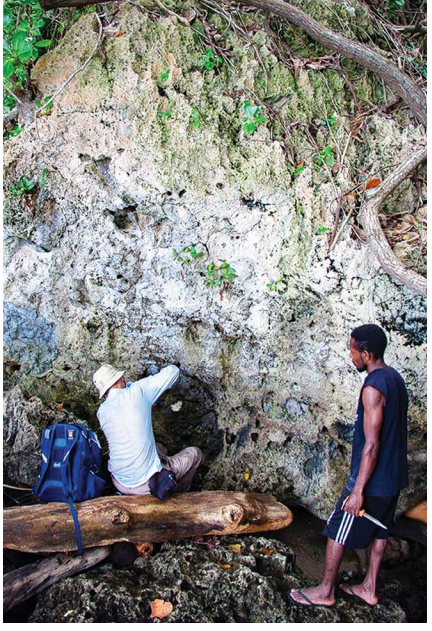
For the southern United States, long-lasting El Niño events mean warm, wet winters and the kind of deluges that flooded Texas throughout 2016 and 2018. Long-lasting La Niña events, on the other hand, can bring months of drought. In the 1950s, a seven-year Texas drought, the most severe on record, was caused by back-to-back La Niñas that pushed moisture-bringing air currents away and left the southern Great Plains to wither to dust. More recently, a similar string of events was behind the 2011 Texas drought that left the state parched for over five years.

Knowing when El Niño and La Niña will strike and how long they will last could mean life or death for agriculture, shipping, homeowners, insurance companies and many others. Today's climate forecasts, however, stretch no further than eight months and struggle to account for the impact of global climate change.

DRILL: JUD PARTIN. CORAL: JACKSON SCHOOL.

OPPOSITE PAGE: UTIG RESEARCH ASSOCIATE JUD PARTIN USES A HAND-HELD CORING DRILL TO GATHER FOSSILIZED CORALS FROM AN UPLIFTED REEF IN VANUATU.

TOP: GRADUATE RESEARCH ASSISTANT ALLISON LAWMAN HOLDS A PIECE OF CORAL THAT LIVED OVER 900 YEARS AGO.



LEFT: FRED TAYLOR AND A MEMBER OF THE VANUATU SCIENCE TEAM TAKE A SAMPLE FROM A FOSSILIZED CORAL ESTIMATED TO BE BETWEEN 12,000 AND 20,000 YEARS OLD. **CENTER:** CORAL SAMPLE READY TO BE X-RAYED AT UT'S PALEOCLIMATE ARCHIVE, AN ALMANAC OF PAST CLIMATE CONDITIONS. **BELOW:** SEA SURFACE TEMPERATURE MEASUREMENTS SHOW HOW THE EQUATORIAL PACIFIC OCEAN BECOMES WARMER DURING EL NIÑO (TOP) AND COOLER DURING LA NIÑA.

This is where UTIG climate scientists step in. Ten years ago, UTIG's former director, Terry Quinn, saw an opportunity to leverage the institute's strengths with a team of experts who could tackle these kinds of big questions about our world's climate.

"We combine climate modeling, statistical analysis, laboratory work, theory and expeditionary science in ways you won't find anywhere else," he said.

Today, UTIG's climate researchers are using all the tools at their disposal to advance predictions about El Niño and La Niña and understand how their effects will change as the world warms.

Predicting the Next Climate Disaster

In 2017, UTIG research scientists Pedro DiNezio and Yuko Okumura correctly predicted that the La Niña event that began earlier that year would continue into a second year, meaning another year without rain for much of Texas and the East Coast. Today, UTIG scientists think they are on the verge of breakthroughs that will allow forecasts to be made up to two years ahead, giving farmers and water management services crucial time to prepare.

"Long term predictions of long-lasting El Niño and La Niña events are possible," said Xian Wu, a Jackson School graduate student who is working on the problem with Okumura and DiNezio.

Earlier this year, Wu published a paper in the *Journal of Climate* that gives an incredibly detailed analysis of climate behavior. Her results, which could help predict the duration of individual events, were elegantly simple: El Niño events that begin in spring or early summer quickly fizzle, and those that develop later return for a second year; La Niña events that follow a strong El Niño will stretch into two years, whereas a weak El Niño will generate a short-lived La Niña.

Wu made this discovery by analyzing climate records spanning the past 120 years and confirmed her hypothesis using a computer model that simulates the Earth's climate. Her work reveals an intricate network of oceanic and atmospheric mechanisms that can trigger climate feedback loops as far away as the North Atlantic and the Indian Ocean. Depending on each individual event, these either return to smother the event early or fuel it for another year or longer.

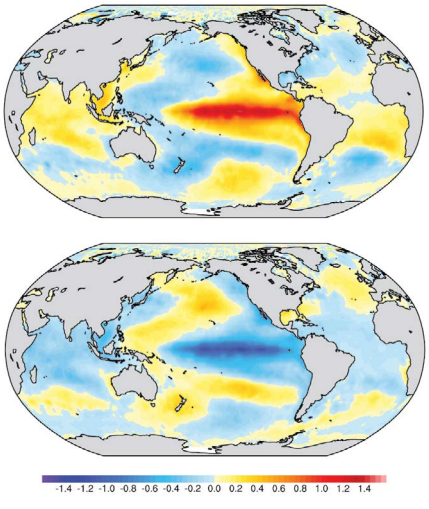
Separating Climate Change From Climate Variation

The computer model Wu used to tease out the parts of the system was the state-of-the-art Community Earth System Model, one of the most sophisticated in the world. The model works by deconstructing the Earth's climate into little 3D pixels of ocean, land and atmosphere, and applying basic laws of physics. The result is a simulation that is unprecedented—and often frightening—in its realism.

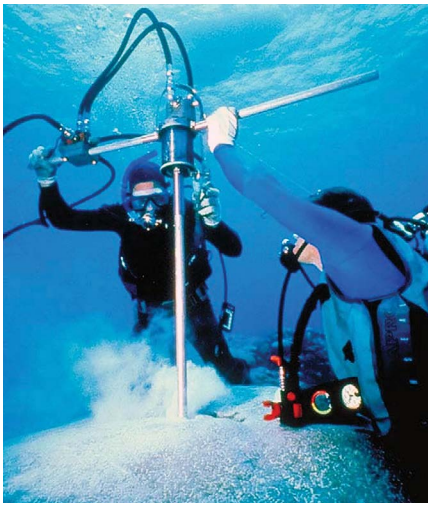
DiNezio said that with the right math, the model can do amazing things.

"You can actually see El Niño spontaneously emerging from the equations, " he said.

Although simulations can predict how greenhouse gas emissions, volcanic eruptions and sunspots can warm or cool the climate year to year, these predictions are muddied by longer periods of climate ups and downs, on the scale of decades and even centuries. This kind of long-term climate variability can skew predictions and distract. For example, in the early years of the 21st century, many wrongly thought a short-lived slow-down in global warming was a sign that human impact on the climate had been exaggerated.



FIELD SHOT: JUD PARTIN. CORE SAMPLE: JACKSON SCHOOL. MAPS: XIAN WU.



DRILLING: JUD PARTIN. DIVING: FRED TAYLOR.

"Understanding how these natural variations are generated is the key to improve climate predictions for the coming decades," said Okumura, who studies long-term climate patterns with Tianyi Sun, a recent doctoral graduate from the Jackson School.

They looked beyond the tropical Pacific and found that the ocean and atmospheric conditions where El Niño and La Niña develop were being partly decided in the vast expanse of ocean lying south of the tropics. Here, changes in ocean and air circulation slowly move north toward the equator over several years, essentially changing the conditions in which El Niño and La Niña form and develop over very long periods.

Okumura said that Sun's work was the first to clearly demonstrate the origins of long-term tropical Pacific variability and its impact on El Niño and La Niña.

"The knowledge we gained through this research is critical to understanding future changes in El Niño and La Niña," Okumura said.

Is Global Climate Change Fueling the Fire?

Overwhelmingly, evidence shows that the effects of El Niño and La Niña are becoming more severe as our world's climate warms. How this will play out is perhaps the most significant question the group is tackling.

"When we look at historical records and when we run climate simulations, we see that a warmer climate leads to more pronounced drought and rain during El Niño and La Niña," said DiNezio.

Sabiha Tabassum, a graduate research assistant at UTIG, is investigating extreme rainfall events that occur during El Niño and La Niña. Her analysis of rainfall data shows that these events are becoming worse as the climate warms. Tabassum, who worked in water resources engineering in Bangladesh before joining UTIG, said that water infrastructure will face much greater stresses in the future. For example, events such as the New Orleans levee failures during Hurricane Katrina might become more common.

Past Climate From Coral Dust

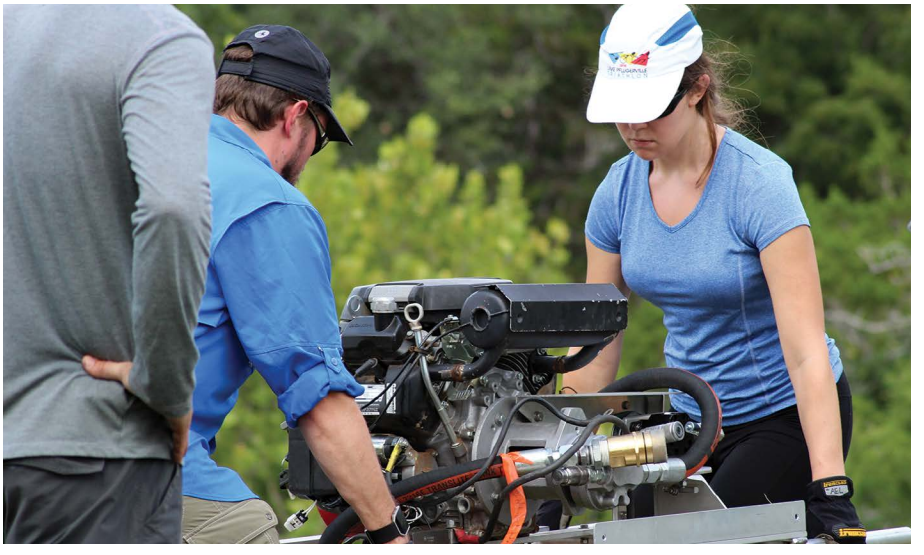
Back in the lab, Lawman is showing Joseph Arias, an undergraduate student at the Department of Geological Sciences, how to drill a series of neat holes into a length of coral using a dentist's drill. The coral dust they collect is dissolved in tiny vials of phosphoric acid, each sample representing a single month of coral growth.

A mass spectrometer measures the ratio of two different oxygen isotopes, telling them how cold and salty the ocean was when the coral was alive. Another instrument called an inductively coupled plasma optical emission spectrometer measures the coral's chemistry.

"The way it works is really quite interesting. It drops tiny amounts of coral into a plasma that burns hotter than the sun and then measures the light that's given off as the sample is being obliterated," Lawman said.

The intensity of that light allows the machine to deduce the concentration of calcium and strontium in the bones of the coral. Under normal conditions, coral will grow their skeleton with calcium. In cooler waters, however, coral prefer to use strontium: the cooler the water, the more strontium. The ratio of the two elements in the skeleton gives Lawman and Arias an accurate month-by-month measurement of ocean temperatures when the coral was alive—in this case, a period about 900 years ago called the Medieval Climate Anomaly.

TOP: THE RESEARCH GROUP PREPARES TO DRILL INTO AN UPLIFTED REEF ON THE SOUTH PACIFIC ISLAND OF VANUATU.
BOTTOM: FRED TAYLOR DRILLS INTO A LIVING CORAL IN THE SOUTH PACIFIC.



TOP: UTIG RESEARCH ASSOCIATE JUD PARTIN CARRIES PART OF THE DRILL USED TO GATHER SAMPLES FROM CORALS THAT GREW DURING THE LAST GLACIAL MAXIMUM.
BOTTOM: JACKSON SCHOOL GRADUATE STUDENTS ROB DOMEYKO AND ALLISON LAWMAN HELP DEPLOY THE DRILL DURING TESTING AT THE WHITE FAMILY OUTDOOR LEARNING CENTER.

"This was a time when we know the Northern Hemisphere experienced a period of warming, similar to modern-day temperatures," said Lawman. "But we don't know very much about the tropics and what El Niño was doing."

By drawing comparisons with modern observations, they can find clues that show how weather patterns change in a warmer world and create a baseline for measuring the extent of human impact on climate change.

Lawman found that the range of extreme El Niño and La Niña events during the Medieval Climate Anomaly was similar to those observed during the early 20th century.

"However, at no point did they meet or surpass what we've seen the last 40 years," she said.

On the Frontlines of Climate Research

According to the researchers, the most useful analog for modern global climate change is, surprisingly, not a period of past global warming, but the peak of the last ice age, when Canada and parts of Europe were buried beneath 2 miles of ice.

Much about this period 21,000 years ago, known as the Last Glacial Maximum, was very different from today. Global temperatures were 10 degrees cooler, and much of the world's oceans were frozen in thick ice sheets that left sea levels up to 400 feet lower than they are in modern times.

Such extreme and global effects make it much easier for scientists to see El Niño and La Niña's shadow in the sediments, ice and remains of corals that grew at that time.

Finding these fossil corals, however, is a significant challenge. Coral skeletons quickly erode when reefs die. Those that remain intact mostly lie buried beneath hundreds of feet of water and rock. About 10 years ago, Fred Taylor, a senior UTIG researcher who studies neotectonics, realized he could use his knowledge of Earth processes to get around the problem.

"We looked at global tectonic and sea-level reconstructions for the last glacial period and calculated the most likely spots to find uplifted corals," said Taylor.

By winding back the clock of tectonic plate movement, Taylor pinpointed exactly where ancient coral reefs had been brought to the surface. One such location was the South Pacific island of Vanuatu, but getting to the corals was not as straightforward as he had anticipated.

"The fossil corals are on land but in very hard-to-reach places such as steep, rocky slopes," said Taylor.

Younger corals grow on top of the older ones, meaning that you need a much longer drill to reach the older coral underneath, he added.

A UTIG Prototype: The Ultra-Portable Shallow Coring Drill

With no commercially available solution, Taylor and fellow UTIG climate scientist Jud Partin decided to build their own. The Ultra-Portable Shallow Coring drill is a prototype device designed to drill cores up to 656 feet below the surface but light enough to be broken down and carried by hand over rocky terrain. After testing the drill at the Jackson School's White Family Outdoor Learning

PHOTOS: JACKSON SCHOOL.

Center in July 2019, Taylor, Partin and Jackson School graduate student Rob Domeyko headed off to Vanuatu in September to find and gather fossil corals using the new drill. The plan is to collect several hundred feet of fossilized coral, which, if successful will exceed the achievements of multi-million-dollar ocean drilling projects at a fraction of the cost.

"We're one of only a few research groups to have ever collected coral samples from the Last Glacial Maximum, and we will be the first to gather this much," said Partin.

Although Taylor's calculations have narrowed the ancient corals' likely location to a single stretch of beach, finding them will require skill, perseverance and quite a bit of luck.

"It's like finding buried treasure on a map without an X," said Partin.

Fortunately, Taylor and Partin are used to overcoming tough challenges in the field and making the most of limited resources. The fieldwork partnership they have cultivated in recent years has already achieved many important firsts, and the scientists are confident they will succeed.

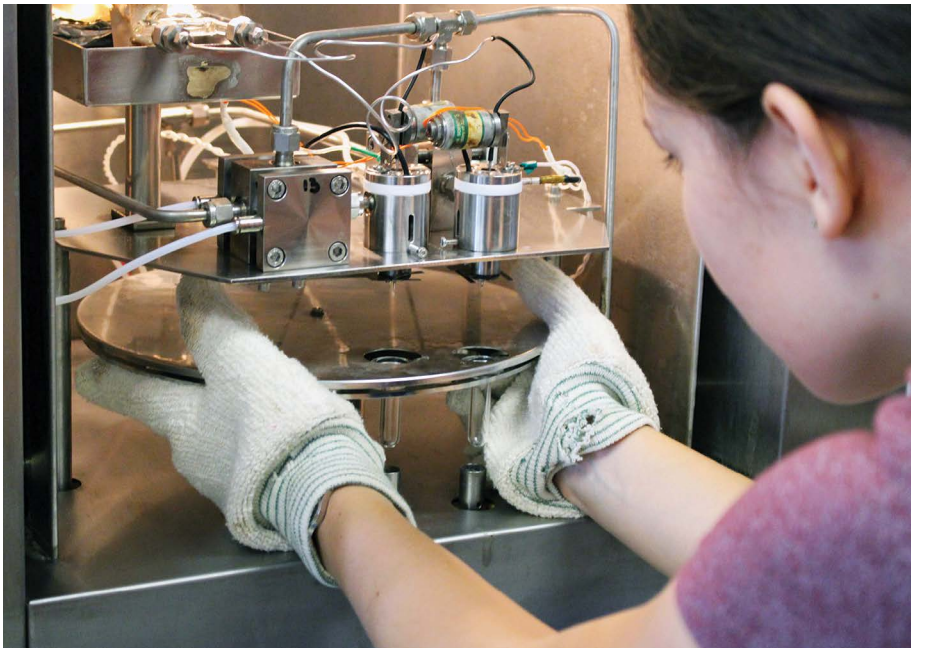
The Vanuatu corals will give the scientists data they need to understand how weather patterns change under drastically different climate conditions. The next challenge will be to feed this data into a refined climate model that can predict how El Niño and La Niña —and their global impacts—will change in the future.

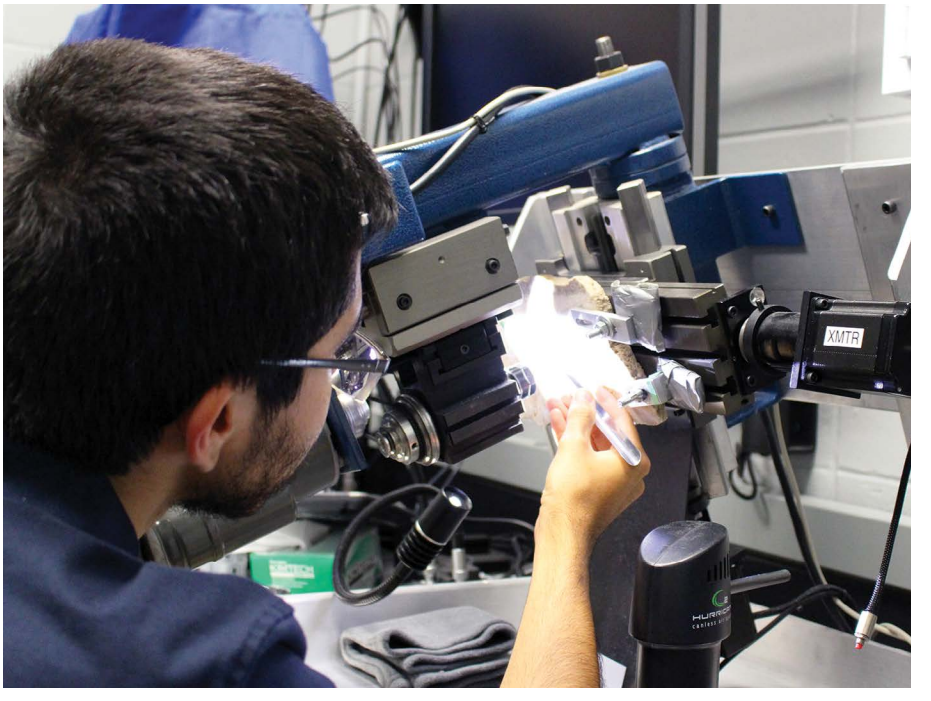
"The integrated approach at UTIG is unique," said DiNezio. "We're able to answer difficult questions about the climate by looking at past, present and future all together."

Indeed, by combining ice age data with computer simulations of our climate, UTIG researchers have already shown alarming signs of what the future might hold.

In 2018, DiNezio found evidence of ancient El Niño and La Niña-like climate patterns in the Indian Ocean, where they would be unheard of today. What worries DiNezio is that his climate simulations show this happening again in a warmer world. If he is right, the implications are serious for heavily populated countries of the region.

Alongside increasing evidence that extreme weather events are becoming more frequent and more destructive as the world warms, it is clear there is much to be concerned about. However, using ancient corals, computer models, chemical sensors, and drills, UTIG's climate researchers are showing us how understanding the past is key to knowing the future. We can be hopeful that with this knowledge scientists, policy makers and vulnerable communities can learn how to better prepare for such eventualities.





TOP: GRADUATE RESEARCH ASSISTANT ALLISON LAWMAN LOADS CORAL SAMPLES INTO THE MASS SPECTROMETER AT THE ANALYTICAL LABORATORY FOR PALEOCLIMATE STUDIES.
BOTTOM: UNDERGRADUATE STUDENT JOSEPH ARIAS OPERATES A MICRO-MILL TO COLLECT SAMPLES FOR FURTHER ANALYSIS.

PHOTOS: JACKSON SCHOOL.

CHANGING THE FUTURE OF HYDROCARBONS

The University of Texas at Austin brings together top-ranked programs and world-class facilities to form a concentration of hydrocarbon expertise focused on profitable, sustainable production that is matched by few institutions in the world.

BY ANTON CAPUTO

Since peaking at 3.4 million barrels of oil a day in 2004, Mexico's oil industry has been in a steady decline and now sits at about half that production. A new partnership with The University of Texas at Austin has plans to help reverse that trajectory by leveraging UT's extensive expertise to discover new fields and extend the life of mature oil fields in Mexico.

The administration of President Andrés Manuel López Obrador wants to overhaul the oil and gas industry and has set the ambitious goal of building crude oil production to at least 2.6 million barrels per day by the end of the administration. Mexico looked all over the world for a partner to help with this monumental task, one that could bring expertise for all issues concerning hydrocarbon production both onshore and offshore. In partnering with UT, it found the perfect choice right next door.

The partnership—called the Advanced Resource Recovery in Mexico (ARRM) project—is run by the Mexican Institute of Petroleum and UT and managed by the Jackson School of Geosciences' Bureau of Economic Geology. Its goal is to improve and enhance oil recovery from existing and mature fields, to better understand regional oil plays onshore and offshore, and to advance innovative solutions for tight oil reservoirs. The project is still being finalized, but the budget will be hundreds of millions of Mexican pesos (tens of millions of U.S. dollars).

Once the plan is launched, researchers from the Jackson School, the Cockrell School of Engineering and other units throughout the university will work with colleagues at the Mexican Institute of Petroleum to conduct research that will increase Mexico's hydrocarbon production, reduce costs and improve recovery efficiency. The team will focus on addressing short-term opportunities with existing technology and developing game-changing technologies and approaches for the longer term.

Mexico's choice to tap oil and gas expertise from UT is rooted in a long history. The two have strong ties in Earth sciences and hydrocarbon energy issues that can be traced back for more than 100 years. In 1905, William Battle Phillips, director of the University of Texas Mining Survey, published a geological characterization of the coal beds in Chihuahua, Mexico. Four years later, in 1909, Phillips would become the first director of the newly created University of Texas Bureau of Economic Geology. Decades later, Peter Flawn —former UT president, professor of geological sciences and director of the Bureau of Economic Geology—would forge strong ties to Mexico during his years of research in the country. He even joined the faculty of the National Autonomous University of Mexico's (UNAM) Institute of Geology in 1964.

Since then, UT geologists and petroleum engineers have been involved in important research collaborations with Mexican counterparts. Among the projects UT scientists have worked on are geological assessments for hydrocarbon resources in Mexico's important Chicontepec and Tampico-Misantla basins, integrated reservoir characterization of the Poza Rica Field, research on the geologic framework of the Laguna Madre-Tuxpan area, studies of the Salina del Bravo region, and a host of projects looking at the deep-water Gulf of Mexico. UT has also long played a crucial role in educating professionals and leaders in the Mexican oil and gas industry.

In recent years, the relationship led to The University of Texas at Austin-Mexico Initiative, an effort pushed by UT President Gregory L. Fenves to further develop interdisciplinary collaboration with Mexican educational and scientific organizations to enhance their mutual mission in education and scientific research. The initiative now has a permanent office on the UNAM campus in Mexico City.

This history offered a compelling backdrop over the two years during which the countries discussed the partnership, said Jay Kipper, the associate director of the bureau. But it was the expertise that UT brought to the table that really sealed the deal, he said.

"It's a cross-university engagement," he said. "This is really about the power of all the different pieces of The University of Texas."

In the next eight pages, you will see highlights of those pieces that make UT a unique institution and one that is changing the future of hydrocarbons.

PHOTO: THE UNIVERSITY OF TEXAS AT AUSTIN.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Tops in the Nation

Nestled in the center of the Lone Star State, The University of Texas at Austin boasts the No. 1 Geology program and the No. 1 Petroleum Engineering program in the country, as ranked by *U.S. News & World Report*. The Jackson School, in addition to its top geology program, is ranked No. 7 in Earth Sciences (No. 3 among public universities) and No. 7 in Geophysics and Seismology (No. 2 among public universities). These top rankings are due to the collective power of its three world-class units—the Bureau of Economic Geology, the Department of Geological Sciences and the Institute for Geophysics. Combined with the prowess of the No. 1-ranked Hildebrand Department of Petroleum and Geosystems Engineering and a bevy of other top-ranked programs at the UT Cockrell School of Engineering, these programs build a foundation for unmatched education and research in hydrocarbon issues.

Unconventional Revolution

No development has redefined the energy landscape in recent years as much as advances in unconventional resources. Hydraulic fracturing has enabled dramatic increases in the production of oil and gas from shale and placed the United States, particularly Texas, once again at the center of the energy universe.

George Mitchell is, of course, credited as the pioneer of the shale revolution. But UT had a hand in it from the beginning. Nicholas Steinsberger, a young petroleum engineer who graduated from UT in 1987, helped perfect the method in the late 1990s and applied it in the field for Mitchell.

UT experts, particularly at the Hildebrand Department and the Bureau of Economic Geology, have been heavily involved ever since and are leading innovative and interdisciplinary research to help improve the safety and efficiency of unconventional methods of producing oil and natural gas.

The bureau, for instance, has performed two comprehensive analyses on four of the largest shale plays in the U.S.—the Barnett, Fayetteville, Haynesville and Marcellus—and is currently finishing studies on the oil-prone Bakken and Eagle Ford. The most recent analysis showed that technological advances since 2012 have increased the amount of recoverable gas by 20 percent ***(see pg. 13)***. These interdisciplinary studies integrate engineering, geology and economics, and they are the most comprehensive reports on unconventional resources publicly available.

The bureau also has deep expertise in the energy, environmental and economic implications of oil and natural gas production in the Permian Basin, one of the most prolific oil and gas provinces in the world.

Amazing Educational and Research Facilities

Since 2015, students at UT have had the opportunity to learn oil and gas operations in what's thought to be the first-of-its-kind drilling simulator in a university setting. The 3D simulator, operated by the Hildebrand Department, gives students a feel for real-world drilling operations in a virtual environment. Students and scientists at UT also have access to the only university-run hydrocarbon distillation units. The facility, operated by the UT Separations Research Program at the James R. Fair Process Science and Technology Center, facilitates cutting-edge experiments on new separations technologies and methods. Technologies are being developed in collaboration with industry partners such as ExxonMobil, Phillips 66, Emerson Automation Solutions, Shell and Eastman.

In addition, there are a host of state-of-the-art labs on UT's campus that are used for hydrocarbon research. Jackson School facilities include labs for geochemistry, mass spectrometry, thermo- and geochronology and mineral physics. The school also boasts a morphodynamics lab, a high-resolution X-ray computed tomography facility, an applied geodynamics laboratory dedicated to producing innovative concepts in salt tectonics, facilities that specialize in seafloor mapping and much more.

See the full list at: ***www.jsg.utexas.edu/research/facilities***.

Enhanced Recovery and Capturing Carbon

UT researchers have been heavily involved for years in figuring out how to improve and maximize production from mature fields through a range of methods under the umbrella of enhanced oil recovery (EOR). The practice involves injecting a variety of substances into an oil well to increase pressure and reduce the viscosity of the remaining oil. This can involve the use of chemicals, low-salinity water, microbes, miscible gas and steam, as well as a variety of novel and hybrid methods such as adding steam with solvents and combining gas and chemicals (low tension gas/foam flooding).

Carbon dioxide is also commonly used in EOR. In recent years, researchers have worked to combine EOR with carbon storage, using the combination as a method to boost oil production and trap carbon dioxide underground where the greenhouse gas cannot contribute to climate change. One great example is the Petra Nova project, which is removing carbon dioxide from a unit of the W.A. Parish power plant near Houston and piping it some 80 miles to the southwest to the West Ranch oil field, where it displaces oil as it is injected underground. The field's increased oil production is a key part of making the $1 billion project economically viable, with the profit from the enhanced oil recovery paying for the carbon capture system. The job of monitoring the carbon dioxide deep underground falls to the bureau's Gulf Coast Carbon Center.

PHOTO: CUTTINGS FROM THE EAGLEFORD SHALE STORED AT THE BUREAU OF ECONOMIC GEOLOGY'S CORE RESEARCH CENTER. THE CUTTINGS WERE COLLECTED IN 1952 AND, IN 2008, HELPED GROUND-TRUTH THE FIRST SHALE DRILLING OPERATIONS IN THE SHALE PLAY.

PHOTO: SARAH WILSON.


X-RAYS
IMMINENT
READY
GEO
TEK

Fire and Ice

Methane hydrate is a mysterious but ubiquitous substance created under high pressure and low temperatures when methane molecules are trapped in a cage-like lattice of water molecules. The ice-like substance is incredibly energy-dense and found in abundance in many parts of the world under Arctic permafrost, and on and under the seafloor. The hydrates are thought to be an energy source of the future, particularly for resource-poor countries.

Researchers at the Jackson School are leading an $80 million national effort funded by the U.S. Department of Energy to study the substance. In 2017, researchers with the Jackson School's Institute for Geophysics and Department of Geological Sciences led a drilling mission to retrieve samples from beneath the seafloor and return them to the surface under the same pressure and temperature conditions in which the hydrates were formed. The Jackson School houses one of the few labs in the world capable of studying and storing the volatile substance. Researchers have been conducting a battery of tests on the samples, including X-ray and CT scans and tests that determine the permeability of the material, quantity and saturation of the methane, and the moisture, density and particle-size distribution of the material. Another mission to retrieve more samples and to test innovations to the drilling technology is scheduled for 2022.

STARR and Industry Collaboration

Perhaps no program at UT better demonstrates the economic value of applied research and industry collaboration than the bureau-managed State of Texas Advanced Resource Recovery (STARR) program. Founded in 1996, STARR conducts geologic research that increases the production and profitability of oil and gas in the state of Texas. During the past 20 years, STARR has completed or is currently working on more than 60 reservoir characterization field studies and more than 15 regional studies with over 50 Texas oil and gas operators. Since its inception, STARR has raised $515.6 million in severance tax revenues, offsetting the program's $39.8 million in state funding.

There are numerous other examples of UT's close working relationship with the oil and gas industry. For instance, the Cockrell School's Center for Petroleum and Geosystems Engineering works with more than 50 corporate partners and numerous federal and state funding agencies to conduct more than $13.7 million in research per year, more than any other petroleum engineering department in the country. Research topics include drilling and completions, enhanced oil recovery, formation evaluation, integrated reservoir characterization, hydraulic fracturing and reservoir geomechanics, reservoir engineering and reservoir simulation.

Carbon Capture Leadership

The Gulf Coast Carbon Center (GCCC) has long had a reputation as a leader in the field of carbon capture and storage. In addition to its role in the Petra Nova project ***(see pg. 89)***, it is leading a regional partnership funded by a $4 million grant from the U.S. Department of Energy to explore how carbon dioxide emitted from industrial facilities along the Gulf Coast can be safely stored in geological formations under the Gulf of Mexico.

The GCCC also has a major international presence. It recently partnered with two Caribbean universities on the dual-island nation of Trinidad and Tobago to create a new clean industry that will store greenhouse gasses underground and eliminate the country's contribution to human-induced climate change ***(see pg. 8)***. On the other side of the world, the carbon center was brought in by the U.S. Department of Energy to work with the Japanese government on the Tomakomai site in northern Japan, a large-scale test project that stores carbon from a nearby refinery under the seafloor ***(see pg. 16)***.

Beyond the GCCC, researchers with the Jackson School's Department of Geological Sciences and Institute for Geophysics have shown that injecting air and carbon dioxide into methane hydrate deposits buried beneath the Gulf of Mexico could unlock vast natural gas energy resources while storing carbon dioxide underground ***(see pg. 16)***. The Cockrell School of Engineering also has robust research into carbon storage and played a major part in the U.S. Department of Energy's Center for Frontiers of Subsurface Energy Security, a joint carbon storage program led by UT.

Nanotechnology

Knowing what's happening under the surface of the Earth is vital when it comes to exploring for and producing energy resources. Researchers at UT are using nanotechnology to better illuminate the subsurface to better understand a range of issues. One of the most notable successes is tiny, computerized sensors developed by the bureau-led Advanced Energy Consortium (AEC) that are sophisticated enough to report downhole temperatures and pressures under real-world conditions. The AEC has also developed contrast agents to help map fracture patterns, fluid flow and the size of reservoirs, as well as delivery systems to transport various chemicals within tiny capsules that open and release their cargoes under pre-determined conditions, such as higher temperatures. The sensors and contrast agents are currently being used and tested by member companies and institutions in the field

Engineers at the Hildebrand Department also conduct significant research on nanotechnology, including a pioneering method for separating water from oil using specially coated magnetic nanoparticles.

PHOTO: JACKSON SCHOOL.

PHOTO: MANAGER OF THE UT PRESSURE CORE CENTER JOSH O'CONNELL (RIGHT) AND UNDERGRADUATE RESEARCH ASSISTANT ADDISON SAVAGE HANDLE SAMPLES OF METHANE HYDRATE UNDER PRESSURE. THE JACKSON SCHOOL IS LEADING RESEARCH ON THE POTENTIAL FUTURE FUEL.

Gulf of Mexico Research Studies

The Gulf of Mexico continues to be one of the world's major hydrocarbon producing regions. Researchers from throughout the Jackson School of Geosciences have a long history of studying and gathering vital data from the Gulf. Projects include the Gulf Basin Depositional Synthesis Project within the Institute for Geophysics. This initiative is an ongoing, industry-supported, comprehensive synthesis of the geology of the Gulf's deep basin fill. Researchers with the Bureau of Economic Geology and the Department of Geological Sciences also have major scientific projects in the region important to the hydrocarbon industry.

Energy-Water Nexus

Energy and water are interconnected at all levels. Among the connections: It takes water to produce most forms of energy, and energy is required for a sustainable supply of clean water; energy production can potentially contaminate water supplies; and the water produced as a byproduct by some forms of energy production can potentially cause seismic activity when injected underground for disposal. UT is conducting cutting-edge research in all aspects of the energy-water nexus. The Cockrell School of Engineering and the Jackson School's Bureau of Economic Geology and Department of Geological Sciences have strong programs in these areas.

Great examples of recent research include a series of studies from the bureau that looked at methane present in water wells outside of Fort Worth. Researchers found that the methane migrated naturally to wells from the relatively shallow Strawn formations, not from the Barnett Shale, where natural gas production and hydraulic fracturing are occurring. Other water research from the bureau includes a study that looked into the potential to reuse produced water in the Permian Basin and a study that examined the link between deep injection of produced water and induced seismic activity ***(see pg. 13)***.

The Most Rocks

A tried and true method of knowing what's happening under the Earth's surface is studying cores, cuttings and other geological specimens. The Bureau of Economic Geology, which also serves as the State Geological Survey of Texas, has three core repositories that contain more than 2 million boxes of geological material, the largest collection in the U.S. These geological specimens hold a wealth of knowledge about potential hydrocarbon resources all over the world. Specimens in the bureau's collections have been the starting point for discovering some of the most prolific oil and gas fields in existence, including the Eagle Ford Shale, one of the most prolific unconventional plays in the United States.

Earthquake Monitoring and Research

One of the more concerning aspects of the recent ramp-up in oil and gas activity in the United States has been the increase in seismic activity that has come along with it. The Bureau of Economic Geology, with the support of the state of Texas, has installed one of the most advanced state-run seismic monitoring systems in the country to track earthquakes. The seismic monitoring system, called TexNet, is operated in parallel with the Center for Integrated Seismicity Research (CISR), a multidisciplinary research effort that is tracking and studying natural and induced earthquakes in Texas. CISR also includes scientists from the Cockrell School of Engineering, the Institute for Geophysics and from other Texas universities.

The monitoring and research by TexNet and CISR are vital parts of ensuring that oil and gas operations can work safely and sustainably in Texas. For instance, a recent study from CISR has found that the majority of faults underlying the Fort Worth Basin are sensitive to changes in stress that could cause them to slip. The study revealed that the faults are relatively stable if left undisturbed, but that wastewater injection significantly increases their potential to slip if not managed properly ***(see pg. 14)***. For more information on TexNet and to view the interactive webpage, go to ***www.beg.utexas.edu/texnet.***

Industry Training and Safety

UT is an active participant in providing training for professionals working in the oil and gas industry with its Petroleum Extension (PETEX) and TOPCORP programs. PETEX, a unit of the Cockrell School, has been involved in industry training since 1944. It is headquartered at the university's J.J. Pickle Research Campus in Austin and also has training centers in Houston and Odessa. TOPCORP is an educational consortium of UT, The Pennsylvania State University and the Colorado School of Mines. Through funding and in-kind support, the program is offered at no cost to many federal and state regulatory agencies. The Cockrell School—along with Texas A&M University and the University of Houston—is also a partner in the Ocean Energy Safety Institute created by the U.S. Bureau of Safety and Environmental Enforcement. The institute provides a forum for dialogue, shared learning and cooperative research in offshore-related technologies and activities that help ensure environmentally safe and responsible offshore operations.

PHOTO: OIL AND GAS OPERATIONS ON UNIVERSITY LANDS, WHICH MANAGES THE SURFACE AND MINERAL INTERESTS OF 2.1 MILLION ACRES OF LAND ACROSS 19 COUNTIES IN WEST TEXAS FOR THE BENEFIT OF THE PERMANENT UNIVERSITY FUND.

PHOTO: UNIVERSITY OF TEXAS SYSTEM.


BRAZOS

Supercomputing, Business, Law, Policy and More

Beyond its collection of high-powered geosciences and engineering expertise, UT has a host of other resources that benefit energy enterprise and research. For example, UT's Texas Advanced Computing Center (TACC) designs and operates some of the planet's most powerful supercomputers—a must-have today when exploring and safely producing hydrocarbons involves processing massive data sets. Its latest system, Frontera, is the fifth-most-powerful supercomputer in the world, third-fastest in the U.S. and the largest at any U.S. university.

In addition, the highly rated University of Texas School of Law has a number of top faculty members and experts on energy law and offers a Master of Laws in Global Energy, International Arbitration & Environmental Law. It also publishes the only student-edited journal in the country focused on energy law. The McCombs School of Business boasts the No. 1 accounting program in the country and a collection of business- and finance-related energy expertise and programs matched by few institutions. These include the school's Energy Certificate program and McCombs Master of Science in Energy Management. These schools come together to help support UT's well-respected Kay Bailey Hutchison Center for Energy, Law & Business.

The Energy and Earth Resources Graduate Program (EER) is another unique energy offering at UT. This multidisciplinary master's program, established in 1981, touches on all aspects of the energy business—from geosciences and engineering to management, finance and economics to policy and law. Students benefit by learning from expert faculty members across UT's affiliated schools, which are the Jackson School of Geosciences, the McCombs School of Business, LBJ School of Public Affairs, Cockrell School of Engineering and the School of Law.

PHOTO: PARTICIPANTS IN THE JACKSON SCHOOL'S 2017 MARINE GEOLOGY AND GEOPHYSICS FIELD COURSE CONDUCT CORING OPERATIONS IN GALVESTON BAY.

EER Program Opens Doors to Energy Career

After finishing his undergraduate geophysics degree from the National Autonomous University of Mexico in 2017, Fernando Apango knew his next step was to UT.

"If you really want to pursue a career in oil and gas, this is the place to come," he said. "It seemed like the right pathway to me."

Apango was following the example of his friend Enrique Arce, who entered graduate school at UT only two years before. Both would study in UT's multidisciplinary Energy and Earth Resources Graduate Program (EER), where students do research and specialize in areas that include renewable energy, water resources and minerals, as well as oil and gas. The program helped Apango expand his technical skills through classes at the Jackson School while learning finance from the McCombs School of Business and energy policy from the LBJ School of Public Affairs.

It wasn't a coincidence the two friends chose to study at UT. Arce, Apango said, sold him hard on the experience, lauding UT for its top-notch education and research and close ties to the industry in which he hoped to work. Two years later, with his master's degree finished, Apango said he doesn't regret his choice. He spent the summer working for Chevron, and he already has one solid job offer and a number of interviews set up.

Arce's and Apango's paths tracked even more closely at UT. Both worked and studied at the Jackson School's Institute for Geophysics (UTIG) in the Gulf Basin Depositional Synthesis Program (GBDS). And both were able to use data provided by the Mexican National Hydrocarbon Commission in their work, which, for Apango, focused on finding an explanation for the lack of significant hydrocarbon accumulations in some prominent deep-water reservoirs in the southern Gulf of Mexico.

The data arrangement is unique to UTIG. The friends are only the first and second students outside of Mexico allowed access to the data. John Snedden, a UTIG senior research scientist who leads GBDS, said the agreements were forged through a long and close relationship between researchers at UT, particularly the Jackson School, and their counterparts in Mexico. Ultimately, he said, it was UT's reputation as a top energy institution that helped seal the deal.

"We were able to present to them and show them our capabilities from both a research and education standpoint," he said. "I think they appreciate what we bring to the table."

The Jackson School's EER multidisciplinary graduate program helps students prepare to solve the inherently interdisciplinary energy challenges of the future. Current student interests include oil and gas and renewable energy resources such as wind, solar and geothermal. For more information on the program, see ***www.jsg.utexas.edu/eer.***

PHOTO: JACKSON SCHOOL.

In Recognition of Donors

WE ARE GRATEFUL TO OUR DONORS, WHETHER IT IS THEIR FIRST OR 100TH TIME GIVING TO THE JACKSON SCHOOL OF GEOSCIENCES. WE WOULD LIKE TO RECOGNIZE ALL DONORS WHO HAVE DESIGNATED THE JACKSON SCHOOL IN THEIR ESTATE PLANS, DONORS WHO ARE MEMBERS OF OUR GIVING SOCIETIES, AND ANNUAL DONORS FOR THEIR LONG-STANDING FAITHFUL CONTRIBUTIONS. THANK YOU FOR YOUR CONTINUED SUPPORT TO ASSURE THE JACKSON SCHOOL PROVIDES A SUPERIOR EDUCATION TO BUDDING GEOSCIENTISTS AND CONTINUES TO LEAD THE WAY IN TRANSFORMATIVE RESEARCH.

Texas Leadership Society

The Texas Leadership Society is composed of a distinguished group of friends and alumni who have included The University of Texas at Austin in their estate plans. Estate gifts support faculty and research, provide scholarships and graduate fellowships, and keep libraries, laboratories and facilities up to date. We would like to recognize those members who have designated the Jackson School as their beneficiary.

Anonymous
David Arctur
Marta Bianchi & John* Boone
Vada & Walt Boyle
Barbara & Philip Braithwaite
Ina* and Jesse* Brundrett
Susan Cage
Louise* & Decker* Dawson
Karen & Ed Duncan
Connie & Byron Dyer
Fred Gibson
Bill Gipson
Hugh Hay-Roe
Charlene & Dean Henney
Kathleen Howard
Caroline Rose* Hunt
Katie* & Jack* Jackson
William Klett
Marietta* & Wann* Langston
Sandra Lindquist
Kenneth Neavel
Cheryl & Woody Pace
Terry & Elliott Pew
Rita & Jimmie Russell
Julia Trimble & Tim Diggs
Kevin Tuerff
Kathy & Steve Weiner
Wendy Weiss & Robert Mace
Raymond Woods*
John Wright*
Edith & Bob Zinn

Flawn Circle of Excellence

The Flawn Circle of Excellence recognizes individuals who have given cumulative gifts of $1 million or more. Established in 2014, this society is named after Peter T. Flawn, former president of The University of Texas at Austin, professor emeritus at the Jackson School of Geosciences and lifetime member of the Geology Foundation Advisory Council.

Anonymous
Jan & Tom* Barrow
Carolyn & John Bookout, Jr.
Marta Bianchi & John* Boone
Vada & Walt Boyle
Barbara & Philip Braithwaite
Louise* & Decker* Dawson
Karen & Ed Duncan
Jacque* & Scotty* Holland
Katie* & Jack* Jackson
Edith & Peter O'Donnell
Rita & Jimmie Russell
Dick Stoneburner
Elizabeth & Joe* Walter
Dianne & Leslie P. White
Cathy & Chuck Williamson

Katie Society

The Katie Society recognizes individuals who have given cumulative gifts of $500,000 or more. It was established in 2014 in fond remembrance of Katherine G. "Katie" Jackson, beloved wife of the late John A. Jackson. Katie was a great philanthropist and Jack's partner in all things, including the creation and naming of the Jackson School of Geosciences.

David Arctur
Kathleen Howard
Kenneth Neavel

*Deceased

L.T. Barrow Founders Circle

The L.T. Barrow Founders Circle recognizes friends and alumni who have given cumulative gifts of $100,000 and above. Named after Leonidas T. and Laura T. Barrow, creators of the first Geology Foundation endowment in 1953, Barrow Founders Circle members honor the legacy of these two guiding spirits of geoscience education at The University of Texas at Austin.

Jamie Austin, Jr
Annell Bay & Robert Suchecki
Patricia Boyd
Ina* & Jesse* Brundrett
Jimmye & Ray* Burke
Susan Cage
Carlotta Chernoff
Betsy & Richard Chuchla
John Clinch
Billy Cotner
Pamela & Barnes Darwin
Caroline & Tim* Denison
Mary Anne & Bill Dingus
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Connie & Byron Dyer
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Allison & Bryan Wagner
Anita & Charles* Weiner
Kathy & Steve Weiner
Wendy Weiss & Robert Mace
Mike* Wiley
Mary Wilkinson
Pinar Yilmaz
Edith & Bob Zinn

Hill Society

The Hill Society honors friends and alumni who have given $10,000 or more over their lifetime in support of the Jackson School. This society is named after Robert T. Hill, the first professor and chair of the Department of Geology and a founding member of the UT Mineral Survey, which would later become the Bureau of Economic Geology.

Anonymous
Doris Allday
Ellen & Gene Ames
Debbie & Jim Anderson
Carol & Rod Baker
Dan* Barker
Louise Barnes
Linda & Virgil Barnes
Donna & Ken Barrow
Kim Bates
Dunya McCammon Bean
Reggie Beasley
Fred & Teresa Becker
Mary Poteet & Chris Bell
Tiffany & Raul Benavidez
Earl* Bescher
Ann & John Bookout, III
Judith & Douglas* Bostwick
Marcelite & David Bristol
Ann & Doug Brown
Thais* Freda Bullard
Tom Burke
Denise Butler
Robert* Bybee
Sarah Bybee
Corinne* & Toby* Carleton
Susan & Bill Carlson
Penni* & Chuck Caughey
Emma & Edward Cazier
Donna & Michael Cervantes
Lorraine Clasquin & Eric Harslem
Sally & Craig Clayton
Peg & Mitch Cline
Caroline & Steve Compton
Diann & Frank Cornish
Carol & Weyman* Crawford
Steve Crews
Trammell Crow
Henry Dean
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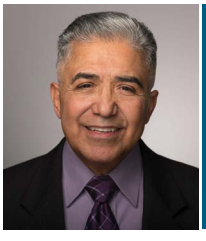

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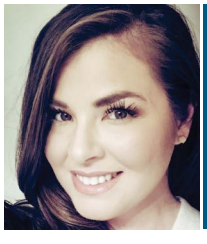

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ALUMNI NOTES

1940's

Howard Lowe (B.S. '48) shares, "Wife and I are now in an independent living facility in Ft. Worth close to a daughter & son in law and two grown grand kids. Spend my time researching climate and writing a second book ... emphasis on climate from the Pliocene onwards. Lots of evidence re global climate change ... lots of it is regional. Had a long phone conversation with Tom Burke (B.S. '49) yesterday. His brother, Ray, passed away a few months back. Ray and I were at Stanolind together in 1948-49. Photo: Found these three old photos of the 1948 Geology 60 field course. In the pic of group kneeling ... I am the guy holding the geology next to Steve Claybaugh. I do not remember the names of the others, nor can I recall the name of the prof on the left ... 95 year old retrieval system not too good."

1950's

Walter Boyle (B.S. '54, M.A. '55) writes, "Our continued world travels for 2019 was a cruise back to Alaska—first time was 1993. I continue to stay active attending Houston Geological Society meetings, a men's book club, and working in my yard and garden. Vada continues to stay active in the Houston Symphony League, the American Association of University Women and several book clubs. Vada and I really enjoy attending the Jackson School of Geosciences luncheons and dinners in Austin and a chance to visit with my old geologic classmates from the 1950's. This year I received a certificate from AAPG in recognition of 65 years of membership."

Jimmie Russell (B.A. '52, M.A. '54) says, "My most-pleasant hi-lite since the last Newsletter was re-establishing contact with my Junior-year 660 field partner. Although we have not had any contact since those years, it was as if there has been no hiatus. Also, each said the other sounded the same as in 1951. However, we admitted that undoubtedly we do not look the same! Another pleasantry was meeting Professor Claudio Faccenna, a professor from the University of Roma. He is a new member of the faculty at UT. His expertise is structural geology, and he is proficient with English. Professor Faccenna was accompanied by his daughter; Emilia is lovely, and was very fashionably attired. Sadly, a close friend and colleague with whom I closely worked at the Texas Water Development Board since returning to Austin in 1967, has moved into a senior-care facility. Otherwise fine, forgetfulness and wandering necessitated continuous surveillance. He was a charter member, and later a president, of the Austin Geological Society. Numerous medical conditions continue and hopefully, are being controlled. Disliking to bore, noteworthy were 2 ER trips and stays in a SNIF (skilled nursing facility). I was hospitalized Thanksgiving and Christmas, with the last week of 2018 spent in an isolation ward caused by the germ "CDIFF" contracted there. Progress? El Patio, at 30th & Guadalupe, is closing. They still made my favorite enchiladas, the same way as "then." The newspaper article of their demise noted a ribeye steak was $1.50 "then," but that was too expensive for me!"

Theodore Stanzel (B.S. '56) shares, "The year has been good with rewarding experiences for both Wanda and myself. Planning for future travel in the States and Europe; however, we reside in Schulenburg, Texas. We recently attended the dental hygiene white coat ceremony at the University of Texas Health Science Center in Houston where Wanda delivered the keynote address to the class of 2021. She received her dental hygiene degree from UT in 1958. She also leads tours of the painted churches in Fayette County organized by the Chamber of Commerce. I built a Nobler 50 inch wing span control line gas powered model airplane from a kit."

Leslie White (B.S. '56) says, "Dianne and I continue on in southwest Austin. We enjoy watching our grandkids moving forward with their lives. And, as always, we remain very, very proud of our Jackson School."

Rex White, Jr. (B.S. '56, M.A. '60) writes, "Still practicing Oil and Gas Law. Run into classmate Les White and his wife from time to time, which always causes us to remember our deceased classmates, professors and the great times we had on field trips." Rex can be reached at rex@rexwhite.com.

William Feathergail Wilson (B.S. '60, M.A. '62) shares, "Working on SWD injection well reports in the Permian Basin, groundwater availability studies in the Texas Hill Country and consulting for two groundwater conservation districts as well as a Board Member of a Regional Groundwater Planning District. At 57-years as a geologist having worked in more than 56-countries I am still camped out along a creek near Tarpley, Texas, living on the Cretaceous Corbula bed as a former Folk student. As a Texas ranch kid, I couldn't be more proud and grateful to have received my degrees from The University of Texas at Austin."

1960's

Charles Caughey (B.S. '69, M.A. '73) says, "Retirement is great! Last year I traveled to Salt Lake City for AAPG, where I enjoyed helping with the Imperial Barrel Award competition for students from all around the US and abroad, then visited Boston and NYC last spring. There was a small boat cruise of the inland passage of Alaska last summer, with hiking, kayaking, and a quick dip in an icy bay. Then hiking Big Bend and exploring mountains of Red River, New Mexico in the fall. This year I visited my nephew in Belize in February and enjoyed San Antonio for the AAPG in May. I am still active with the AAPG Publications Pipeline, helping arrange donation of the entire AAPG library to University of the Western Cape in South Africa in time for recognition at the AAPG conference (ICE) there last year and shipment of 2 major donations to universities in Senegal this spring and summer."

Joe Meadows (B.A. '62) shares, "Hope all are well and above room temperature. Enjoy keeping up with oil and gas business and scuba diving as old age will permit. God bless everyone."

Tom Patty (M.A. '68) writes, "So far in 2019, both the petrographic studies at the WJE Austin office as well as field geological consultation work has seen more available time since the passing of JoAnn, wife of 58 years, in late 2017. With continued increase in local construction in the Austin and Central Texas area, the demand for crushed stone and sand and gravel is also on the increase. Additional time has been spent in the Llano/Mason county areas to the west and Hearne/Bryan/College Station areas to the east. It seems that every floodplain has to be checked out for sand and gravel. While field and lab studies are great, time spent with the kids and grandkids are becoming more and more important, like presenting a grandchild a fossil or a choice mineral specimen. This year marks 51 years since I was hired to open up a geology/petrographic laboratory for TXDOT's Materials and Test Division Austin Office in 1968. I can be reached at tpatty@wje.com or tspgeorock@gmail.com."

Rubin Schultz (B.S. '61) says, "Still enjoying retirement. Spending time with great grandkids and traveling. Spent some time at the Welk Resort last spring."

Mark Valencia (M.A. '68) shares, "My little Piece of Paradise: As a youth I truly hated New England winters. To me they were not an inconvenience as they seemed to most others, but a dreaded annual ordeal to be survived. On dark snowy nights, as the howling wind rattled my bedroom window pane, I often dreamed of living in a tropical paradise. In my mind's eye I was sitting on a powdery white sandy beach with the warm sun on my back, gazing at the calm crystal blue waters. On those long winter nights I read voraciously about expatriate life and adventure in the tropics—Somerset Maugham, Jack London, Robert Louis Stevenson, Rudyard Kipling and its more modern interpreters—Anthony Burgess and Paul Theroux. My dream was not just a passing fancy. It infused my soul and its pursuit often affected the trajectory of my life. When Lynton Land, who had been on sabbatical to Hawaii, suggested I apply there for my Ph.D., I did and was accepted. I chose it over Indiana and Oklahoma which were then leaders in my chosen field of petroleum geology, even though it meant switching to geological oceanography. Once there, I spent as much time as I could living my dream. The elements were all within easy reach: pristine beaches, turquoise waters, cooling mountain breezes—just as I had imagined. I was hooked for life. My experiences as a seagoing oceanographer enabled visits to remote South Pacific islands that reinforced my desire to fulfill my dream. I realized it was not going to be exactly as I had imagined. There were 'complications' of economics, culture and inconvenience. But it was close enough to provide the hedonistic pleasures bestowed by the climate that I had longed for. But the challenge was to figure out how to make a living while living my dream. Upon graduation, there were no intellectually appealing jobs in Hawaii. I wanted desperately to stay. I even briefly considered becoming a taro farmer. But reality and the lust for further adventure pushed me on. I wound up in Penang, Malaysia—a 'spice island' of yore. There I quickly discovered that the tales of Maugham, Kipling, Burgess and Theroux reflected reality. It was like living in a novel among the flawed expatriate characters and their misadventures with the locals. I became one of them. As part of my desire to experience the expatriate adventures of old, I chose to immerse myself in Malay culture by living in a village rather than a town among the cloistered expatriates. It was there that I met my dusky maiden. With the final piece of my dream potentially in place, I returned to Hawaii. After nearly running out of money, I secured an intellectually and financially rewarding academic position. I then sent for the dusky maiden, who to my everlasting joy, traveled across civilizations to be with me. We have had a good life together—wonderful children who are a great source of pride and satisfaction for us as interracial, intercultural adventurers.

And they have given us grandchildren —four amazing sparks of life and hope who have made my life worth living. Eventually we bought a house, a modified late 1950's cookie cutter large 'cottage,' in New England terms. But it is at the end of a cul-de-sac de sac in a local rural neighborhood. To the back is a channeled stream and a forested hill and a small flood control pond. My favorite accoutrement is the large swimming pool that is shielded from prying eyes by the house, the forest and an ivy covered fence. I sit by the pool, listening to Hawaiian music and absorbing the ambiance. I am surrounded by a kaleidoscope of colors in the garden. The sky fades from cerulean to pale blue and then 'purples.' Memories sweep over me. It is then that I realize I am living my dream. I have found my little piece of paradise.

Richard Waitt (B.S. '66, M.A. '70) says, "I remain with the USGS (not retired) at Cascades Volcano Observatory in Vancouver Washington. Will have published several reports this year about Mount St. Helens' 1980 eruption and about the great Pleistocene Missoula floods through the Channeled Scabland and Columbia valley. An element of the latter presented at the 2019 INQUA Congress in Dublin. Am senior editor for a multichapter GSA Special Paper on interdisciplinary Quaternary geology (to honor Stephen C. Porter) that should appear in early 2020. On a long driving trip in fall, Cynthia and I hope to include Austin and UT."

1970's

C. Elmo Brown (B.A. '76) shares, "Kathy and I have taken on a new adventure. We sold our Denver house of 35+ years and have moved to Kerrville in the hill country of Texas. It is amazing how much stuff accumulates over 35 years and how long it takes to sort, pack, unpack and put away those memories. But as of this writing, we are well on our way in getting our new house to being our new home. At which point, we will look for new adventures to tackle."

Arthur Busbey (B.S.'75, M.A. '77) writes, "Now starting 3 year term as Chair of the Department of Geological Sciences at TCU. I plan to retire in 3 years (at 70), so I will spend the last few years busy administrating and helping support young faculty."

Frank Cornish (M.A. '75) writes, "This has been a rewarding and disappointing year. The rewards are two grandsons, Arthur and Kai in Georgia and Florida, to accompany my granddaughter. I'm rewarded to have them, disappointed they are far away. Another reward is placing a major work 60 × 40" - "Harbor bridge abstract" in the new tower at our local Spohn Hospital at the major elevator entrance from the cafeteria to the rest of the facility. The disappointment is that art isn't supporting me. Go figure. We enjoyed staying at the "Here's Johnny" Stanton Hotel in Estes Park this summer at the annual SIPES convention, and I caught dancing elks, bighorns etc. I was disappointed that the whole year can't be as pleasant as the Rockies in spring and summer. It was rewarding to be surrounded by rocks. Coming up this fall I will have a poster describing the stratigraphy of Wilcox canyons in Tyler Co., Texas,. I'm continuing to record past work on canyons, and will have another previously undescribed canyon to present at the 2021 convention in a poster as well. I've finished out my term as benevolent overlord of the Corpus Christi Geological Society and will remain a board member as we try to build the membership or slow the decline from retirement, and lack of local jobs for the newly minted Geology students. I continue to be underemployed and officing with Suemaur in Corpus. I have some consulting with Hurd in San Antonio trying to mature leads into drillable prospects. Seems like no one wants to do that though, so I'm waiting for the turn. Will it come?"

Patricia Dickerson (B.A. '70, Ph.D. '95) shares, "Bursts of field work and preparations for field trips enlivened fall of 2018 into spring of 2019. Presented our new data at a GSA meeting and in invited lectures, as well as in the guidebook and during Big Bend Ranch State Park field trips. Excursions that compadres and I led for the Austin and Houston Geological Societies brought lengthening and deepening colleague-ships ... Far afield from the Chihuahuan Desert, the trail led to Patagonia in January. The trip began in Buenos Aires, so both field boots and tango heels went into the suitcase. I was instructing on a Smithsonian excursion there—fascinated by the complex glacial dynamics in southern South America. Grey Glacier in Torres del Paine National Park presented a new face compared to that in 2016, after the calving of an immense iceberg in 2017. Awed by the groaning of the ice and moved by the magnificence of Torres del Paine massif... Other ice-sculpted scenes are fresh in my mind—I just returned from Iceland and another Smithsonian tour. Geysir, who gave his name to all such spouters, was more active than during my previous visits, and Strokkur put on an exuberant show —aah, the shifting plumbing system on an active plate boundary. In addition to standing on the Mid-Atlantic Ridge, we visited a lunar landscape and walked on one of the basalt flows where Apollo astronauts had trained. Apollo 11 landed on lunar lavas 50 years—almost to the day—before our rover (= bus) transported us to the northern highlands... inspiring! More black bedrock sea cliffs to come—with sea lions lounging on pillow basalts —when I return to the Galapagos hot spot this fall. In the meantime, world geoscience literature is the focus of my GeoRef work with most congenial cohorts in Alexandria and here. Being based in one of the best geological libraries on any celestial body is a boon to the bibliography and to my research.

Speaking of research, I'd best close this report now and get back to the manuscript factory."

Steven Dildine (B.S. '72) writes, "We remain in Carmel, CA.—riding bikes, doing some non-profit work and drinking California wine! Getting ready to reread John McPhee's "Annals of a Former World" and once again revel in the glory that is geology. Looking forward to seeing some old friends and 660 buddies later this year. Wishing Dr. Fisher a long, healthy and happy retirement!"

Thomas Dubois (B.S. '77) shares, "After starting out with Sohio Petroleum in Houston in 1977-1980, I spent the next 30 years in Corpus Christi (my home town) as an independent petroleum geologist. The last 10 years, my wife Debbie and I have spent on our ranch near Shiner. Still piddle in oil and gas but most time spent on the tractor. Time sure does fly! HOOK 'EM!!"

Lisa "Rusty" Goetz (M.A. '77) says, "I gave up on Houston after getting hit by three major storms three years in a row and finding that nothing was learned by the various government entities about geology and flood abatement. In March of this year I moved to the Sandia/Manzanita Mountain foothills of southeastern Albuquerque, NM. Mostly unpacked and am now taking time to explore and hike the wonderful high desert geology." Rusty can be reached at rustygoetz@comcast.net.

Robbie Gries (M.A. '70) shares, "Finished up a year as GSA President and helped to wrap up a Decade Strategic Plan with many cool ideas to enhance and improve the Society for our members. The sale of my book, "Anomalies—Pioneering Women in Petroleum Geology: 1917-2017," has gone well and I am working toward a TV series on the incredible women that stood out in this research. David and I continue to enjoy Denver 6 months, Tucson 6 months!" Photo: Robbie with Rafael Tenreyro, CUPET, in Cuba as GSA speaker and Geological Society of Cuba meeting, April, 2019.

Douglas Johnson (B.S. '78) says, "I am currently working on seismic inversion of a 700 square mile 3D survey in South Texas. Fun class note: I am mentoring Micaela Pedrazas, a UT geology grad student, in seismic interpretation. Micaela's summer intern project is seismic reservoir characterization of the Austin Chalk in South Texas. Hook 'em Horns!!" Doug can be reached at doujo@equinor.com.

Richard Leach (B.S. '77) shares, "This summer, on June 21, I got married to Kimberley Loveless. We are now living in McKinney."

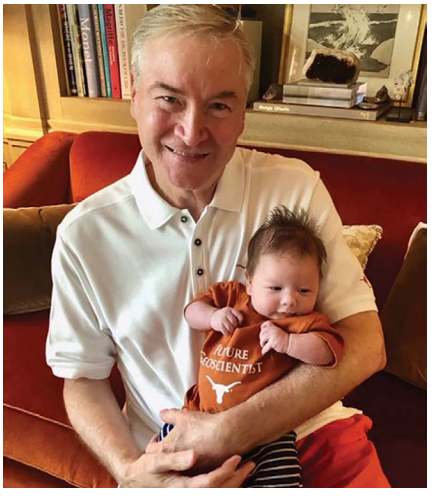
James McCalpin (B.A. '72) writes, "Recently elected President of the TERPRO Commission of INQUA (International Union for Quaternary Research) for 2019-2023. Guess I'll learn a lot about currently funded research into climate change. Ironic after spending a 40-year consulting career in geologic hazards and paleoseismology. Still chasing down bothersome active faults worldwide. In spare time am Director of Crestone (CO) Historical Museum in my hometown, an old gold mining camp." James can be reached at mccalpin@geohaz.com.

Don F. Parker (B.S. '70, M.A. '72, Ph.D. '76) currently resides in Round Rock, Texas, and can be reached at Don_Parker@baylor.edu.

John Pigott (B.S. '74, M.A. '77) says, ''Folk's cosmopolitan interests in "all things" coupled with Land's quantitative rigor and the wild unconstrained discussions of "what if" with all my wonderful fellow grads of the late 70's (Kitty Lou M., Susan H., Shirley D., Dennis P., Chuck W. and too many others to mention) not only infected me, but continues to lead me through the gratifying "fog" of intrepidly trying to make sense of all things sedimentologic, albeit with a carbonate bias, and admittedly nonutilitarian bias toward O&G. If I am not in my office, I am either on top of a mountain or underwater... speaking of water, too much water under the bridge in the past flying decades but in brief I am still here at OU as an Assoc. Prof. I continue to have wonderful students who, before acquiring jobs of mucho mammon, conduct research for their theses by traveling with me domestically or overseas and sharing in adventures on the outcrop to the subsurface, subaerial to subaqueous, from the petrophysical to the petrographic, from basin modeling to 3D seismic all with abundant toys (LiDar, portable XRF, Schmidt hammer, BMOD, Petrel, etc.). So, together with the pragmatic collaboration of my pragmatic geochemical chemo-stratigraphic side-kick (wife that is, Kulwadee) I continue to have fun, consult in those months when not teaching, and disregard the thought of 'retirement.' Recent discoveries include deepwater evidence of giant Tsunamis, imaging of a fragile skeleton in a Chinese dinosaur egg, determining outcrop lithology directly from LiDar over a km away, seis strat work on the giant

East Coast Jurassic barrief reef, and new conventional and unconventional play concepts in Eagle Ford and the Permian Basin. Oh yes, and I just became a certified Padi Dive Master... not bad for a sexagenarian." John can be reached at jpigott@ou.edu.

John Preston (B.S. '70) says, "Just can't figure out how to 'retire.' Have worked since I was eleven, so still pluggin' away at 72. God help me, but I still love looking for grease. Did get Lobo Wx. well drilled, but best sd. F/O or thin. Have 30 to 40 more to drill. Surely if you stick enough holes in the ground, grease has to eventually bubble up. This is in Webb if anyone is interested. Retirement: what folks do when they're ready to croak! Cheers friends and Hook 'em!" John can be reached at johnwmp@gmail.com.



David Pustka (B.S. '76) with his grandson Dallas David White, the "Future Geoscientist," born May 10, 2019.

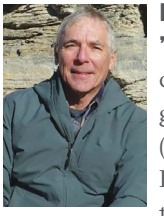
Brendan Sidereas (B.S. '74) shares, "I've been retired 5 years now and all is well. Still live in Rockwall, Texas. Have 4 grandkids all living very close by, ages 4-8. I've been witnessing a lot of gymnastics, swimming, tee-ball, and most recently Taekwondo. My career in petroleum geology was good to me. But my original interest in surface geology, particularly in the Texas Hill Country, has once again returned, but at the expense of subsurface geology, 3D seismic, electric logs, and spreadsheet evaluations. My wife and I usually go on one "big deal" trip a year —this year it's Portugal (on my way there now as I write this) and maybe a couple of Austin trips per year to attend a football game with a couple of old college buddies. My, Austin has changed a lot, but I still like Longhorn football, some bbq & beer, and their Mexican food with an occasional margarita. I find that the wine boom around Fredericksburg blends well with Cretaceous field trips."

1980's

Patricia Bobeck (M.A. '85, Ph.D. '17) says, "One of this year's highlights was GSA's publication of my translation of Jean-Baptiste Paramelle's "The Art of Finding Springs." The translation was a chapter of my 2017 dissertation. Paramelle published his book in 1856, same year as Henry Darcy published his account of the experiments that led to Darcy's Law. Paramelle was an early hydrogeologist; he found groundwater in more than 10,000 places in France in the 19th century. "The Art of Finding Springs" is available as GSA Special Paper 539. I was invited to present a lecture on Paramelle and Henry Darcy at the Karlsruhe Institute of Technology in Germany in June 2019. I had a lovely visit with my host Nico Goldscheider, whom I met at Barton Springs several years ago. This year I was again lucky enough to spend the summer in France, where I visited Paris' mineralogical, water, and of course, art museums. I spent many days walking the city looking at magnificent structures and the limestone that was quarried from beneath the city to build them. Also spent many hours looking at fountains and aqueducts that supplied water to Paris. In the fall, I'll be back in Austin, hanging out at Barton Springs and probably hula-hooping. For my swimmer friends, I will present a little slide show on Paris swimming pools. I continue to translate geologic literature from French to English and to edit geologic articles for publication."

Steven Carlson (M.A. '84) writes, "I'm still working Deepwater GoM at Ecopetrol America; 2 more years until retirement. All 4 kids and 2 grandkids are happy and healthy. 2019 has been a good year for travel. Jenny and I got to visit our globetrotting son Russell in Tasmania, and we saw Eric Clapton play at Royal Albert Hall in London (on my birthday)." Steve can be reached at steve_carlson@windstream.net and steve.carlson@ecopetrol-america.com.

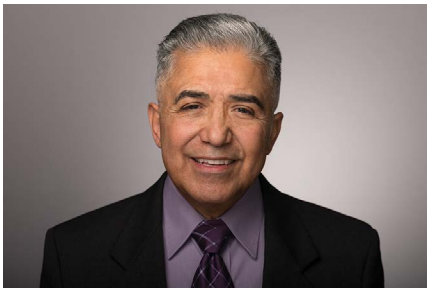
Joel Coffman (B.S. '84) shares, "Still working at EPA Region 9 but trying to relocate to the Atlanta area so we can be near our almost 3 year old granddaughter —Ana Rose. The past 3 years have been interesting, to say the least. Working on deep injection wells in California and out on Navajo Nation and have projects on the Big Island and Maui in Hawaii. I hope all my '80 to '84 UT Geology Grads are doing well, and if you are ever in the Bay Area, look me up!"



Daniel Huston (M.A. '87) says, "After a couple of decades as consulting geophysicists in Houston (since 1996 to be exact), Holly and I have retired to a nice rural property up in Indiana. Life is good. Best wishes to all our likewise retired friends as well as those still toiling in the oil patch."

Vincent Kluth (B.S. '86) shares, "Hello class of '86! After 32 years in the DoD Intel Community, I retired. I highly recommend it. Feel free to keep up with my current endeavors at HoldingFast.net."

Bill Layton (B.S. '81) writes, "Hard to believe this is year 37 in the Petroleum search, currently working at Abraxas Petroleum in San Antonio, Texas, in the unconventional and digital world these days ... Ha! Having phun tho, big shouts to field camp 1981 buds, remember, the Phantom rules!"



Bruno Maldonado (B.S. '82) says, "Hello fellow Longhorns. I am still applying my craft and plan to continue working as long as I am having fun. I continue to enjoy prospecting and applying the latest geophysical technology to 3D seismic data sets in search of the black gold. Some of my most recent projects include the evaluation of oil and gas reserves in offshore Congo, Cameron and Nigeria. Domestically, I was involved in the assessment of helium reserves in the Williston basin and just finished a project in the Austin Chalk. Those of us that love geoscience are certainly fortunate to be involved in a profession that is quite enjoyable. I have also had the pleasure of working with Dean Mosher while on the Jackson School of Geosciences FANs Board. As most of you know, Dean Mosher will be stepping down from her position as Dean by the time you read this note. I know that I will certainly miss working with her and congratulate her and her staff for building a great school in The University of Texas at Austin Jackson School of Geosciences. Thank you Dean Mosher for all you have done for the geosciences and the University of Texas."

Laura Moffett (B.A. '84) shares, "Last October I completed my Master Water Steward training. Volunteer opportunities have included rain garden installation and maintenance, rain barrel installation, native prairie plantings, public information events and clean ups of the Mississippi river watershed. Educational opportunities have included soil development, water conservation and community engagement. I also got to see the headwaters of the Mississippi river at Itasca State Park!"

Keith Pollman (M.A. '83) says, "I've enjoyed two small reunions with UT colleagues this summer. The first was in July when Emil Bramson and his son visited Denver for a soccer tournament. I've attached a photo of (from left to right) Emil, John Curchin, myself, and Roger Wiggin. Emil has not aged a bit —he must have a painting in the attic that ages for him. The rest of us ... the years have been kind. John Curchin and I also traveled to Austin in early August to celebrate Allan Standen's 70th birthday. This was my first trip back to UT since 1989, and I was stunned by all the changes on campus and around town. I wish we'd had more time to tour the Jackson School. Of course, we had to go to the Library so that we could view our theses on the shelves. It was great to see Al and other UT alums, including Arten Avakian, at Al's birthday party. I'll try not to let another 30 years elapse before I visit again."

Jerry Schwarzbach (B.A. '83) shares, "Still living & working in Tyler. Practicing medicine, flying & ranching. Have a token Longhorn. Had a great trip with friends to Tanzania for photosafari. Planning on catching some football games in Austin fall 2019."

Scott Simmons (B.S. '87) writes, "I'm currently looking after operations for the Open Geospatial Consortium —a standards body dedicated to all things location and maps. The work is far more interesting that you'd think when considering standards, and I get to interact with a global membership all working hard to ensure that those little maps function on our smartphones. Perhaps best for me is the large number of geologists in our Consortium; we even publish a standard for geologic data known as GeoSciML (www.opengeospatial.org/standards/geosciml). On a personal note, I'm still having fun in the sun in Fort Collins, CO with too many hobbies, a great family, and not enough time."

Margaret Sipplle-Srinivasan (B.S. '82) says, "I'm still at the Jet Propulsion Laboratory —why are so many of you retiring?! Aren't we too young?! I am Manager of the JPL Center for Climate Sciences, and the NASA Deputy Program Applications Lead for the Surface Water and Ocean Topography (SWOT) mission, which will launch in 2021. I look back fondly on my time at UT Austin, and have the chance to visit every few years for meetings of the GRACE and GRACE-Follow On science teams. The UT Center for Space Research (CSR) is an important partnering organization on these missions."

Stephen Speer (M.A. '83) says, "Greetings from the SC Lowcountry... pray this finds all of the Dirty Dozen doing well and enjoying life. No real

updates of importance, still enjoying it here with my lovely Therese (and Emma, our Westie) playing tennis and tending to business, in that order. Gonna open up a small tavern here in Mt. Pleasant with a partner this fall just to keep me on my toes and to make things interesting...and also to get free beer (yeah, right). If you ever find yourself coming to the Charleston area, feel free to look us up, eh? Cheers."

Danny Worrell (B.S. '80) shares, "I am still working as an environmental lawyer for Katten Muchin Rosenman in Austin! Come visit if you are in town!" **Gail Worrell (B.S. '82)** adds, "Hello everyone! I have retired from ExxonMobil after 33 years! My career went full circle starting out in Midland, Texas, working the Permian Basin, and ended with my last assignment bringing new Delaware Basin production to the Gulf Coast! Now, it is on to tennis, travel, family, fun, and ukulele lessons!" Danny and Gail can be reached at gail.f.worrell@gmail.com.

1990's

Donald Andrew Bowen (B.S. '91) shares, "Stayed in Austin. Transitioned from groundwater development and consulting to business strategy. I now run a trust/value consulting & coaching company. Enjoy all things outdoors and I am still a lover of rocks and fossils. Will never forget my experiences at UT Geo! Please feel free to reach out! Would love to hear what you are doing and am always open to meeting for a social beverage to talk geology. I can be reached at bowen.andrew@gmail.com."

Ray Newby (B.S. '91) says, "I'm still having fun working for the Texas General Land Office to restore coastal marshes, bird islands, and beaches."

Becky Smyth (M.A. '95) writes, "Checking in here - for the FIRST time (Thank you Jimmie Russell for SUGGESTING I do so). Since I'm now officially old and have not been keeping up with y'all, the story is long. I twice enjoyed fantastic geological education ——undergraduate course work (1976-79) and Master's degree (1995)——at UT. In my early burnt-orange days, I learned from giants: Barker, Clabaugh, Folk, Jonas, Long, Lundelius, McBride, Muehlberger, and Scott. My undergraduate years at UT were sandwiched between two stints at my Dad's alma mater, Va. Tech: 1975-76 then returning to finally finish my B.S. in Geology in 1980. Some said I had no clear direction. Maybe I was just restless? After Blacksburg I ended up in NYC, but the concrete and poverty nearly killed me. At that point Dallas looked good. Dad was sending geology job advertisements from EVERY Sunday edition of the Dallas Morning News and the Ft. Worth Star Telegram. The 1973 VW bug and I chugged back to Dallas where I took a job with Core Labs doing thin-section, XRD, and SEM descriptions of core samples, including volcanic reservoir rocks from Japan. Having spent the first 17 years of my life in Big D and knowing Austin, it tempted me to return——by 1982. Back in Austin I worked two part-time jobs (USGS——Water Resources Division and Bureau of Economic Geology——igneous petrology with Henry and Price), camped at Enchanted Rock, wind-surfed on Lake Travis, tried being a chemistry major, bicycled for transportation——lived a good life. Then geologist Steve and I sold everything, married in Ireland, spent 15 months in a VW van driving across most of Europe, multiple Soviet-bloc countries, and around the eastern Mediterranean. Nights in campgrounds, days in museums and cathedrals; we discovered art and cultural anthropology. We worked for three months on a Moshav in the Negev desert on the Jordanian border, eating well and learning Israeli farming methods. Back to Austin by 1987, I worked part-time at BEG (with Hovorka) until landing a job with Hall Southwest Water Consultants, two years later moving to McCulley, Frick & Gilman. Doug Frick kindly suggested I get a Master's degree in hydrogeology or find another job, so I went to see Jack Sharp. Then graduate school, daughter Joanna, graduate school, work, work, work and great joy. Barker, Muehlberger, Sharp, and fellow graduate students helped me through classes and the thesis——a combination of physical hydrogeology and igneous petrology——by 1995. By 1997 I was back at BEG (with A. Dutton/ Gibeaut/Hovorka) until "retiring" in 2017. After reflection, rest, and a little consulting I returned to BEG as a part-time University professional (hydrogeology group) in January 2018. Stay tuned, the cycles will continue, just not sure what is next." Becky can be reached at rcsmyth@utexas.edu.

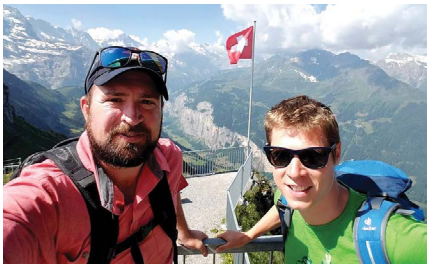
Jean-Paul van Gestel (Ph.D. '00) says, "It has probably been a while since my last update, but I am still at BP working the deepwater Gulf of Mexico in the production group, working various producing assets. The most interesting part is still the time lapse seismic on various fields where the largest remaining challenge is to get the subsalt 4D to work. But with acquisition, processing and imaging improving, we are getting closer, especially using FWI which has made a step change improvement over the years. Personally very happy to bike to work every day for my five minute commute as we live right next to the office while the kids (now 9, 8 and 6) attend the local elementary school. Also love spending time in the Hill Country as we were able to buy a place in New Braunfels. Not Austin, but close. Very much enjoyed the chance to join the UT staff at the Texas-USC football game last year and hope to come back for a game again this year. Hook'em!"

2000's

Kelly Iacono Daniel (B.S. '04) was promoted to the Kleinfelder Austin office's role of Operations Manager. In addition, Kelly was selected for Engineering News-Record's distinguished Top 20 Under 40 national title and appeared on the August 12th cover of the magazine along with her fellow winners. Kelly was invited to New York City to

complete the cover story of ENR's August issue, "ENR 2019 Top 20 Under 40: On the Move." The group of industry leaders were assembled for a photo shoot around Manhattan, and then tasked with becoming a think tank — offering ideas in four critical industry challenge areas: workforce growth and diversity, project delivery and productivity, sustainability and resilience, and infrastructure investment advocacy. Their thoughts on each topic were shared in four articles, with Kelly predominantly featured in the "Top 20 Under 40: Brainstorming Ways to Help Industry Go Greener."

Ben Davis (M.S. '07) says, "I have been working in the Permian Basin for the last 8 years, first with SM Energy and currently with Concho Resources. Both companies have given me great opportunities to drill wells, prospect, explore, and do some 3D modeling. In my spare time, my family has enjoyed camping and hiking in Texas and New Mexico, and we have picked up learning lapidary, which we used to raise money for a charity called Heart to Heart; which provides heart surgery for children in China. We have been able to visit China twice in the last 8 years and have had a wonderful time." Ben can be reached at bdavis@concho.com.



Chadwick Hintz (B.S. '02) shares, "I have been working as a PGS geophysicist for 11 years. I am based in Houston, but I was given the opportunity to work in London for 3 years and am currently on 6 months assignment in Oslo, Norway. PGS is an excellent company and has given me a chance to work with cutting edge technology and high end imaging algorithms. I've seen data from West Africa, New Zealand, North Sea, Brazil, and the Mediterranean Sea to name a few. Along the way I've seen more of the Earth (above ground and below) than I ever thought I would. I've also met some of the most brilliant geologists and geophysicists in the world. I am grateful to The University of Texas at Austin and the Jackson School for giving me the foundation for what has been a truly adventurous life. I can be reached at cahintz@gmail.com."

Junru Jiao (Ph.D. '01) is working as VP of Imaging at Forland Geophysical Services in Houston and can be reached at jiaojunru@hotmail.com.

Dax McDavid (B.A. '03, M.A. '06) writes, "This year was an extremely exciting time for Brigham Minerals, Inc. and myself, where I serve as Vice President of Exploration for Texas and North Dakota. Brigham Minerals is led by Ben M. ("Bud") Brigham, Executive Chairman (B.S. '83), and Robert Roosa, Chief Executive Officer ('92 BBA). In April 2019, we executed a very successful Initial Public Offering despite a volatile market. Our IPO was one of the first successful energy IPOs since early 2017. I currently lead all geologic activities for the Permian and Williston Basins and allocate most of my time to our mineral acquisition efforts. Kevin L'abbe (B.A. '04), another Jackson School alumnus, serves as Vice President of Exploration for the Anadarko and DJ Basins. Thus far in 2019, we have acquired 5,700 net royalty acres and have deployed $80 million of capital largely to the Permian and SCOOP/STACK and have $200 million of liquidity to continue to acquire minerals in our core basins. I started at Brigham Minerals in 2013 as one of the very early employees and it's been an amazing experience to build Brigham Minerals to what it is today. We started acquiring minerals in 2012 with the strategy of acquiring core, tier 1 geology in liquids-rich plays under top performing, well capitalized operators and have acquired 74,100 net royalty acres position through approximately 1,500 transactions across the Permian, Williston, DJ and Anadarko Basins. Today, Brigham Minerals is traded on the New York Stock Exchange under the ticker "MNRL", has over a $1 billion market capitalization and currently employs 36 individuals across multiple energy disciplines. A special thanks to Bud Brigham who has been an pioneer in the energy space for many years and whose companies and ideas have been creating jobs for UT Geology alumni for many years."

Stephanie Mills (B.S. '09) shares, "After 8 years spent completing my PhD and working in the minerals exploration industry in Australia, my husband and I moved back to the US in 2018. I'm delighted to be working as Utah's Senior Metals Geologist, as part of the Utah Geological Survey. For anyone interested in Utah's mining, geology, or if you're just passing through please feel free to get in touch at smills@utah.gov!"

Julymar Morantes (M.S. '03) says, "After 11 years with ConocoPhillips, I accepted a new position as Sr. Reservoir Quality Specialist at Chevron in Houston. I am currently working in the ETC group and can be reached at morantesj@hotmail.com."

Nataleigh Perez (B.S. '09, M.S. '13) and husband Nicholas Perez (B.S. '09, Ph.D. '15) welcomed Miles Vann Perez on May 8, 2019. Nataleigh has been at BHP in Houston since 2014. Nick is an assistant professor at Texas A&M starting his 5th year. This year he received an NSF CAREER Award!

2010's

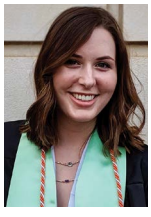
Hellen Aldrich (B.S. '11) works at Costofcial Solutions in Australia and can be reached at hellenaldrich@gmail.com.

Alexander Aronovitz (M.S. '12) shares, "I've taken some time off from my career to pursue another passion of mine: bicycle touring. After leaving Houston in early May, I explored portions of the south and Appalachians en route to the outer banks of North Carolina. Upon reaching the coast, I turned north and west with my sights set on the west coast. I'm currently in Minnesota on the Paul Bunyan trail, complete with a statue of him and his ox. I continue to be inspired by the diverse landscapes in our country, and humbled by the kindness of strangers along the way."

April Bievenour (B.S. '14) currently works as a Geoscientist at Oxy (Occidental) and can be reached at april_bievenour@oxy.com.

Brent Blackwell (B.S. '11) is currently working in the Marketing and Trading group as a Crude Oil Scheduler with Sunoco Partners Marketing and Terminals.

Parker Brant (M.S. '18) is currently working as a Data Scientist with Big Data Energy Services. He can be reached at parker.brant@bigdataenergy.com.



Christine Bunting (B.S. '18) is a geologist at TRC, Inc. in Austin, Texas.

Robert Castillo (B.A. '11) says, "I spent five years working in the oil and gas industry, specifically directional drilling and field geology, then worked in water conservation for the City of Austin for three years. I currently work as an Engineering Specialist II with the Texas Railroad Commission. My main duties are performing technical and seismic reviews on injection and disposal well applications in the State of Texas. I can be reached at robc1234@gmail.com."

Ted Cross (B.S. '11) shares, "I just started a new position as Technical Advisor at Novi Labs in Austin. I am excited to bring my industry expertise to help develop and grow a software startup focused on machine learning solutions for oil and gas. I can be reached at tcross88@gmail.com."

Autumn Eakin (M.S.'11) writes, "Last September, **Dan (Ph.D. '14)** and I welcomed a baby boy, Aksel Eakin, to our family! He's been a joy to watch grow & learn the world around him. We'll be celebrating his first birthday in Iceland where we can teach him about tectonic plates!"

Reynaldy Fifariz (Ph.D. '18) says, "Hello! I continue to work as a Postdoctoral Fellow at the Bureau of Economic Geology with the Gulf Coast Carbon Center. I am forever grateful to be part of Jackson School of Geosciences. It has been a truly joyful and rewarding experience for me and my family. Thank you!" Reynaldy can be reached at rfifariz@utexas.edu.

Hector Garza (B.S. '16) is a Geoscientist at Premier Oilfield Group in Houston, Texas.

Emma Heitmann (B.S. '16) is moving to Seattle to begin a PhD program at the University of Washington.

Aaron Jones (M.S. '11, Ph.D. '15) was promoted to the position of Senior Researcher - Biosciences at ExxonMobil Corporate Strategic Research in Clinton, New Jersey. Aaron was previously a Postdoctoral Research Fellow at ExxonMobil.

Han Kyul (Kyra) Kim (B.S. '13) successfully defended her dissertation at the University of Delaware this April, titled "Spatiotemporal dynamics of biogeochemical reactions in an intertidal beach aquifer: A field, laboratory, and numerical modeling study." She will be heading to NASA JPL for a postdoctoral fellowship in August.

Alex Lamb (M.S. '12) shares, "We welcomed our first child, a boy, in November 2018, and I've already started his rock collection! I also recently started a job as

a Data Scientist at OspreyData in Orange County, CA. We work on applying machine learning and artificial intelligence to oil and gas production optimization."

Darby Lee (B.S. '19) recently graduated and can be reached at darbydlee@gmail.com.

Marco Longoria (B.A. '19) is going to spend time with an Outdoor School teaching and leading all different types of programs.

Frank Morgan (B.S. '11) says, "I'm enjoying my second year with ATX Energy Partners in Austin, Texas. We're currently operating in the Powder River Basin up in Wyoming, and we're looking forward to advancing the play there."

Evan Pearson (B.S. '10) writes, "I'll be finishing up my law degree in May 2020 at the greatest university and then clerking for Judge Alan Albright in the US District Court for the Western District of Texas in Waco. UT's so nice, I came twice! Hook 'em!"

Arisa Ruangsirikulchai (B.S. '19 joined PTT Exploration and Production Public Company Limited as an Associated Geoscientist based in Bangkok, Thailand.

Makoto Sadahiro (M.S. '14) can be reached at sadahiro@gmail.com.

Joe (Kendall) Salinas (B.S. '15) shares, "I currently work at Arcadis as an Environmental Task Leader. I direct site assessments, soil/groundwater remediation, and groundwater monitoring activities for various clients in the petroleum industry, industrial manufacturing, multinational package delivery industry, the State of Florida, aerospace/defense industry, and the US military. I spend most of my time working on projects in Florida but also spend time on projects in neighboring southeastern states such as Mississippi, Alabama, and Georgia. I appreciate the education I received in my hydrogeology courses at UT Austin because I get to apply that knowledge towards my various projects each day. My education also allows me to provide environmental solutions to improve the quality of life for individuals who live in communities impacted by hazardous substances in the soil and groundwater." Kendall can be reached at ksali6549@ufl.edu.

Josia Simanjuntak (M.A. '19) shares, "My two years of graduate school at the Jackson School of Geosciences have been one of the times in my life. I learned so much from my professors and made some great friends throughout my study! I will definitely cherish these memories as I return to my home country in Indonesia." Josia can be reached at josia.simanjuntak@gmail.com.

Stephanie Elaine Suarez (B.S. '17) writes, "I completed my Masters in Geology at the University of Houston in summer 2019. Starting a PhD at the same institution as an NSF Graduate Research Fellowship Program awardee."

Kevin Toth (B.S. '16) accepted a position at Arcadis (design and consultancy for natural and built assets) as an environmental scientist working in the greater New York City area and has a manuscript in review with AAPG Bulletin. He can be reached at kjt44023@gmail.com.

Keelan Umbarger (B.S. '15) graduated with his M.S. in Geology from the University of Kansas in August of 2018. He currently works as a geologist for EOG Resources in Artesia, NM. Keelan can be reached at keelan_umbarger@eogresources.com.

Julie Zurbuchen (B.S. '14) successfully defended her PhD in Earth Science at UC Santa Barbara this past summer. She is now excited to embark on a career as an exploration geologist with BP in Houston.

Professors Emeriti

Jack Sharp shares, "Carol and I had two visits to Canada—Toronto & Winnipeg this year. Finally, the GRA Memoir (#215, The Edwards Aquifer: The Past, Present, and Future of a Vital Water Resource) is in print and may be ready by the Annual Meeting in Phoenix.

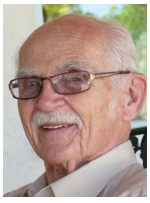
James Sprinkle says, "This was my 6th year as a Professor Emeritus. Last fall, I was honored in a full-day session on Echinoderm Paleobiology (24 talks total) at the 2018 Geological Society of America Annual Meeting in Indianapolis, plus a poster session the next day with 15 posters. These sessions were organized by two of my former Ph.D. students, Colin Sumrall and Chris Schneider. After this meeting, my wife G.K. and I rented a large SUV and drove east about 110 miles to near Dayton, Ohio, where we picked up a large collection of nice Paleozoic fossils that were being donated to our Non-vertebrate Paleontology Laboratory here at UT. We then drove back southwest through several states to Austin, where we unloaded this collection and turned in the vehicle. Even after eight months of work at one evening a week, I'm still inventorying this large collection and finding new surprises. My work load got heavier in the spring when I became a co-author on three new projects, and two others were finally completed and submitted for publication. A multi-author rebuttal paper led by Samuel Zamora of Spain argues whether an Early Cambrian deuterostome might be the earliest fossil echinoderm; this paper is now in review. Another joint paper led by my colleague Tom Guensburg at the Field Museum described a new Early Ordovician crinoid from western Utah, where we've been doing field work for the past 30 years; this paper is also now in review. Another huge project led by Peter Jell in Brisbane, Australia, describing several new or poorly known Middle Cambrian echinoderms based on over 800 silicified plates is nearly finished 17 years after we collected the 1st samples. Another smaller project, also led by Samuel Zamora, describes a new flattened echinoderm from the Middle Ordovician of Maryland. Finally, a member of our local fossil club got really lucky on the club's field trip up to southern Oklahoma in April and found a small, complete, and beautifully preserved starfish at one of our Late Silurian fossil localities, the 1st starfish ever found on this trip. Dan Blake at Illinois, our US fossil starfish expert, and I have now written a short paper that is nearly finished describing this starfish as a new genus and species named after the collector. Hopefully, two of these five research projects will be published, or at least put online, by the end of this year."

Friends

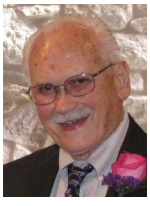
Alan Dulaney (M.A.'75 in Anthropology) says, "August 2019: retired as Water Policy Administrator, City of Peoria, AZ."

William I. (Bill) Woods says: This year was mostly a "Texas" year, although Francisco and I did take his Mother to El Salvador to visit family in Feb-March. In April we stayed a week at Palo Duro Canyon State Park and hiked there, and visited Caprock Canyon State Park. Both are beautiful places. In May we spent a rainy week in Port Aransas, but made the most of it by visiting the Texas State Aquarium and Our Lady of Corpus Christi church. In June our nephew and his family from Brasil visited for two weeks. I'm still working out at GRE 3×week. I'd love to hear from former faculty, staff, and student friends.

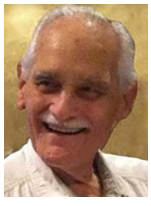
MEMORIALS



Peyton O. Abbott (B.S. '50) passed away on March 7, 2019. He was born to Agnes Weed Abbott and Merlin C. "Jack" Abbott in Houston on September 10, 1927. He was raised in Austin and graduated from The University of Texas at Austin with a degree in Geology. He married Geraldine (Gerri) Jaye in 1956 and had a son, James Travis Abbott, in 1957 and a daughter, Laura Kathryn Abbott, in 1962. In 1963 the family relocated to Pueblo, Co, where he spent his career at the United States Bureau of Reclamation and the United States Geological Survey. After retiring, he and Gerri travelled extensively, exploring their shared passion for nature and history. He moved back to Austin to be near family after Gerri's passing in 2012. He is survived by son James Travis Abbott (Susan), daughter Laura Kathryn Abbott (Tim Wilson), and his cherished grandchildren Samantha Abbott, Nick Abbott, Tom Abbott, and Alan Wilson.



Samuel C. Adair (B.S. '56) passed away on May 18, 2019 at the age of 92. Born in Nocona, Texas, Sam grew up with 7 brothers and sisters on a farm. He was drafted into the navy at 17 years of age to serve our country in the Korean War. After his service, he was honorably discharged and traveled to Ft. Worth to attend Texas Wesleyan College. While living there with his grandmother Callie Reynolds, Sam met his true love Doris Giles, who lived just across the street. They married in 1950 and spent 69 awesome years together. He was re-drafted in 1952 and served in the Navy until being honorably discharged in 1954. Sam finally graduated with a degree in Geology from the University of Texas and started his career at Esso. Sam and Doris lived in several places in the US and had two children, Sam and Donna. In 1963, Esso Libya offered him the chance to work in Tripoli, Libya. After many unusual experiences including survival of the "The Six Day War" when Gaddafi took over, they lived there for 6 years and traveled extensively throughout Europe and Africa. Esso Europe transferred him to England in 1970 where he enjoyed the fine English customs and developed an attraction for antique clocks and high tea. After 8 years in England, Esso Norway moved him to Stavanger. Sam loved this beautiful country and the friendly people there. He was very involved with the church there started by ex-pats. Sam came back to the US in 1980 to finish his career with Exxon after 35 years of service. Sam walked closely with God and shared his love of Christ everywhere he went. Sam was one of the founding members of Walden Community Church and helped build it from the ground up in 1982. Sam was admired by his friends, family and coworkers for his integrity, core values and strong work ethic. He never missed a day of work, which was commemorated by an award from Exxon. Sam will be missed, but he is in a much better place with his Lord and Savior Jesus Christ. Preceded in death by his parents Samuel Clyde Adair and Lorene Boyles and grandson Mark Daniel Adair, he is survived by his wife of 69 years, Doris Adair, his son Samuel Clyde Adair, daughter Donna Sue Adair Frenzel, granddaughter Heather Adair Rohani and grandsons Christopher and Bryan.



Terry V. Bills (B.S. '55, M.A. '57) served as a Sergeant in the Korean War in the South and Central Theatre from 1947 to 1952. He was honorably discharged in 1956. While serving in the Marine Reserves, he attended the University of Texas earning his Master's Degree in Geology. He moved to Lafayette in 1960 beginning his career in oil and gas with Unocal. In 1962, he launched his own oilfield company called SEVARG. In later years, he recruited his nephew Dave and his daughter Linzee to work side by side for many years. He enjoyed telling very lengthy war stories, siting incredible historical facts, recapping trips across the world and life experiences. Terry was preceded in death by his wife, Barbara Guidry Bills; his parents, Terry Vance Bills, Sr. and Mildred Phelps Bills; and his five sisters. Survivors include his three sons, Gordon, Jonathan and Daniel; two daughters, Marjorie Cupit (Wayne) and Linzee Evans LaGrange (Kenny); one great grandchild, Ayden Fontenot.

John L. Boone (B.S. '73, M.A. '79) died on January 9, 2019 at 68 years old. John was passionate about his intellectual calling. He loved true science, particularly geology in its myriad forms. A single course in geology while attending Wofford Junior College in Spartanburg, SC resulted in a lifetime fascination with the subject. In 1971, John transferred to The University of Texas at Austin to pursue his interest, earning BS and MA degrees in geology. His keen mind led him to constantly read about discoveries and theories about the Earth's formation, its secrets, its resources, and the geology of places beyond Earth. After graduation, his oil and gas career began at Getty Oil Company in Houston. Business was booming and he chose to move to Corpus Christi to join TexasO Production Co., and then moved to Tondu Corporation, a small independent company. When the "boom" went "bust," he found new challenges at Everest Minerals, where he evaluated oil and gas deals and explored for uranium. He also became the company's de facto IT trouble-shooter with the introduction of computers and printers, which kick-started his life-time interest in the latest technology for computers, phones, TV, AV and every other thing that plugged into a wall until Bluetooth and wireless were developed. In 1986, John changed the focus of his

career to hydrogeological and environmental assessment at Conoco, Inc. When he received his 5-year pin, he moved on, with time at GSI, RMT and ERM, all environmental consulting companies. He ultimately joined Arcadis U.S., Inc. as a Principal Geologist, actively consulting there through November 2018. John was always torn by his desire to truly remediate environmental damage in opposition to most clients' desires to do as little as possible for the least amount of money. He worked tirelessly to find acceptable solutions for cleaning up the Earth. He was a past member of the American Association of Petroleum Geologists, the Corpus Christi Geological Society, the Houston Geological Society and the National Groundwater Association. Hurricane Harvey captured his interest (and house) and resulted in an obsessively researched article specific to his Lakeside Forest neighborhood. He mapped precipitation totals for the Harvey deluge, researched historical rainfall data in the area, surveyed maximum flood elevation at his home, and determined an average recurrence interval of 34,000 years for a similar event. He was passionate about history—from the Greeks and Romans to the Franco Prussian wars to World War II to Vietnam to today's tumultuous climate. He understood history and put it into the context of today's events. A day discussing history with John was a day in a graduate-level history course. One of John's most consuming passions was a small plot of land near Yorktown, Texas, where he loved spending time working and, occasionally, pig hunting. He nurtured the land, observed the wildlife, watched the changing of the seasons and reveled in nature. He was a true outdoorsman. John was passionate about good food and wine and relished eating and drinking with friends and family. He loved cooking for his wife Marta and was famous among family and friends for his annual Christmas Eve spread. John was a man of many talents and interests. He piloted his V-tailed Bonanza, sailed, rode horses, bicycles and motorcycles, played classical guitar, ran, skied, wind-surfed, kayaked, canoed, hiked, worked out, played tennis and was an all-around handy man. He had a great sense of humor and was a voracious reader. For many years, he and Marta regularly attended performances presented by Chamber Music Houston, as well as those by the Houston Symphony and Austin Classical Guitar Society. However, his first date with Marta in 1981 involved flying her in his private plane from Corpus Christi to Houston to see and hear the Rolling Stones in the Astrodome. Their return trip to Corpus that evening was very romantic as they watched the Orionid Meteorites streak through the crystal-clear night sky from the Cessna's front wind screen. John admired and respected Marta's wit and intelligence, her drive and determination. John was predeceased by his parents, Ellen and John A. Boone, MD. He is survived by his wife of 33 years, Marta B. Bianchi; brother, David (Rosaline); their children Kate Boone Airhart (Ernie) and John G. Boone; his sister, Anne Boone; her children Christine Reed Johnson (Vaughn) and Daniel Reed (Mandy). Marta's sister, Beth Frantes (Tom), their sons Matt, Gus and Truett, and Marta's brother Cletus Bianchi (Daphne), and their daughters Sophia and Marina, loved and supported John and Marta through the many long months of fighting metastatic prostate cancer. In lieu of flowers, the family welcomes memorial contributions to the "John C. Bianchi, Jr. & John L. Boone Endowed Presidential Fellowship." This Fellowship was established in appreciation for The University's excellent education which resulted in John's lifelong geology career, and in memory of Marta's father, John Bianchi, who was a 1949 UT geology graduate and had a long, successful oil and gas career as well. The Fellowship at their alma mater will be used to provide financial support to academically outstanding graduate geology students.

Rodney J. Camp (B.S. '43), born September 16, 1922, passed away on December 7, 2018 surrounded by family and loved ones. He was raised on a farm just north of Helotes by his parents, John F. Camp, Sr., and Martha Lenora Laughter as well as his beloved grandmother, Nanny. Vacations were spent at Blue Cedar Ranch at the headwaters of the North Prong of the Medina River, his favorite place on this earth. His father purchased it when he was only 6, so it was an important part of his entire life. This upbringing instilled in him a lifelong love of nature, the country, the outdoors and all God's creatures. By Rodney's high school years, the family had moved into San Antonio where he graduated from Jefferson High School in 1939. He continued on to The University of Texas at Austin where he obtained his degree in Geology in 1943. While there, he was a member of Pi Kappa Alpha social fraternity and Sigma Gamma Epsilon scholastic fraternity. Upon graduation, he enlisted in the Army and served as a Staff Sargent until shortly before his marriage on April 19, 1946. Rodney's cousin was a boarding student at St. Mary's Hall. She had a classmate, Martha "Pete" Otto, who was one of the friends invited to a senior year House Party at Blue Cedar Ranch. Rodney's mother assigned him the duty of showing the girls around, and he took a "shine" to one who also enjoyed the outdoor things he did! It wasn't long before he was riding his Harley out to her family's ranch to go "courting" which led to a marriage that lasted until her death in 2009. Rodney worked as a geologist for Camp Oil Company and lived in San Antonio, Casper, WY and, primarily, Midland, Texas, until his retirement. At that point "Pete" and Rodney returned to their beloved Hill Country, living near Medina. Those years were spent breeding, raising and showing miniature horses with their Horses, Limited business. Rodney was always involved in the local community. He was Chairman of the Building Committee of St. Christopher's Episcopal Church when the new Parish Hall was built. Both were early supporters of the Medina Community Library as well as other organizations including Peterson Regional Medical Center and the Southwest Seminary. Preceded in death by his parents, his brothers John Jr., Tom and Bill as well as his beloved wife. Rodney is survived by his daughter Kathleen Casper Lackey

(David). Rodney J. Camp was a true gentleman--a very gentle soul who thought of others before himself. He was an extraordinarily giving, sweet, generous man with a lovely sense of humor who has left many wonderful memories to be cherished forever.

James Wallace Collins (B.S. '56) passed from this world on August 5, 2019 at home surrounded by family. Jim was born in San Antonio, Texas, to James Elmore and Grace (Charlton) Collins. He was very proud to have been born across the street from The Alamo and to have been named after his grandfather James Wallace Collins, who was the San Antonio Fire Chief in 1897. He moved to Corpus Christi in 1939 and loved the Bay and sailing, and later loved telling stories of the way Corpus Christi was before the War. Though too young to serve in WWII, he did his part by carving balsa models of warplanes used by the Navy in flight training at the Naval Air Station Corpus Christi. After high school, Jim attended Texas A&I in Kingsville and worked summers in the oil field and refineries. He joined the Army in 1950 and served as part of the NATO forces in Europe as a tank mechanic. He was discharged in 1952 and went on to earn a degree in Geology from The University of Texas at Austin and become a lifelong Texas Longhorn fan. Jim met Betty Lamar, his wife of 61 years, while working for Tidewater Oil Company in Houston. After a brief transfer to New Orleans, where their two children James Lamar and Martha Ann Collins were born, the family returned to Corpus Christi in 1963. Jim became an independent Geologist in 1969 and filled out the rest of his career generating Oil and Gas deals while serving the Corpus Christi Geological Society. While he served the Geological Society in many roles, Jim most loved the opportunity to mentor young Geoscientists. Jim had a passion for woodworking and sailing, which he combined to build a homemade "Funfish" sailboat from scratch. He also often handmade toys for his children and grandchildren. He loved gardening and tending to his Koi pond and passed as much of this love of outdoors and working with his hands on to his children and grandchildren as they could learn. He also had a passion for cars and flew his own plane. Jim is preceded in death by his parents. He will be missed most by wife Betty, son James L. (Patricia), daughter Martha, grandchildren James Keith, Lora, and Stefan Collins; and Melissa and Justin Crocker. He also loved spending time with great grandchildren James David, Westley and Lilith.

Matthew K. Davenport (B.A. '83) 59, passed away on the September 6 after a year-long, hard-fought battle with cancer. He was surrounded by his wife and children and knew how much he was loved. He was born in Amarillo, Texas on July 3, 1959. Matthew graduated from The University of Texas at Austin with a Bachelor of Arts in Geological Science in 1983. He later received his MBA from The University of Texas San Antonio. Matthew went through Officer Candidate School in Pensacola, Florida and became an Officer in the United States Navy in 1988. He spent 30 years in honorable and dedicated service to the Navy and the Nation. He served as a Naval Intelligence Officer in each war subsequent to his induction into military service. He received countless awards, the final of which was the Legion of Merit, a military award of the United States Armed Forces that is given for exceptionally meritorious conduct in the performance of outstanding services and achievements. He will be greatly missed by his family and all who knew him. Matthew was preceded in death by his father David E. Davenport. He is survived by his mother Betty; his sister Linda; his wife Deborah; his son Ellison (Caitlin); his daughter Carly (Jake); and his son Ethan. He was lovingly known as Skipper to his 2 granddaughters Harper and Stella.

Louisa E. Eclarinal (B.A. '91), 59, passed away unexpectedly on February 11. Affectionately known as "Louie" by her friends and family, she was a strong woman who passionately loved those close to her and vigorously protected everything she cared about. She was known for her courageous and compassionate soul, commanding presence, and contagious laughter. Louie exuded independence with a tenacious spirit. The middle child of Eulogio and Felicitas Eclarinal in Subic, Zambales, Philippines, Louie was a staunch advocate for justice. Graduating from the University of the Philippines with a degree in Foreign Service, Louie advocated for the rights of the Filipino people and protested against the Marcos regime. She traveled extensively around the Philippines with her fellow activists on many adventures. In 1982, though invested in the struggle of the country of her birth, Louie joined her parents and siblings in San Antonio, Texas, to seek better opportunities. Pursuing her interest in the environment, she graduated from the University of Texas with a degree in geology. Louie and Charles met on the San Antonio riverwalk. They spent their first date at a music festival, and it was immediate love. They married in 1987 and had two radiant children, Vida and Maya. An environmental scientist by trade, Louie worked to make her community more sustainable. She was an expert on water, and she used her green thumb to fill the world with plants. She enjoyed cooking for her loved ones the delicious Filipino cuisine she grew up with. Well-read and cultured in the arts, Louie was inquisitive and constantly searching for new things to learn. Louie always supported her brothers in their musical endeavors and film projects. She immersed her daughters in Filipino culture, encouraging their participation in the Karilagan traditional dance troupe. Louie ardently supported her daughters in their aspirations - Maya in her dance career and Vida's study of psychology. Louie herself was an excellent photographer. Her legacy lives on in the

women who have come after her, all of whom emulate her independence, her loyalty, and her limitless capacity for love. Louisa is survived by her husband Charles, their daughters Vida and Maya, her aunts Oding, Edita and Noring, her sister Zenaida, her brothers Eulogio, Rommel, and Oliver, their spouses Alice, Cathleen, and Mariel.

Diane S. Emmert (B.S. '58) died September 21, 2018, surrounded by her three children. Diane loved order; the accomplishment of daily, calendared tasks; her family; and Jesus most of all. She found many true joys-in the company of her grandchildren; in singing; in beautiful music, culture, and the arts; and in reading, traveling, and learning. Diane was resolute and positive, full of faith through years of caring for her husband as he slipped into dementia, and as she contracted and battled the rare autoimmune disease that finally took her from us. She would most want to be remembered as a faithful Christian and a loving and devoted wife, mother, grandmother, sister, cousin, and friend. A member of a multi-generational Texas German Lutheran family and community, she remained an active parishioner of Christ Lutheran Church in Austin, Texas. In all things, her great rest was in her love for God, her family, and her church. In times of joy and sorrow, in happiness and pain, Diane clung to the words of Isaiah 40:31, "They that wait upon the Lord shall renew their strength; they shall mount up with wings as eagles; they shall run, and not be weary; they shall walk, and not faint." These were among the last words that she heard. Diane Beverly Schmidt was born in Galveston, Texas, on April 15, 1937. The daughter of Joseph Henry and Louise Thiem Schmidt, she was a fifth-generation born-on-the-island Galvestonian. She attended parochial and public schools in Galveston and graduated from The University of Texas at Austin with degrees in geology and mathematics. In search of adventure and independence after her graduation, she chose not to return home to Galveston, but took "far away" teaching positions-first in Midland, and later in Fairbanks. It was in Alaska that she met her lifelong love and companion, David Lee Emmert, and they settled in Anchorage, where they had two daughters. They moved south in 1967 with two young daughters and settled in the Sonoran Desert town of Sierra Vista, AZ, where they raised their girls and joyfully welcomed a baby boy. Following nineteen years of full-time motherhood, Diane returned to her love of fractions and the base number system, teaching mathematics and encouraging her students to aspire to great things at Belton Junior High School, in Belton, Texas. She retired in 1995 after thirteen years of service in the classroom. Diane was preceded in death by her husband and by her parents. Her survivors include her children Dana Leigh Parker (David), Deanna Lyn King (Jack), and Mark David Emmert; her grandchildren, Colin, Rachel, and Stephanie; as well as her brother, Joseph Henry Schmidt II (Patricia).

Eugene Martin Goltz (B.S. '49), 93, passed away on June 2nd. He was a proud lifelong Abilene resident. Gene served as a US Marine during WWII earning a Purple Heart for bravery. He earned a geology degree from The University of Texas at Austin. He worked as an independent geologist for almost 70 years. He was a lifelong member and leader of Temple Mitzpah. Gene made friends wherever he went due to his large upbeat personality. Gene is survived by his niece, Sandy Wolkowicz (Joe) and nephew Jeff Wolf (Colleen). He is also survived by special friend Betty Jackson. He was preceded in death by his parents, Harry and Sadie Goltz, and his sister, Esther Goltz Wolf.

Edward F. Haye (B.S. '51) died on August 13, from a fall doing what he loved to do—— powerwalking in his neighborhood. His repertoire of well-worn jokes and aphorisms, infectious laugh, and self-proclaimed expertise on subjects from religion to politics, and anything in between, have finally been silenced. Ed was born the only child to Erich Paul and Martha Fabra Haye in San Antonio on April 22, 1929. He attended McKinley Grade School and Mark Twain Junior High. He frequently credited his hardy immune system to swimming as a child in the San Antonio River just downstream from the zoo. "Germs are my friend," was a common refrain. Ed attended Central Catholic and Alamo Heights high schools, where he first began to develop the extensive list of lifelong friends. He briefly enrolled at Trinity University and then transferred to The University of Texas at Austin, although he ultimately sent his daughters to Texas A&M. He graduated in 1951 with a BS degree in Geology. Ed married Janice Jacqueline Thomas, the love of his life, and fellow UT alum, that same year. He went to work for Standard Oil of Texas, now Chevron. He and Janice moved from San Antonio to Midland, and then to Gainesville, Texas, where Ed labored, as he readily admitted, as an undistinguished subsurface geologist doing field development and wellsite geology. Afterwards he was transferred to the gravity meter department in Houston where, again he admitted, oil industry careers, at that time went to die. Ed adopted his first child (Ellen), told Chevron to pound hydrocarbon sands, and then started his own gravity meter company, Photogravity, in 1959. Just as the adoption agency expressed concerns about his career moves, Ed secured his first contract and Photogravity became financially viable providing photogeologic and gravity services to oil industry customers. While Ed and company ran gravity surveys in Africa, Canada, and Alaska, he and Janice added daughter, Paula, and son, Bryan, to the family. Not long afterward, Ed and a childhood friend built what would become a focal point for Ed's mission and ministry on earth——the Lake Livingston lake house. Ed was a body in constant motion as he tirelessly worked on cars, golf carts, boats, and whatever else caught his attention. He implored his ever-widening circle of friends to come visit and stay for the tremendous therapeutic

benefit. Ed sold Photogravity in 1977 and started Benchmark Exploration, Inc. where he developed and sold oil and gas prospects to the oil industry. Ed and Janice later welcomed in-laws; Jason Doughty (Paula), Charlie Palmer (Bryan), and J Kelly Mowry (Ellen); to their fan base and then five grandchildren; Jake, Eric, Kyndall, Jack and Alex.

T. Curry Hendricks, Jr. (B.S. '56) passed away on March 17, 2019 after succumbing to his battle with cancer. Known to his many friends and family as Curry, he was born to Tom C. Hendricks and Beulah Richmond Hendricks on November 24, 1929 in Colorado City, Texas, and lived in Jacksonville, Texas, as a young child before moving to Kilgore, Texas, in elementary school. Curry attended The University of Texas at Austin before serving in the US Marines Corp. Following his military service, he attended the University of Houston where he obtained a geology degree and began his successful career in the oil and gas industry and later as a partner in a gravel company in Columbus, Texas—when it didn't interfere with the Longhorn football schedule. He wouldn't admit that he retired early to Horseshoe Bay to be closer to Austin and to have more time to follow the teams. In addition to the years he spent attending football, basketball and baseball games, Curry spent many happy hours playing golf, and fishing and hunting throughout the US, Mexico, North and South America. He loved swapping stories whether tailgating or sitting at his kitchen table with friends and family. Without even knowing, Curry had a great impact on his family, friends and caregivers. He lived life fully, generously and on his own terms. Curry was preceded in death by his parents, wife Patricia (Pat) E. Hendricks, sister Peggy Hendricks Whittington, and his special friend and partner Martha Badgett. He is survived by his stepsons Fred (Trey) Bunde III, Mark Bunde and Robbie Locklier as well as step grandchildren Sam, Jessica and Mike and their families.

Carroll Ann Hodges (B.A. '58) was born in Pomona, CA on June 30, 1936 and died on March 2 after a long illness during which she was supported by friends and caregivers. She was 82. Carroll Ann grew up in St. Louis and Austin and graduated from The University of Texas at Austin with a degree in geology. A pioneer for her generation, she continued in that field to earn a master's degree from the University of Wisconsin and a doctorate from Stanford in 1966. In 1970 she settled permanently in California for a job with the US Geological Survey in Menlo Park, arriving in Woodside pulling a bay horse named Torch behind a rare 1964 ½ red Mustang convertible. She became Assistant Chief Geologist for the USGS Western Region, led studies of the Apollo mission lunar data, and created atlases of features on both the Moon and Mars. She spent 1980-81 as a Congressional Science Fellow in Washington, DC, which stimulated her interest in local government. Carroll Ann also served as a visiting and consulting professor at Stanford for several years before retiring from the USGS in 1995. She spent her last decades serving on planning, conservation, and environmental boards for NGOs and especially in the Woodside community, where she was elected to two terms on the Town Council including a stint as Mayor. For fun, she traveled the world, built furniture and shingled her home, played clarinet in the Woodside Village Band and piano during festive gatherings at her home, cared for her beloved cats and horse Midnight Cavalier, wrote and performed satirical limericks, and sang Christmas carols on horseback. Carroll Ann is survived by her sister, Margaret Hodges.

Richard T. Houser (B.A. '49) died peacefully at the age of 98 on January 22, 2019. He was born in Lynchburg, VA on August 12, 1920, to Richard Laviere Houser and Carrie Parrish Houser. Red graduated from E. C. Glass High School in 1940 and attended Virginia Polytechnic Institute for two years. Thereafter, Red enlisted in the U.S. Army and was assigned to the Ninth Infantry Division Artillery Headquarters where he spent three and a half years serving in World War II. The division was involved in eight campaigns in North Africa and European Theaters of Operation, including the landing in Normandy and the Battle of the Bulge. Later, on September 25, 1995, in Austin, the President du Conseil de Basse-Normandie presented the Medal of the Jubilee of Liberty to all the University of Texas Alumni who fought in Normandy in the summer of 1944. After his tour of duty, Red married Audrey Dell Haas on December 28, 1945 in Lynchburg, VA. Red graduated from the University of Texas in May 1949. Soon thereafter, his career as a petroleum landman began with Sunray Oil Company in San Antonio. After 29 years, he retired from Sun Production Company. In 1982, Red accepted the position of Land Manager with Osborn Heirs Company, a family joint-venture in San Antonio. He became Vice President of Land in 1987, and retired in December 1988, but remained for another year as VP of Acquisitions. He continued to do contract work with several independent operators after returning to Houston. He became a member of the American Association of Professional Landmen (AAPL) in 1956 and served as Director of Region IV from 1965 to 1968, and became President of Corpus Christi APL in 1968. He joined Houston APL in 1970, served as Director in 1973, and became a member of San Antonio APL from 1982 to 1989. Red was a devout Christian and a member of the Baptist denomination, starting with his baptism in the 1930's and was a dedicated member of Champion Forest Baptist Church until his death. Red was an avid Bible reader and commentary studier and proclaimed his faith to many. Due in large part to his faith, his children and grandchildren are active members of the Baptist, Catholic, and Episcopal communities. Preceding him in death are two siblings, William "Monk" Freeman Houser and

Courtenaye Houser McGregor and one son, Richard Truett Houser, Jr. He is survived by his wife, Audrey Haas Houser; children, Laura Houser Goebel (Peter), Thomas Steele Houser (Kathleen), and daughter-in-law Melinda Arnold Houser; six grandchildren, the Rev. Richard Truett Houser III (Patricia), Allison Houser Forester (David), Anne Marie Abigail Houser, Jackson Luce Goebel, Maxwell Steele Houser, and Lauren Claire Goebel; and one great-grandchild, Ellen Rae Houser.

Emmett A. Humble (B.A. '49, M.A. '51), age 93, was born on January 25, 1925, in Kerens, Texas. He was a veteran of the U.S. Navy, having served during the Pacific Theater of World War II, then returned to Texas and married his high school sweetheart, Lorine Crumpler. He attended The University of Texas at Austin, then went to work for Humble Oil and Refining Company, now ExxonMobil, in Tyler, Texas. The Humbles returned to Houston in 1971. Mr. Humble's tenure at Exxon included 13 years of Board level service, the last five years as CEO of Esso Exploration, Inc., Exxon's affiliate responsible for international exploration and drilling, and as a Director of Exxon Production Research Company. Upon retirement from Exxon in 1986, he formed a consulting firm, Petroleum Associates International. Mr. Humble is a Life Member of the Board of Directors for Sam Houston Area Council of the Boy Scouts of America and was awarded the Silver Beaver Award in 1975. Emmett was instrumental in restructuring the Retina Research Foundation after being asked to join in 1974. He served in various Chairmanship positions from 1974 through 2017. In honor of his outstanding service to the foundation, he was endowed a chair at McPherson Eye Research Institute at the University of Wisconsin-Madison in 2007. Emmett is preceded in death by his parents, Omer and Estelle, his wife Lorine and his grandson Eric. He is survived by his brother, Omer Ralph; sons, Deral and Keith; grandchildren, Kelley and Heather; great-grandchildren, Ethan, Preston, and Evan; and his nieces, Susan, Sally, and Sarah.

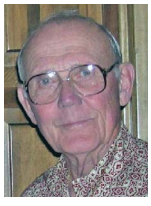
Helmut Werner Kasiske (B.S. '54), 95, passed away on May 3, 2019. He was born March 13, 1924 in Kurten, Texas, to Julius Johan Kasiske and Minnie Henrietta Mohr. Helmut grew up near Austin in a German settlement known as Richland. His father was the pastor at St. John Evangelical Lutheran Church, and the family with 9 children lived in the parsonage next door. He graduated from Manor High School in 1941, lettering in football, basketball and track. He was also musical, singing in the glee club and playing sousaphone in the band. During World War II, he served in the Army Air Corps as a navigator, and also played sousaphone for the Headquarters Band for Troop Carrier Command at Stout Field in Indianapolis. He and his wife Teresa were married in Austin on August 1, 1952. He graduated from The University of Texas at Austin in 1954 with a degree in geology. Helmut had a lifelong career in the oil industry and was one of the most respected geophysicists of his time. Upon his retirement from Esso Exploration, he enjoyed many hobbies and activities including fishing, hunting, production of fishing rods, welding, touring in their RV, gardening and mesquite woodworking (including several years exhibiting at the annual Texas Mesquite Arts Festival in Fredericksburg). He is survived by his wife Teresa, son Larry (Carolyn), daughter Diane Spilman (Ron), daughter Patricia Roberts (Richard) and daughter Janis Dismukes (Eddie). He is also survived by grandchildren: Jaclyn, Sarah, Ryan and Jeff; and six great-grandchildren: Lillian, Claire, Jackson, James, Kodiak and Werner; and sister Edelweiss Hempel. He was preceded in death by siblings Emanuel Kasiske, Gretchen Pfluger, Eibert Kasiske, Selma Harvey, Leonard Kasiske, Thekla Hamann, and Norma Lentz.

Robert Felts Kent (B.S. '52), 92, went to his heavenly home, October 30, 2018, after a brief illness. Bob was born December 24, 1925 in Tyler to Merlene Felts Steel and Paul E. Kent. Bobby worshipped at Emerald Bay Community Church and was also a faithful member of the Thursday morning Men's Bible Study. Bob graduated from Tyler High School in 1942. Responding to his patriotic duty, he joined the U.S. Navy in 1943 where he served in WW II on the aircraft carrier, USS Shangri-La, as a gunner on a dive bomber. On September 1, 1945, his ship entered Tokyo Bay where he witnessed the formal Japanese surrender on September 2. After separating from service in May 1946, Bobby began his college studies graduating from TJC and The University of Texas at Austin with a geology degree. He worked for Humble Oil, later Exxon, as a Senior Exploration Geophysicist until his retirement in 1986. At that time, he and Charlene moved to Emerald Bay. Bobby was preceded in death by wives Doris, Charlene, and Frances, as well his daughter Cindy Kent Mathis and sister Paula Kent (Bob) Breedlove. Bobby is survived by his daughter, Karen Kent Youngblood (Terry Gimble); grandchildren, Marcus (Serene) Youngblood, Michael (Susie) Gentry, Ryan Mathis, Kristin Mathis (Brandon) Jones, Megan (Alex) Alexander. In addition, Bobby has 9 great-grandchildren. Bob especially enjoyed bringing a smile to many faces by sharing his special peanut brittle and divinity candy and chocolate chip cookies with everyone. Although he will be missed deeply, his Christian faith and personal witness is a consolation to us all that, as Christians, we will see him again. He loved many so very well and demonstrated the true measure of a good man by his loyalty, honor, and faith.

John Kinsella (B.A. '49) passed away on October 25, 2018, at age 92. Survived by his wife, Lucille Kinsella; daughters, Susan Kinsella, Pat (Glenn) Herdeg, Beth (Takeshi) Sakanishi; sons, Dan (Liz), Tim (Rosemary), Tom (Christine), Jim (Jill) and Chris (Jenn); grandchildren, Kristin (Tim), Paul (Angela), Matt (Gina), Brian (Gina), Alison, Nicholas, Alexander, Maddy, Kelly, Maggie, Bridget, Patrick and Joe; 8 great-grandchildren; brother, Robert Kinsella. A graduate of Waterloo High School Class of '44, Jack received a B.S. in Geology from the University of Texas and a M.S. in Physics from Syracuse. He was a WW II US Navy Veteran. He retired from the Xerox Corp after 30 years in various assignments in Research, Engineering and Manufacturing Divisions.

Eugene Ray Lyerly (B.S. '59) passed away on November 1, 2018.

Jack L. Phillips (B.S. '49) passed away July 24, 2019, at the age of 94. He was born February 11, 1925 to Inez Scarborough Phillips and Loyce Phillips. He graduated Gladewater High School, attended Kemper Military in Boonville, Missouri, and, during World War II, at the age of seventeen, enlisted in the United States Army Air Force. He rose in rank to Second Lieutenant, piloting B-17's. In 1945, he enrolled in The University of Texas at Austin and joined Phi Gamma Delta fraternity. He married Barbara Wampler on December 21, 1946. They remained in Austin until Jack graduated, at which time they moved back home to Gladewater. Jack joined his father in the oil and gas business, a family venture that has endured for some seventy years. He and Barbara had two daughters, Gail and Nancy. Throughout his distinguished career, Jack discovered fourteen oil and gas fields located in Texas, New Mexico, Louisiana, and Mississippi. For sixty-eight years, he was a member of AAPG. He served six years as a Director and two years as a Vice-President for IPAA. He was appointed to the Interstate Oil Compact Commission in 1991. He was also a member of the East Texas Geological Society. In 1987, Jack received the Dad Joiner Award as the Most Outstanding Oil Man in East Texas, given by the East Texas Producers' and Royalty Association. He was awarded the Pelzi Award in 1994 for the most important on-shore oil discovery in North America (Mississippi). For his contributions to the oil and gas industry, The Texas Alliance of Energy Producers presented Jack their Living Legends Medal in 2009. Though not one to dwell on his honors, Jack was immensely humbled to be recognized by his peers in the oilfield. He attributed his success in the industry to the men he befriended and the camaraderie they shared. He was very proud to have his daughter, Nancy, and two of his grandsons join him at Jack L Phillips Co. Jack called Gladewater home, but his community involvement spanned all of East Texas. He served twenty-two years as President of the Gladewater Round-Up Association and remained as a Director Emeritus on the rodeo Board. He was a director of the First State Bank of Gladewater, M-Bank of Longview, Bank One of Longview, and Regions Bank. A Thirty-Second Degree Scottish Rite Mason, Jack was Potentate of Sharon Temple in 1982 and a Director of the Jesters in Tyler. He was a Director of Southwestern Electric Power Company, a Board member and Chairman of Good Shepherd Medical Center in Longview, and a member of the Board of the University of Texas Health System at Tyler, as well as the Engineering Advisory Board of the University of Texas at Tyler. Jack was elected to the Gladewater City Commission in 1961 and served his hometown as Mayor from 1963 to 1965. On the occasion of his eightieth birthday, the City of Gladewater proclaimed February 11, 2005, as Jack L. Phillips Day. He and Barbara were members of the First United Methodist Church of Gladewater for seventy years, where Jack served as Chairman of the Board of Trustees as well as Chairman of the Finance Committee. Jack's lifelong love of the outdoors led him to travel to many remote and exotic locales. His knowledge of geology and wildlife were a source of pleasure, and he was ever yearning to re-visit the cradle of civilization, the continent of Africa. He took his family on safaris to numerous African countries and nurtured in them his same passion for adventure. The ranch he and Barbara cultivated in South Texas is home to over fifteen species of exotic game, some of them on an endangered list in their native lands. Jack also was a scientific breeder of native whitetail deer and quarter horses. A friend to all and a stranger to none, his true wealth lay in his family and friends. He rarely missed an opportunity to say, "I love you," to his children, grandchildren, and great grandchildren. He is survived by his daughters, Gail Mizer and Nancy Abernathy (Mark). He is also survived by Gail's children, Ashley Morris (Justin), Stephen Jack Mizer (Alex), Whitney Land (Mark), and Sutton Mizer; Nancy's children, Leslie Johnson (Burke), Clay Abernathy (Jaclyn), and Claire Henry (David). His great grandchildren are Hyde, Styles, Stephen Jack, Jr., Clay, Stella, Mark, Jr., Anna, Kate, Jack Madison, Eloise and Sarah. He is preceded in death by his parents; sister, Lavon Phillips Philips; and his loving wife of seventy years.



Phil M. Pitzer (B.S. '54), age 87, was united with his Lord and Savior on November 30, 2018. Phil was born October 19, 1931 in Dallas, Texas, to parents Paul and Ethel Pitzer and was raised in Breckenridge, Texas. He graduated from Breckenridge High School in 1948 and remained a diehard Buckaroo fan his entire life. He earned a degree in Geology from The University of Texas at Austin and came back home to work initially with his father in both the oil business and ranching. He later worked as an independent Geologist, and started two oil companies, along with his ranching

interests. He was a long-time board member of the West Texas Rehab facility in Abilene and a founding board member of Citizens National Bank of Breckenridge. Phil was a longtime member of St. Andrew's church and served on the vestry many times. He was a sports enthusiast and enjoyed watching his sons, grandchildren and their friends play. He also supported the Boy Scouts of America throughout his life, attaining the rank of Eagle Scout in High School, followed by two sons and four grandsons who attained the rank as well. Phil loved to hunt and fish, and shared his passion with his children and grandchildren. Most of all he loved being on his ranch, and working with his grandchildren. Many individuals came to know Phil's generosity over the years, although his selfless nature always emphasized subtlety and anonymity. He is survived by his wife, Lola, his children, Greg and Lisa Pitzer, Kathy and Steve Scully, Holly Oman and Sandy Hampton and by his grandchildren, Clark Pitzer, Scott and Abbie Pitzer, Adele and Stephen Reckling, Ash and Ashley Stoker, Mary and Lee Blue, Paul and Kristen Pitzer, John and Harriete Scully, Patrick and Elizabeth Scully, Sam Scully, Conner and Jack Oman; and great grandchildren, Effie and Declan Blue, Kaul, Crawford and Colette Pitzer, Betty Ann and Clay Pitzer. He was preceded in death by sons, Marc and Clay Pitzer.

Terry L. Ramsey (M.A. '99, Ph.D. '03) passed away on December 5, 2018 of cancer. Growing up in Borger, Texas, he became an Eagle Scout and graduated from Borger High School. He lived in Dallas, Austin and Tyler in his lifetime. A petroleum engineer, Terry earned a bachelors at Colorado School of Mines (1964), a Masters in Petroleum Engineering at the University of Tulsa (1971), and at the University of Texas in Energy and Mineral Resources (1997), and a PhD in Geological Sciences (2003). Throughout his career, Terry worked in several cities in the US and 15 countries including Iran and France for City Service Oil Company, the Texas Independent Producers and Royalty Owners Assoc., and DeGolyer & MacNaughton. He also founded a consulting company in the 1980s. Terry was a member of the Masonic Lodge of Frankston, Texas, and an active member of the Texas Geological Society in Tyler. In retirement, he enjoyed fishing, and researching artificial intelligence and the connection between macro and micro economics. Born on December 21, 1940 in Borger, Texas, he was preceded in death by his parents Betty Jo Baker and Roy Hansford Ramsey. Terry is survived by his wife, Hope Glenn Ramsey, his daughter, Ann Ramsey, his daughter Felicia Ramsey and her sons Austin and Aden Mestemacher, and by his sister, Francine Carraro.

Floyd F. Sabins, Jr. (B.S. '52), an American petroleum geologist, educator and author who was a pioneer in the development, application and advocacy for the field of geological remote sensing. Floyd was born on January 5, 1931 in Houston, Texas, and graduated from The University of Texas at Austin in 1952 with a B.S. in Geology and went on to earn a Ph.D. in Geology from Yale University in 1955. He met his wife Janice in New Haven, CT while studying at Yale and they married on October 2, 1954. Floyd and Jan had 2 children, Barbara and Edward. Floyd loved his family and was a proud grandfather to 4 grandsons, Robert and Eric Belfield and Connor and Spencer Sabins. Floyd worked for Chevron for 37 years and was fortunate to travel the world and work on many projects. He was proud to be on the discovery teams for Chevron's propects in the North Slope of Alaska, and the Hawtah Trend complex, Raghib Oil Field and Dilham Oil Fields in Saudi Arabia. He was also a key player in the exploration success at the Hedinia and Agogo Oil Fields in Papua New Guinea. Floyd's parallel career within Chevron's mineral division was no less impressive. He worked on the discovery teams for copper deposits at Ujina and Collahuasi in northern Chile as well as the El Penon gold deposit also in Chile. Significant discoveries were also made by Floyd and the Chevron team for boron and lithium deposits at Salar de Uyuni in Bolivia along with multicommodity exploration targeting using remote sensing in Peru and Mexico. From 2010 to 2013, supported by the US Dept. of Defense and the USGS, Floyd guided processing and interpreted multispectral and hyperspectral imagery of over 25 sites across Afghanistan, finding new mineral exploration targets to promote economic development. Floyd became involved in the higher educational system starting as an Adjunct Professor in 1966 in the Geological Sciences Department, University of Southern California and later as a Regent's Professor with the Earth and Space Sciences Department at UCLA in a teaching role concurrent with his Chevron position. He was a giant among other remote sensing experts and an entertaining field guide for trips to remote sensing sites in the western United States. He led many field trips under the auspices of GSA, ERIM, NASA and JPL to classic test sites including Cuprite, Virginia City, Yerington and Death Valley often giving insightful presentations on the outcrop with imagery on display. One of Floyd's other lasting professional contributions includes the landmark book entitled "Remote Sensing Principles and Interpretation" first published in 1978 at the dawn of earth-looking satellite technology. It was the first textbook on the subject of geological remote sensing at university level. Floyd stated that "There was no remote sensing text so each week I prepared a syllabus for a chapter in the eventual book and handed it out to the class. Each year I revised the syllabus to incorporate student reaction. After a couple of years I submitted the revised text for publication. I think the student input contributed to the wide acceptance of the book and the very positive reviews." Subsequent editions of the text won critical acclaim as one of the top five geoscientific books in print and is still considered the gold standard of geological remote sensing textbooks along with a detailed laboratory manual

that has been used by multiple generations of teachers and students world-wide. Floyd was nearly finished completing the 4th edition of his landmark text with co-author Jim Ellis and it will be published later this year. Floyd received a number of honors and professional awards notably the William T. Pecora Award by NASA and U.S. Department of Interior in 1983 for "His outstanding contributions in education, science, and policy formulation to the field of remote sensing." This award is the highest recognition in the field of remote sensing in the United States. A decade later in 1993 Floyd received the Chevron Chairman's Award for "His contribution to the discovery of a major copper deposit in Chile." This is Chevron's highest achievement award. With all of his professional and academic accomplishments, Floyd always considered himself first and foremost a field geologist, largely due to his early training at the University of Texas. In his spare time Floyd loved to fish and travelled the world to many exotic and storied fishing spots with each photo of his catches becoming larger and more colorful than the last. He volunteered for many organizations including Trout in the Classroom, St Jude Hospital, the Southern California Bluebird Club and MADD. He was especially proud of growing and maintaining his impressive collection of fern plants in his back yard. Floyd will be greatly missed by family, friends and colleagues. He is an inspiration to all those who follow the career path of geological remote sensing and those who aspire to a life well-lived.

Edwin L. Smith (B.S. '51), 91, of Wichita Falls, Texas, passed away on May 4, 2019. He was born on October 17, 1927 in Amarillo, Texas, to Lucian Edwin and Ada Lee Smith. He graduated from Graham High School in 1945, and he received his bachelor of science degree in petroleum geology in 1951 from The University of Texas at Austin. He served in the First Cavalry Division of the United States Army and was stationed in Japan in 1947 and 1948. On September 22, 1951 he married Betty Lou Carey in Graham, Texas. He worked for Mid-Continent Oil Company as a geologist and for Sun-Ray Oil Company in Wichita Falls as district geologist from 1951 to 1955. He became an independent geologist in 1955 and continued as an independent geologist for the rest of his career. Mr. Smith served on the Board of Directors of North Texas Rehabilitation Center, Floral Heights Methodist Church, Wichita Falls Museum, American National Bank and Trust, and The Wichita Club. He is past President of The University of Texas Ex-Students Association. He was a longtime member of the North Texas Geological Society, Texas, Alliance of Energy Producers, American Association of Petroleum Geologists, and Independent Petroleum Association of America. He participated in fund drives for United Way, The Boys and Girls Club, Boys Scouts of America, and YMCA. He is survived by his wife of 66 years, Betty Lou Smith, daughter Lisa Williamson (Jim), son, Edwin Scott Smith, sister, Donna Bell McClanahan, granddaughters Lindsey Lang and Laura Lunn (Zac), Natalie Wolfe, Katie Lang, and grandson Scott Smith Jr., and 4 great-grandchildren. Mr. Smith was preceded in death by his parents, his sister Imogene Hays, and his grandson, Donald Blair Lang, Jr.

Joseph T. Smith, Jr. (B.S. '50, M.A. '56) passed away on May 10 at the age of 92. He was born on January 15, 1927, in San Antonio, Texas, to Joseph T. and Willodene Watkins Smith. He married Carolyn Eberhard on February 4th, 1956 in the Emanuel Lutheran Church, Seguin, Texas. Mr. Joseph T. Smith, Jr. is survived by his wife Carolyn Eberhard Smith, daughter Susan Horne (Roy), grandchildren: John Gibson and Jennifer Gibson, Brother and spouse: James Smith (Sue), Brother in law: Warren Hahn. Mr. Smith is preceded in death by his parents, sister Martha Kate Hahn, and brother Eugene C. Smith. He served in the U.S. Marine Corps from 1944 to 1953.

Herbert M. Stanley (B.S. '49), 91, passed away on March 5, 2019 after a brief illness. A man of quiet grace and dignity, he devoted himself to the care and support of his grateful family. We have been blessed. Herb was born on January 19, 1928 in Ponca City, OK to Herbert M. Stanley, Sr. and Anna Marie (Riley) Stanley, but was raised in Dallas. He attended Holy Trinity Elementary and Highland Park Middle schools, then became part of the first sophomore class of Jesuit High School. He joined the "family business" when he graduated with a BS in Geology from the University of Texas in 1949, a member of the Alpha Tau Omega fraternity. Herb also served in the US Marine Corps. It was in Dallas that he met and fell in love with Patricia Elder McKeown. Herb and Pat were married on December 28, 1957 at Holy Trinity. They started their married life in Tyler, but moved to Midland in 1961, where Herb had a productive career at Atlantic Richfield, Texas American, and for many years as an independent geologist. He truly loved geology, and family camping trips were not complete without a geological map, hammer, and gold pan. A devout Catholic, Herb was a long-time parishioner at St. Ann's Church, participating in Nocturnal Adoration Society and the annual Family Fair. Preceded in death by his sister Ann and brother Don, Herb leaves to cherish his memory Pat, his wife of 61 years; sister Peggy and brother Ed; his four children, Eileen Schmidt (Greg), Mark Stanley (Kathleen), Margaret McDowell (Carrin), and Beth Martinez (Ray); and eleven grandchildren, Calvin (Stephanie), Duncan, Oliver, Philip, Evan, Gordon, Chris, Will, Nicki, Sofia and Lorenzo.

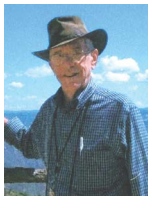
Winston H. Upshaw (B.A. '57) passed away on July 13, 2019 after a lengthy illness. He was born to George William and Era Bell Upshaw on December 1, 1930 in Hearne, Texas. He was raised in Groesbeck, Texas. He proudly graduated from The University of Texas at Austin in 1957 and continued to

be a lifelong fan of Longhorn sports. He served three years in the Coast Guard, and was retired from the Social Security Administration after 31 years of service. He was a member of First Baptist Church Canton, Texas. He was preceded in death by his parents, George and Era Upshaw; son, Winston Kermit Upshaw; parents-in-law, Clarence and Gordie Burns; sisters, Ina Faye Knight and Lila Maye Lewis; and brothers and sisters-in-law, Audrey Lewis, Todd and Doris Burns, Jim and Veta Burns, Billy John and Jo Burns. Survivors include his wife, Melba Burns Upshaw; children, Tracy Betz (Bob), Laura Upshaw, Pam Herrin (Mike), and David Stone (Karen); grandchildren, Jason, Zachary, Colleen, Kimberly, Matt, Mark, Reid, and Judson; five great-grandchildren; brothers-in-law, Herbert Knight, and Jerry and Sue Burns.

Salvatore Valastro (M.A. '75) was born on February 4, 1931 and passed away on May 18, 2019. He was the first in his family of fisherman to get a higher education. Sam attended school at Kirwin High School where he graduated Valedictorian of his class despite having difficulty with the English language. Sam was drafted in the Army in September of 1954 and served during the Korean War. He was loved and cherished by many people including: his brothers, Placido and Antonio; his children, Michael Valastro, Maria Harris and Cecile Valastro; his wife June Valastro; his children-in-law, Jackie Valastro, Travis Harris and Doug Williamson; his grandchildren, Michael, Jonathon, Alyssa, Alex and Anthony.

George E. Welder (B.S. '49), 92, died peacefully on May 27, 2019. He was a WWII Veteran who graduated with a BS in geology from The University of Texas at Austin and a MS from University of Colorado. He worked in Wyoming and New Mexico as geologist/hydrologist with the USGS for thirty years. He is survived by his wife Anne, son Carl, and daughter Adrienne.

Burford L. Westlund (B.A. '44), 92, passed away on May 13, 2019. Burford was born in Austin on March 1, 1927. He graduated from Austin High School and studied Geology, Music, and Botany at the University of Texas. He married Dorothy Ann Chavana on Dec. 23, 1950. Burford served as organist at St. Martin's Lutheran Church for over 30 years and choir director/organist for 10 years at Holy Cross Lutheran Church. He was a member of the motion picture operators/stage hands union. "Cactus Bur" as he was affectionately known had a passion for cactus, all plants, his dogs, and antiques. He was preceded in death by his oldest son John Lee Westlund. He is survived by his wife, Dorothy; his children, Karin Westlund High, Burford Paul Westlund, and Lissa Westlund McKay; his grandchildren, Nathaniel, Cory, Jonathan and Daniel; great grandchildren, Riley, Parker, Kasey, Tanner, and Chase.



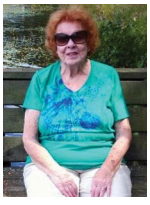
Kenneth E. Woodyard (M.A. '56), went to his forever home May 10, 2019 at the age of 90. He was born April 25, 1929 in Enid, OK moving to Ponca City, OK in 1936. He graduated from Ponca City High School in 1947 and Rice University in 1951. At Rice he was very involved in the Rice band (The Mob) where he served as president his senior year. After graduation, he spent time in the Grand Tetons before entering the Army on Jan. 2, 1952. He was discharged in Dec. 1953 after serving in the Army engineer corps during the Korean Conflict. He attended the University of Texas receiving his Masters in Geology in 1956. He married Margaret Orr of Bertram, Texas, on June 9, 1956 then began a 30-year career as a Petroleum Geologist for Continental Oil Company. He retired in Houston, Texas, in 1985. His wife, Margaret, preceded him in death July 1990. He married Carol Wood Christy, whom he had known since 1940 in Ponca City, on Oct. 19, 1991 and moved to Tulsa. They built their home and moved to Bertram in Dec. 1993. They volunteered with the Republican Party for a number of years and traveled a great deal throughout the world until he was no longer able to do so. He loved history, especially military history, and read extensively on the subject until his failing vision made it too difficult to read. He is survived by his wife, Carol; his three children, Cathy McDaniel (Glenn), Lynn Kelley, and Pat Woodyard (Paula); his eight grandchildren, Jennifer Jannicke (Deron), Nicole Purnell (Tim), Elizabeth Schlicksup (Kevin), Julieanne Braackeen (Justin), Sarah Gordy (Andy), Cassandra Clark (Robert), Cody Woodyard (Ashley), and Dustin Woodyard; and 11 great-grandchildren.

Spouses & Friends

Corinne P. Carleton (Spouse of the late Toby Carleton, B.S. '51, M.A. '52) passed away on February 2, 2019. Corinne grew up on the family ranch close to Ozona, Texas, where she attended school. From there she attended Gulf Park Girls School in Gulf Port, Mississippi. She then attended The University of Texas at Austin, where she was also a member of Zeta Tau Alpha Fraternity. It was at UT that she met Toby Carleton on a blind date in 1949. Some years later they were married and spent 62 happy years together. On June 20, 1953, she and Toby Carleton were married in Ozona, Texas. After their honeymoon, they moved to Lamesa, Texas, for Toby's assignment on a seismic crew with the Ohio Oil Company (now Marathon). Subsequently they were moved to Midland in 1953, were transferred to Roswell, NM in 1954, and returned to Midland in June, 1955 when Toby was offered a job with Zapata Petroleum Corporation, a new company founded by George H. W. Bush and Hugh Liedke. Corinne was involved extensively in the Midland community. In addition, she was an active partner in Tocor Investments, Inc. (Toby and Corinne), which is an oil investment and participation company. Also, she was a partner with her husband in ranching

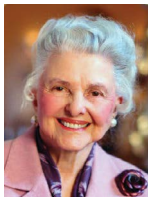
operations in Crockett and Val Verde Counties, Texas. Corinne loved to travel and she and Toby (and the children when they were younger) traveled extensively. One of her biggest sources of joy was being a loving and devoted wife, a caring mother, and a doting grandmother to her 6 grandchildren-all of whom called her "Coco."

James A. Feibelman (Spouse of Irma Feibelman, B.S. '59), age 85, passed away on March 20, 2019. Jim attended Port Chester High School in NY and graduated from Lamar High School in Houston, Texas.



Lucy S. Grant (Spouse of the late Richard Grant, Ph.D. '58) grew up in Austin, where she attended the University of Texas, earned a Master of Arts degree in music, was a member of the UT Traveling Madrigals, and a life-long member of Alpha Phi sorority. She was the beloved wife and well-traveled companion for more than four decades of Smithsonian Institution Paleontologist Dr. Richard Evans Grant (1927-1994). Lucy taught music during a career that spanned over 40 years to students of all ages in public schools and was also conductor and pianist of the Arlington "All County Chorus" for many years. Lucy was a devoted congregation and choir member of Lutheran Church of the Reformation in Washington, D.C. Her life-long love of music and teaching touched thousands of lives and inspired countless young musicians.

Jacque N. Holland (Spouse of the late Scotty Holland, B.S. '57) passed away on October 17, less than one month shy of her 87th birthday. Jacque's family lived in Dallas during the early period of the Great Depression until her father found employment in the East Texas Oilfield. For the next fifteen years Jacque and her mother traveled with her father, George Hunter, moving frequently to oilfield boomtowns. Her family settled in Abilene in 1946, in order for Jacque to attend high school, where she met the love of her life, Scotty. They married in 1952. Jacque Nell and Scotty moved to Midland in 1957, the two young parents beginning their formative years of marriage. In addition to her role as mother, Jacque Nell sang in the Midland Symphony and Chorale and volunteered for Midland Memorial Hospital. The family moved to Houston in 1971 and remained there for nearly 50 years. She was a devout Christian and participant and follower of the performing arts, including symphony and opera. Jacque always had a smile for everyone and truly impacted the lives of many.



Caroline Rose Hunt (Friend) passed away on November 13, 2018 at the age of 95. Caroline was born in 1923 to pioneer oilman H.L. Hunt, II and his wife Lyda Bunker. Caroline received a BA degree in English and Art History from The University of Texas in 1943. She married Loyd Sands and devoted the next three decades to raising her five children, Steve, Bunker, David, Laurie and Patrick. In every aspect of her life she was led by her deep Christian faith. In the 1970's, The Rosewood Corporation was formed and became the primary operating vehicle for her family business interests including oil and gas exploration, real estate development, private equity and venture capital. Throughout Caroline's life, she hoped to leave a legacy, insisting that The Rosewood Corporation and its subsidiaries focus on excellence and fair and ethical dealings. She liked to refer to its employees as "Rosewood family." She taught both her immediate and Rosewood family the importance of responsible philanthropy and set an example of corporate involvement, regularly attending board meetings well into her nineties. In 1999, The Caroline Rose Hunt Family was honored by induction into the Texas Business Hall of Fame. She had an adventuresome spirit, was a world traveler, outdoorsman, and a hunter, going on an African Safari and fishing in Alaska with her late husband. She spent many hours on airplanes and weeks on boats during which time she honed her writing skills and eventually authored several books. Like many of the Hunt family, she was exceedingly frugal. Her family and friends were far more important to her than material possessions. Her long life was filled with interesting adventures, experiences and people, and, in later years, she enjoyed nothing more than sharing this trove of stories with those around her.

Kathryn C. Johnson (Spouse of the late Ken Johnson, B.S. '50) died on February 13, 2019. Kathy graduated in Plan II Honors Program from The University of Texas at Austin in 1950, where she served on the Student Assembly, was a Sweetheart nominee, and president of Delta Delta Delta sorority. For most of her adult life she has participated in Bible study groups for which she always felt great gratitude. Kathy was interested in serving her community and participated in The Houston Symphony Society, the Bayou Bend Docent Organization, the Ima Hogg Ceramic Circle, the Tanglewood Garden Club, and the Bluebird Circle. Over the years she and her family enjoyed spending time on Galveston Island and in the Texas Hill Country. She was an avid fisherman and birdwatcher. She was very creative and loved playing the violin, writing poetry, painting, and ceramics.

Suzanne P. Walston (Spouse of the late Virgil Walston, B.S. '60), age 82, passed away peacefully in her sleep on September 9. Suzanne graduated from Lubbock High School before attending The University

of Texas at Austin where she received a bachelor's degree, majoring in Art with a minor in English. It there that she met her husband of 55 years, Virgil Alfred Walston. Virgil's career as an international oil explorationist took them to various locations around the world including Libya, Singapore, Indonesia, Houston, Texas, Bakersfield, California and ultimately Moulton, Texas. The support, dedication, and strength she gave Virgil was instrumental in his success, all while raising their three sons and being very involved in their school and extracurricular activities.

Faculty & Researchers

Arthur E. (Art) Maxwell, former director of the University of Texas Institute for Geophysics (UTIG) and Professor Emeritus, passed away in Austin on August 21, 2019. He was 94 years old. Art had one of the most distinguished careers in administration in the history of the ocean sciences in the U.S. He served in the U.S. Navy during part of WWII, after receiving an undergraduate degree from New Mexico Tech. He received a graduate degree from Scripps Institution of Oceanography, advised by the legendary Roger Revelle. Following his time in La Jolla, Art served for a number of years as a program manager with the Office of Naval Research, during a period in the 1950s-1960s when the Navy was as important a part of the funding of academic ocean sciences research as the National Science Foundation. Art was hired in the 1960s to be the provost of Woods Hole Oceanographic Institution (WHOI), serving as primary assistant to the legendary WHOI director Paul Fye. WHOI was then and remains today the largest private oceanographic research organization in the world. During that period, he served in a number of other prominent advisory roles, including as president of the American Geophysical Union (1976-1978). He was also co-chief scientist of Leg 3 of the Deep-Sea Drilling Project (1968-1969), which will always be famous as the expedition which provided the first unequivocal proof of the existence of seafloor spreading in the South Atlantic. In 1982, Art put his considerable managerial expertise to work as the director of the University of Texas Institute for Geophysics. At that time, UTIG was located in Galveston, Texas, far from the main campus in Austin. Under Art's leadership, the institute was moved to Austin, and over the next decade became one of the U.S.'s leading marine geological and geophysical research laboratories. Art stayed on in that capacity until 1994, when he handed the role to Paul Stoffa, who Art had hired in the mid-1980s. Since 1994, Art lived out the remainder of his life in comfortable retirement with his wife Colleen, both in Austin and in Santa Fe, New Mexico. He will always be fondly remembered by his colleagues and friends for his leadership, his humanism, and his love of the ocean sciences.

H. Seay Nance (B.S. '78, M.A. '88, Ph.D. '10), former research associate at the Bureau of Economic Geology (variously known as Buck, Seay, or "Dr. Rock" to family and friends) was born August 8, 1948 to Hardie Seay Nance, Jr. and Geraldine Bruggeman Nance. He and his two sisters, Idelette and Marianne, grew up in La Marque, Texas, and spent some summers at their grandparents' home on the Sabinal River near Utopia, Texas—a place that was always very special to Seay. It was there where he started his scuba-diving adventures, and roamed the nearby hills collecting fossils. After graduating from Kirwin High School in Galveston in 1966, he moved to Austin to begin college at The University of Texas at Austin (which would turn into a lifetime pursuit of knowledge), met and married Deborah Miller, and they had a daughter, Santa Christina, in 1969. For several years during that time, Seay served in the U.S. Merchant Marine, where he went around the world on ships and returned with memories of flying fish on the deck and sparkling phosphorescent waters in the ink-black ocean at night, walking through the crowded streets of India, and waiting out a typhoon in Japan. Deborah and Seay were divorced in 1972, but both remained in Austin and continued a warm relationship throughout the years. In 1974, Seay met Jean Costin where they both worked in the Travis Unit of the Austin State Hospital (of all crazy places to meet!). They were married May 30, 1976, and celebrated their marriage and the country's bicentennial with a months-long backpacking/camping tour through the western states and some of our greatest national parks. Seay and Jean continued the adventures, first with skydiving and then earning pilots' licenses and owning a Cessna Skyhawk (until Seay had to land in a field near Houston due to an engine failure--a worthy story of its own!), backpacking and camping throughout the country, and traveling around the world as much as possible. Thanks to his combination of professional and personal travel, Seay set foot on every continent in the world with the exception of Antarctica. Seay continued his education in geology at The University of Texas at Austin. His areas of expertise included hydrogeology, sedimentology, and stratigraphy. As a senior author, he wrote 18 scientific articles and technical reports, and he co-wrote 44 more. He gave many presentations and earned awards and accolades for his talks at conferences and meetings. In addition to his professional work, Seay was happy to volunteer his time with the Balcones Canyonlands National Wildlife Refuge, he played guitar and piano, he painted and drew fascinating, geometric, abstract pictures, and he entertained family and friends with his dry wit and clear observations of life. On February 15, 2019, Seay died after a long illness, quietly and peacefully with his wife Jean at his side. He is survived by his wife Jean, daughter Santa, grandson Christian Ramos, granddaughter Karina Mays (Desmond), sister and brother-in-law Idelette and Jim Peery, three great-grandchildren.

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ALUMNI NEWS UPDATE SUBMISSION FORM

All personal and work information submitted is confidential and will not be shared outside of The University of Texas at Austin. All fields are optional but we appreciate your effort to help us keep your information accurate and current. All alumni, research scientists, faculty and staff affiliated with JSG and its research units are encouraged to submit.

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Class Notes for the 2020 Newsletter

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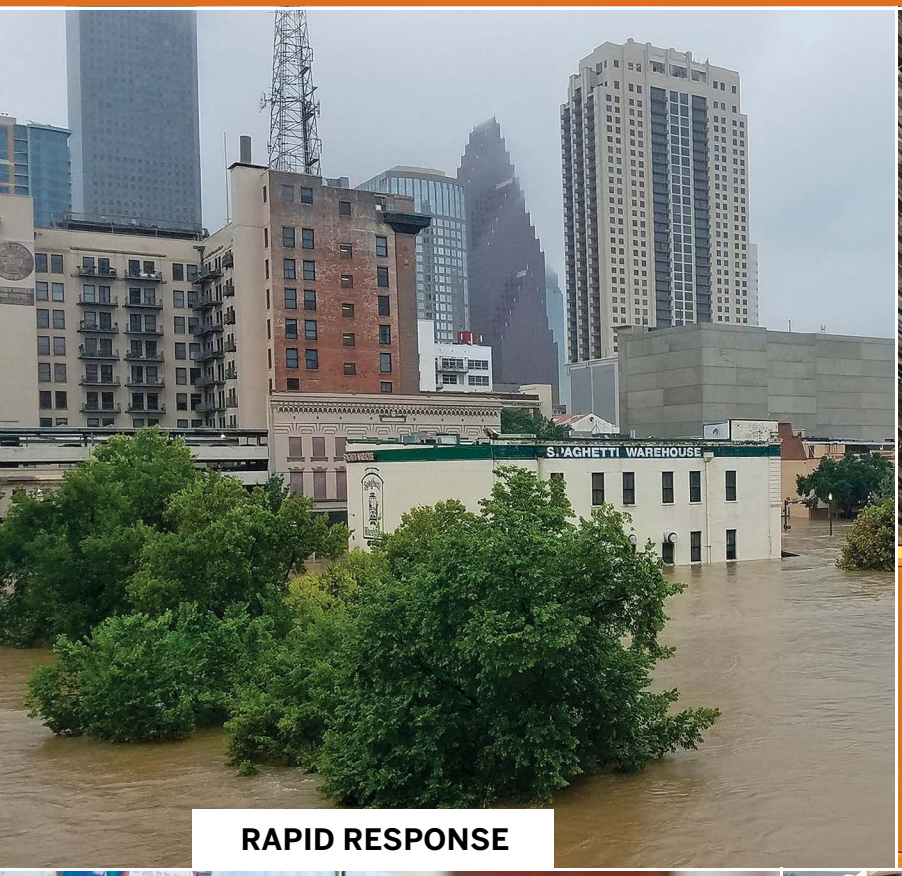

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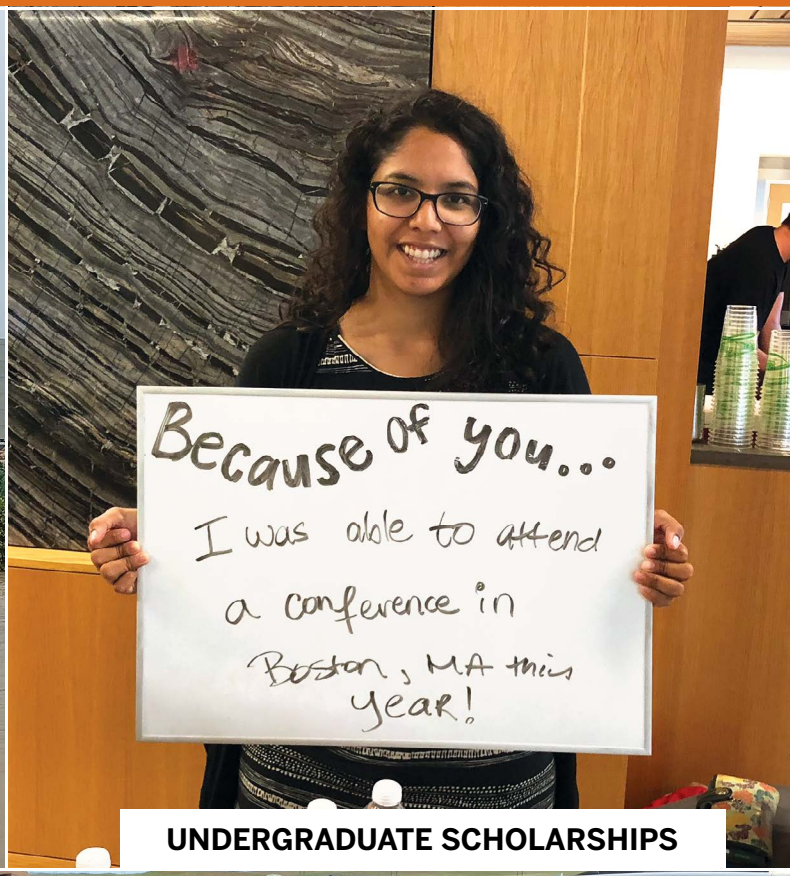

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