THE UNIVERSITY OF TEXAS AT AUSTIN · JACKSON SCHOOL OF GEOSCIENCES · 2021 NEWSLETTER

2021 Newsletter

Leading the Energy Transition, Understanding Climate Impacts, Making a Difference in Texas

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

THANK YOU!

From the next generation of geoscientists to the ones who paved the way

WELCOME

Dear Alumni and Friends,

I am happy to share this 72nd annual Jackson School of Geosciences *Newsletter*. Despite the seemingly endless craziness of the pandemic and a winter freeze that shut down Texas for a week, the Jackson School of Geosciences has remained vibrant. The tireless efforts of faculty, research scientists, staff and students, together with the generous support of our alumni and friends, kept the engines of science and education running throughout the past year. Just take a look through this year's *Newsletter* and you will see what I mean. From cover to cover, we report on great examples of cutting-edge research vital to the big issues facing society and of a world-class education with student opportunities offered by no other institution.

One thing that jumps out to me as I scan the *Newsletter* is the breadth and impact of the work being done at the Jackson School. The need for skillful and broadly trained geoscientists has never been greater as societies seek to navigate the simultaneous challenges of climate change impacts and reducing the carbon footprint of our energy systems while meeting the natural resource and energy pressures of a large—and still largely poor—global population. What makes geoscientists so vital in this environment is that we are educated to work on open, complex systems that are often under-defined and in wringing solutions out of incomplete data or knowledge. Many of our former students took those skills to the oil and gas industry, and we are proud of their accomplishments in that arena. We continue to engage the industry through consortia and partnerships and seek to work hand-in-hand with our historic partners to take on the challenges of energy production through the 21st century.

The scientific reach of our current faculty, researchers and students across the Earth sciences is impressive. The Jackson School encompasses geosciences across the spectrum of fundamental to applied research, from the core to the cosmos, and we seek to educate our students with the skills and knowledge needed to be leaders across many challenges and themes. Our breadth is apparent in stories such as "Powering the Energy Transition," on page 32, which shows how the Jackson School's Bureau of Economic Geology is applying the wealth of oil and gas knowledge it helped build over the last century to lead in the energy transition, with an eye to keep Texas front and center in energy production.

Simultaneously, our students are finding new, and sometimes surprising, ways to use their geoscience educations. I hope you enjoy reading about some of these alumni in "The Geosciences Advantage" on page 56. In a fast-changing world, we must prepare students with important, transferable skills and imbue them with the adventurous and entrepreneurial spirit the new world demands of them.

Take note of our ongoing research on climate and water issues and natural disasters, including right here at home in Austin. The Department of Geological Sciences' Dev Niyogi, for instance, is helping the city combat extreme heat areas in the urban core (page 18), and researchers at our Institute for Geophysics are helping Austin safeguard its lakes (page 54).

On page 74, we report great news on the reinvigoration of our GeoFORCE Texas outreach program under the leadership of Director Leah Turner, and the promise of our Undergraduate Research Traineeship Experience (RTX) program in helping students transition to college. You can read about the Jackson School's participation in a worldwide program, Unlearning Racism in Geosciences, that helped 80 Jackson School participants to frame ideas and plans for making the Jackson School a more inclusive and welcoming place. In late breaking news, the Jackson School named its first associate dean for diversity, equity and inclusion, Professor Julia Clarke. We are extremely excited to welcome Julia, a longtime champion of equity and diversity in the school, to this new position and will report in more detail in other forums soon.

We are pleased to share on page 86 the wonderful news that Professor Ian Dalziel is receiving the prestigious Penrose Medal this fall from the Geological Society of America (GSA). The Penrose Medal is GSA's top honor and is given to Ian in recognition of his many contributions to science's understanding of the assembly and breaking apart of the Pangea supercontinent. Finally, we ran all three of our summer field camps this year without a hitch! See page 70.

It is impossible to look at the *Newsletter* without a sense of pride and the feeling that the Jackson School is a special place. It ***is*** special. I am so proud of the people in this school and all they accomplish. I am sure that you share this same pride and joy!

Hook 'em and enjoy,

Claudia Mora, Dean

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DALZIEL WINS PENROSE MEDAL

FIELD CAMPS RETURN

MAPPING AUSTIN HEAT

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Diversity, equity and inclusion continue to be priorities at the Jackson School of Geosciences. Learn more about our GeoFORCE outreach program expanding its reach; the successful second cohort of the Undergraduate Research Traineeship Experience; and the local chapter of URGE, a group focused on addressing racism in the geosciences.

79 New STARR Leadership

After Bill Ambrose retired this spring, Lorena Moscardelli took the helm of the State of Texas Advanced Resource Recovery Group, a Bureau of Economic Geology group focused on increasing the production and profitability of earth resources in Texas.

67 DeFord Diversifies

The iconic DeFord Lecture Series prioritized diversity on all fronts, welcoming speakers from different racial backgrounds and geosciences disciplines.

10 Texas Sand Security

UTIG researchers are surveying the Texas coast for ancient sand deposits that could help restore and replenish the state's beaches.

17 Thawing Coastal Permafrost

Department of Geological Sciences researchers found that permafrost was largely absent in a remote Alaskan lagoon, a finding that raises concerns about coastal erosion and climate change.

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The University of Texas at Austin Jackson School of Geosciences is one of the top research institutions in the world, with a depth and breadth of research that sets it apart. This is made possible by the Jackson School's three world-class units: the Bureau of Economic Geology, the Department of Geological Sciences and the University of Texas Institute for Geophysics. Following are some research highlights from the past year.

- *Climate & Environment*
- *Energy Geosciences*
- *Marine Geosciences*
- *Planetary Sciences & Geobiology*
- *Solid Earth & Tectonic Processes*
- *Surface & Hydrologic Processes*
- *Other*

Manatees in Ice Age Texas

Planetary Sciences & Geobiology

Populations of manatees probably called Texas home during the last ice age, according to fossil research led by the Jackson School of Geosciences.

The findings were published in *Palaeontologia Electronica* in October 2020. Jackson School Professor Christopher Bell led the research.

The paper describes eight fossils. Most were collected from McFaddin Beach near Port Arthur and Caplen Beach near Galveston by amateur fossil collectors who donated their finds to the Sam Houston State University Natural History Collections. Two of the fossils are from the Jackson School Museum of Earth History collections.

A lower jawbone fossil donated by amateur collector Joe Liggio jumpstarted the research. When the researchers sought other manatee fossils for comparison, they were initially met with skepticism by fossil sellers, who told them point-blank "there are no Pleistocene manatees in Texas."

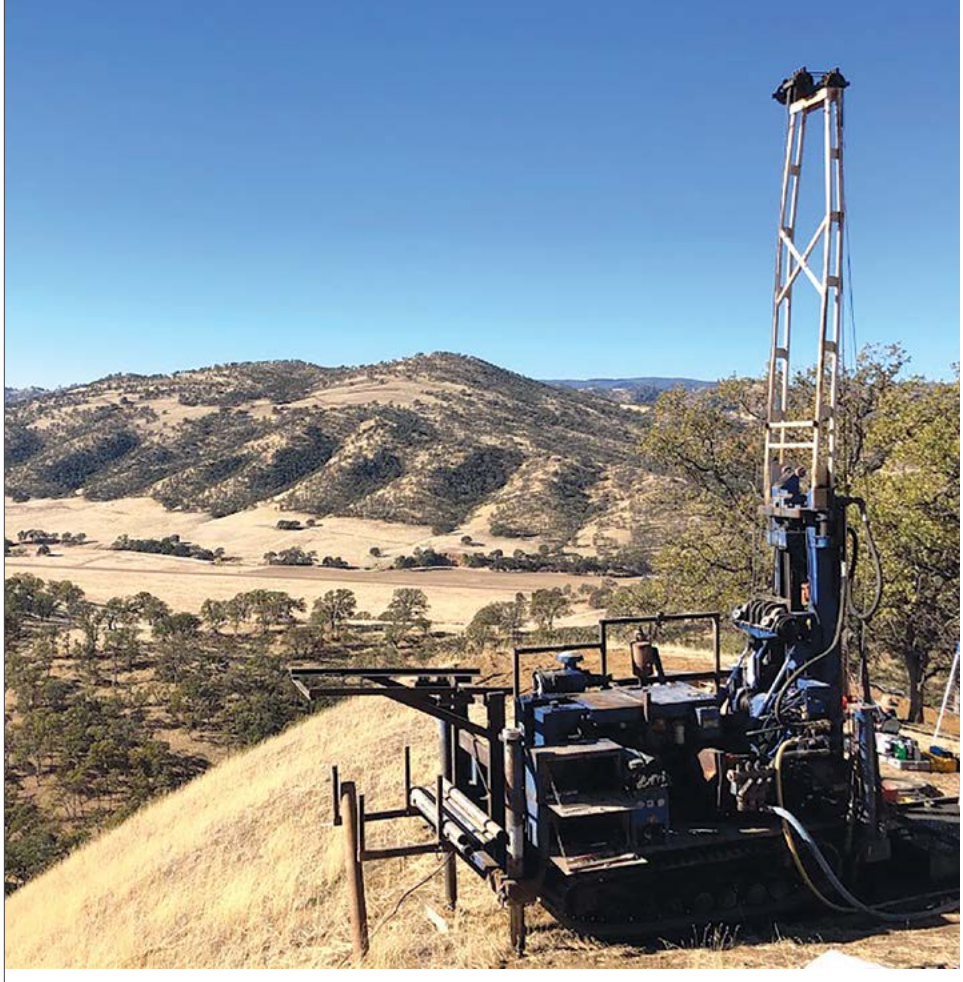
But examination of the fossils proved most of the bones belonged to the same species of manatee that visits the Texas coast today, *Trichechus manatus*. An upper jawbone donated by U.S. Rep. Brian Babin belongs to an extinct form of the manatee, *Trichechus manatus bakerorum*.

The fact that manatees were in Texas when waters were even less hospitable than they are today raises questions about the ancient environment and ancient manatees. Either the coastal climate was warmer than is generally thought, or ice age manatees were more resilient to cooler temperatures than manatees of today.

According to Jackson School Professor David Mohrig, who was not part of the research team, the Texas manatees may have ridden out winters in river outlets, as they do today in Florida and Mexico.

ABOVE: A FLORIDA MANATEE.

PHOTO: ROBERT BONDE/U.S. GEOLOGICAL SURVEY.



Dissecting Hill Slopes

Surface & Hydrologic Processes

A first-of-its-kind study has found that rock weathering and water storage appear to follow a similar pattern across undulating landscapes where hills rise and fall for miles.

The findings are important because they suggest these patterns could improve predictions of wildfire and landslide risk and how droughts will affect the landscape, since weathering and water storage influence how water and nutrients flow throughout landscapes.

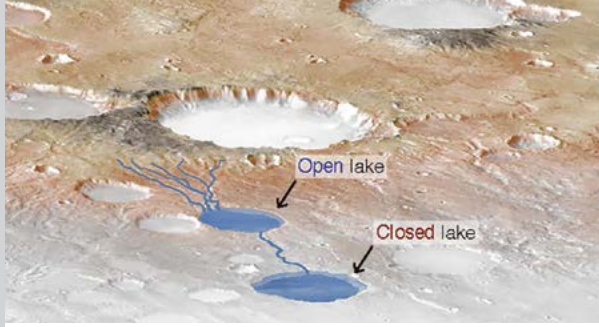
"There's a lot of momentum to do this work right now," said study co-author Daniella Rempe, an assistant professor in the Department of Geological Sciences. "This kind of data, across large scales, is what is needed to inform next-generation models of land-surface processes."

The research was led by Michelle Pedrazas, who conducted the work while earning a master's degree at the Jackson School of Geosciences. It was published in the *Journal of Geophysical Research: Earth Surface*.

Despite the importance of what's happening inside hills, most computer models for simulating landscape behavior don't go deeper than the soil due to a lack of data that can scale to large areas, Rempe said. This study helps fill that knowledge gap, being the first to methodically sample the interiors of a sequence of hill slopes. The research focused on investigating the "critical zone," the near surface layer that includes trees, soils, weathered rock and fractures.

The research site in Northern California is part of a national network of Critical Zone Observatories. The scientists drilled 35 boreholes across a series of hill slopes and their valleys to collect subsurface samples and other data. They also collected a core sample at the peak of each hill slope that captured the entire height of the hill.

ABOVE: A VIEW OF THE BOREHOLE DRILLING RIG FROM ONE OF THE HILLSLOPE RIDGETOPS.



Rainstorms Once Filled Martian Lakes

Planetary Sciences & Geobiology

The ancient climate of Mars is an enigma to scientists. The existence of geologic riverbeds and lake basins paints a picture of a planet with significant rainfall or snowmelt. But computer climate models have been unable to reproduce an ancient climate with liquid water that lasts long enough to account for the observed geology.

A study led by the Jackson School of Geosciences is helping scientists piece together the ancient climate of Mars by revealing how much rainfall and snowmelt filled its lake beds and river valleys 3.5 billion to 4 billion years ago.

The study was published in August 2020 in *Geology* and led by Gaia Stucky de Quay, a postdoctoral fellow at the Jackson School.

The researchers used satellite images and topography to figure out how much water was needed to fill lakes and their watersheds. They found that precipitation must have been between 13 to 520 feet (4 to 159 meters) in a single episode to fill the lakes and, in some cases, provide enough water to overflow and breach the lake basins.

Although the range is large, it can be used to help understand which climate models are accurate.

The next step of the research is to figure out whether the rainfall or snowmelt lasted days, years or thousands of years, Stucky de Quay said.

ABOVE: THE RESEARCH USED DRY MARTIAN LAKE BEDS TO DETERMINE HOW MUCH PRECIPITATION WAS ONCE PRESENT ON THE PLANET.

‘Big Data’ Shrub Census

Climate & Environment

The scraggly creosote shrub dominates the landscape of the American Southwest, creating mini oases from the harsh heat for desert wildlife.

Using computer algorithms and high-resolution survey data, researchers at the Jackson School of Geosciences conducted the first-ever creosote census — counting every creosote plant in a 135-square-mile area of Nevada. The final count was 23 million creosotes among a total population of 66 million plants.

The census revealed new information about the plant species. It also shows how a new data technique can improve on conventional plant counting methods.

The results were published in November 2020 in the journal *Landscape Ecology*.

“This was first and foremost a big data project,” said Jackson School graduate student Jake Gearon, who led the study.

By analyzing the plants en masse, the scientists found that the direction of the slope, or aspect, was the main control on creosote volume — with the plants growing on east-facing slopes being about five times as bushy as plants on west-facing slopes.

“That’s five times more cover on the ground for the critters, for land use, or for understanding just how hot the ground is going to get,” said Gearon. “That has a huge impact.”

They also found that soil age influences creosote volume, with plants in the younger soil being about 27% larger than plants in the oldest.

The census is a milestone for plant science. Most plant population data comes from samples of fewer than 1,000 plants or aerial surveys that capture community snapshots. This research presents a way to account for every individual in a plant community.

“This is the first time I’ve seen something that takes plot level data and really expands it to a landscape scale, to a basin scale,” said Erik Hamerlynck, a research ecologist at the U.S. Department of Agriculture. “That’s just a huge accomplishment.”

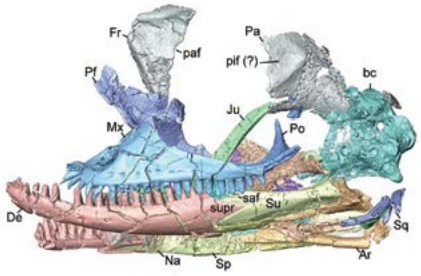
The creosote research is built on repurposed data collected during a 2017 aerial survey of threatened desert tortoise burrows in the Boulder City Conservation Easement in the Mojave Desert.

ABOVE: CREOSOTE PLANTS IN LAS VEGAS VALLEY.

PHOTO: MICHAEL YOUNG.

'Perplexing' Fossil Skull is New Species

Planetary Sciences & Geobiology



While browsing the fossil collections of Yale's Peabody Museum of Natural History in 2017, Simon Scarpetta, a Jackson School of Geosciences graduate student, came across a small lizard skull just under an inch long.

The skull was 52 million years old and beautifully preserved, with a mouth full of curved, sharp teeth.

He took the skull back to the Jackson School for a closer look and ended up discovering a new species, which he dubbed *Kopidosaurus perplexus.*

The first part of the name refers to the lizard's distinct teeth, which resemble a curved kopis blade. The second part is a nod to the perplexing matter of just where the extinct lizard should be placed on the tree of life.

According to an analysis conducted by Scarpetta and published in September 2020 in *Scientific Reports*, the evidence points to several plausible spots.

The spots can be divided into two groups of lizards, representing two general hypotheses of where the new species belongs. How those two groups relate to each other can shift depending on the particular evolutionary tree that's examined.

The case of where exactly to put the perplexing lizard highlights an important lesson for paleontologists: Just because a specimen fits in one place doesn't mean that it won't fit equally well in another.

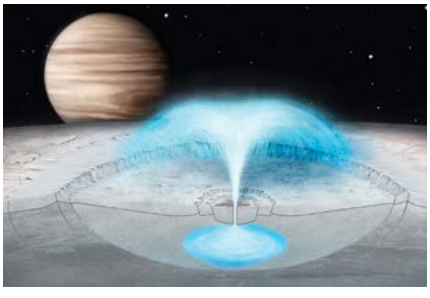
Joshua Lively, a curator at the Utah State University Eastern Prehistoric Museum and Jackson School alumnus, said that embracing this uncertainty can lead to better science.

"Something that I think the broader scientific community should pull from this is that you have to be realistic about your data and acknowledge what we can actually pull from our results and conclude, and where there are still uncertainties," he said.

ABOVE: A CT IMAGE OF THE KOPIDOSAURUS PERPLEXUS SKULL IN LEFT LATERAL VIEW.

Europa's Icy Plumes

Planetary Sciences & Geobiology



The cryovolcanoes of Jupiter's moon Europa are a space spectacle, shooting plumes of ice miles high. Thanks to research from the Jackson School of Geosciences and Stanford University, scientists are learning more about how the plumes originate and whether they could contain elements needed to support life.

"Understanding where these water plumes are coming from is very important for knowing whether future Europa explorers could have a chance to actually detect life from space," said Gregor Steinbrügge, who led the research when he was a postdoctoral researcher at the University of Texas Institute for Geophysics (UTIG) and is now a postdoctoral research fellow at Stanford.

The results were published in November 2020 in *Geophysical Research Letters.*

The researchers modeled how melting and subsequent freezing of an impact crater could cause a cryovolcanic plume. In their model, when a brine pocket at the center of the crater began freezing, it generated pressure that eventually resulted in a plume over a mile high. The eruption left a distinguishing mark: a spider-shaped feature on Europa's surface that was photographed by NASA's spacecraft Galileo.

The study also estimates the saltiness of Europa's frozen surface and ocean, which could affect its transparency to radar waves. The calculations show Europa's ocean may be about one-fifth as salty as Earth's ocean. This information will help calibrate the Europa Clipper mission's radar sounder so it can collect data from Europa's interior.

That radar sounder—called Radar for Europa Assessment and Sounding: Ocean to Near-surface (REASON)—is currently being developed at UTIG.

ABOVE: AN ARTIST'S CONCEPTION OF JUPITER'S ICY MOON EUROPA SHOWING A HYPOTHESIZED CRYOVOLCANIC ERUPTION.

FOSSIL SKULL: SIMON SCARPETTA. EUROPA: JUSTICE BLAINE WAINWRIGHT.

Origins of Gulf's 'Super Basin' Success

Energy Geosciences

The geologic processes that shaped the Gulf of Mexico basin also deposited and preserved vast reserves of oil and gas, of which only a fraction has been extracted.

That's the assessment of researchers at the Jackson School of Geosciences who reviewed decades of geological research and current production figures to understand the secret behind the basin's success.

The research was featured in a December 2020 special volume of the *American Association of Petroleum Geologists Bulletin* focused on the world's super basins: a small number of prolific basins that supply the bulk of the world's oil and gas.

The Gulf of Mexico remains one of the richest petroleum basins in the world despite 60 years of continuous exploration and development, said lead author John Snedden, a senior research scientist at the University of Texas Institute for Geophysics (UTIG). He said that the basin's ability to deliver new hydrocarbon reserves means it will remain a significant resource for Texas and the nation for years to come.

"When we looked at the geologic elements that power a super basin—its reservoirs, source rocks, seals and traps—it turns out that in the Gulf of Mexico, many of those are pretty unique," he said.

According to the paper, the geologic elements that have made the Gulf of Mexico such a formidable petroleum resource include a steady supply of fine- and coarse-grained sediments, and salt.

In fact, the bulk of the northern offshore basin's potential remains in giant, deep-water oil fields beneath the salt blanket.

Snedden said there is still much to learn about hydrocarbons beneath the Gulf of Mexico. This is especially true in the southern Gulf of Mexico, which was closed to international exploration until 2014. One of the few publicly available datasets was a series of UTIG seismic surveys conducted during the 1970s. Now, a wealth of prospects is emerging from new seismic imaging of the southern basin's deep-water region.

Snedden's research is part of the Gulf Basin Depositional Synthesis project, which he directs. The project has been continuously funded by an industry consortium since 1995.

ABOVE: THE SUN LIGHTS UP THE TEXAS AND LOUISIANA COAST.

The Future of Geosciences

Other

As society grapples with big questions on climate, energy, the environment and natural resources, one thing is clear: The world needs geoscientists to help find answers.

A new report, spearheaded by the Jackson School of Geosciences and published by the American Geosciences Institute in March 2021, offers a guide for educating undergraduate geoscience students so they are prepared to tackle these questions and adapt to a rapidly changing field.

The report comes after six years of summits, workshops and surveys that collected input and feedback

Hot or Cold, Weather Has Little Influence on Coronavirus Spread

Climate & Environment

Research led by the Jackson School of Geosciences is adding some clarity on weather's role in COVID-19, with a study finding that temperature and humidity do not play a significant role in coronavirus spread.

That means whether it's hot or cold outside, the transmission of the coronavirus from one person to

PHOTO: NASA.

from more than 1,000 members of the geosciences community, both in academia and industry. The document presents a consensus view on the future needs and approaches for educating future geoscientists.

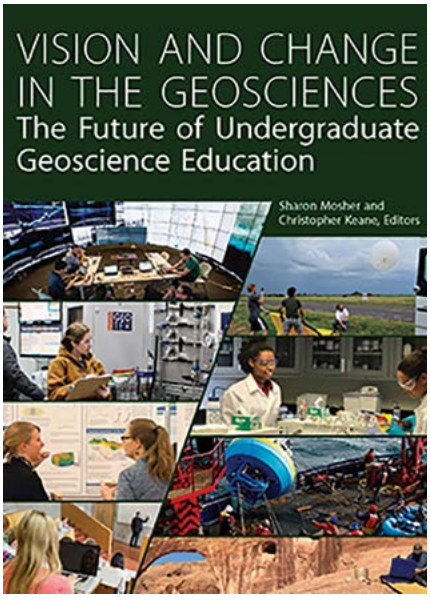
"In this report, the community has come together to address the critical roles academic institutions play in educating the next generation of diverse geoscientists to address societal challenges," said Jackson School Professor Sharon Mosher, who stepped down as Jackson School dean in 2020 after more than a decade at the helm. "I hope this effort enables change in geoscience programs across the broad spectrum of institutions and will be useful to departments that may be facing challenges."

Mosher is the report's principal investigator and the driving force behind the project, hosting summits and workshops on the future of geoscience education. The 13-section report addresses the drivers, needs and strategies for preparing future generations of geoscientists. It covers a wide range of topics in key geoscience concepts, pedagogy and preparing students for future careers. It also confronts challenges in recruitment, increasing diversity and facilitating change in geoscience departments.

A core theme of the report is that the largest challenges facing society have geosciences at their root and that skills inherent to geosciences—such as working with complex systems; temporal and spatial reasoning; and the collection, interpretation and analysis of complex natural data—are among the most crucial approaches to addressing them.

The full text of the report and a free PDF version are available at ***www.americangeosciences.org/change.***

Print copies can be purchased through Amazon.



THE COVER OF THE VISION AND CHANGE REPORT, WHICH WAS RELEASED ON MARCH 3, 2021, AND INCLUDES INPUTS FROM MORE THAN 1,000 GEOSCIENTISTS.

FUTURE OF GEOSCIENCES: AMERICAN GEOSCIENCES INSTITUTE. COVID-19 SPREAD: IAN DOLPHIN.

the next depends almost entirely on human behavior.

The research was published in October 2020 in the *International Journal of Environmental Research and Public Health*.

"The effect of weather is low, and other features such as mobility have more impact than weather," said Jackson School Professor Dev Niyogi, who led the study. "In terms of relative importance, weather is one of the last parameters."

The study defined weather as "equivalent air temperature," which combines temperature and humidity into a single value. The scientists then analyzed how this value tracked with coronavirus spread in different areas from March to July 2020, with their scale ranging from U.S. states and counties, to countries, regions and the world at large.

Across scales, the scientists found that the weather had almost no influence.

When it was compared with other factors using a statistical metric that breaks down the relative contribution of each factor toward a particular outcome, the weather's relative importance at the county scale was less than 3%, with no indication that a specific type of weather promoted spread over another.

Niyogi said that one of the key lessons of the coronavirus pandemic is the importance of analyzing phenomena at the "human scale"—the scale at which humans live their day-to-day lives. He said that this research is an example of this type of perspective.

The study was co-authored by Sajad Jamshidi, a research assistant at Purdue University, and Maryam Baniasad, a doctoral candidate at Ohio State University.

THE WEATHER HAS LITTLE INFLUENCE ON COVID-19 SPREAD, ACCORDING TO RESEARCH LED BY UT.

Dust Confirms Mass Dino Killer

Planetary Sciences & Geobiology

Researchers believe they have closed the case of what killed the dinosaurs, definitively linking their extinction with an asteroid that slammed into Earth 66 million years ago by finding a key piece of evidence: asteroid dust inside the impact crater.

Death by asteroid rather than by a series of volcanic eruptions or some other global calamity has been the leading hypothesis since the 1980s, when scientists found asteroid dust in the geologic layer that marks the extinction of the dinosaurs. This discovery painted an apocalyptic picture of dust from the vaporized asteroid and rocks from impact circling the planet, blocking out the sun and bringing about mass death through a dark, sustained global winter—all before drifting back to Earth to form the layer enriched in asteroid material that's visible today.

In the 1990s, the connection was strengthened with the discovery of the 125-mile-wide Chicxulub impact crater beneath the Gulf of Mexico that is the same age as the rock layer. The new study seals the deal, researchers said, by finding asteroid dust with a matching chemical fingerprint within that crater at the precise geological location that marks the time of the extinction.

The study, which was published in *Science Advances* in February 2021, is the latest to come from a 2016 International Ocean Discovery Program mission co-led by the Jackson School of Geosciences that collected nearly 3,000 feet of rock core from the crater buried under the seafloor. Research from this mission has helped fill in gaps about the impact, the aftermath and the recovery of life.

The telltale sign of asteroid dust is the element iridium—which is rare in Earth's crust but present at elevated levels in certain types of asteroids. An iridium spike in the geologic layer found all over the world is how the asteroid hypothesis was born. In the new study, researchers found a similar spike in a section of rock pulled from the crater. In the crater, the sediment layer deposited in the days to years after the strike is so thick that scientists were able to precisely date the dust to a mere two decades after impact.

"We are now at the level of coincidence that geologically doesn't happen without causation," said co-author Sean Gulick, a Jackson School research professor who co-led the 2016 expedition. "It puts to bed any doubts that the iridium anomaly [in the geologic layer] is not related to the Chicxulub crater."

ABOVE: DUST FROM THE ASTEROID IMPACT WAS BLOWN INTO THE ATMOSPHERE WHERE IT BLOCKED OUT THE SUN AND LED TO THE EXTINCTION OF 75% OF LIFE, INCLUDING ALL NON-AVIAN DINOSAURS.

Protecting Texas — Searching for Sand

Marine Geosciences

Scientists at the Jackson School of Geosciences embarked from Galveston, Texas, in April 2021 in search of sunken treasure that holds the key to protecting Texas from storms and rising seas: sand.

About 80% of Texas' Gulf shoreline is critically eroded, and the state is running out of easily accessible sand to rebuild and protect the shore, as the Texas General Land Office (GLO) has done for decades through its Coastal Erosion Planning and Response Act (CEPRA) Program.

"That's where we come in," said John Goff, a coastal geophysicist at the University of Texas Institute for Geophysics (UTIG), whose group is helping CEPRA locate the sand needed to restore and reinforce the state's beleaguered beaches and build a formal sand inventory for Texas.

The Texas General Land Office's beach restoration projects have, for years, protected coastal communities, industries and ecosystems—quite literally—from the rising tide, but

DINO KILLER: WILLGARD KRAUSE FROM PIXABAY. PROTECTING TEXAS: GENERAL LAND OFFICE.

those projects are becoming more difficult as high-quality sand is becoming scarce.

Goff and a team of UTIG scientists aboard the Tommy Munro research vessel began their search for sunken sand deposits in sand-filled remnants of rivers that flowed into the Gulf of Mexico when sea levels were much lower than they are today. Those ancient rivers and estuaries hold seams of easy to reach sand-ore, vital for the GLO's coastal planning efforts. To both CEPRA and the UTIG scientists, the seams are also vital clues in deciphering what happened to the ancient coastline when sea levels began to rise.

"From a scientific standpoint, we're looking back in time 8,000 years to understand how the shoreline and this whole estuarine system responded," Goff said.

Ongoing sea level rise is a problem because it worsens coastal erosion and allows storms to do more damage. During the 2020 tropical storm season, storm systems lingered in the Gulf of Mexico for days, causing extraordinarily high tides that ate away at the shoreline of the entire Texas coast, damaging infrastructure relied on by tourism, residents, fishing and industry, including evacuation routes.

To help locate the millions of cubic yards of sand the engineers need to restore and reinforce the state's beaches, Goff and his team will create a high-resolution seismic map of the ancient Trinity River Valley and examine core samples from within the sand deposits. This will help the researchers estimate the volume and quality of the sand and predict the location of other offshore deposits. The team will follow up with similar surveys of the sunken Sabine and Brazos river valleys.

OPPOSITE PAGE: DESPITE SUFFERING DAMAGE AFTER HURRICANE LAURA IN 2020, THE RESTORED SAND DUNES AT MCFADDIN NATIONAL WILDLIFE REFUGE REMAINED INTACT AND ALLOWED THE BEACH ECOSYSTEM TO RECOVER AFTER THE STORM.

PHOTO: CALIFORNIA DEPARTMENT OF WATER RESOURCES.

LAKE OROVILLE, THE SECOND LARGEST HUMAN-MADE LAKE IN CALIFORNIA.

Climate Extremes Threaten California's Water

Climate & Environment

Climate change is making water management more difficult in California, according to a study led by the Jackson School of Geosciences in collaboration with the Union of Concerned Scientists.

The study found that climate change will shift the timing and intensity of rainfall and the health of the state's snowpack in ways that will make water management more difficult during the coming decades.

"If you think about the type of shifts that matter to water managers, it's typically these much more complicated aspects of the hydroclimate like how long the wet season is or how extreme the most extreme event is or how frequent high-risk events are," said lead author Geeta Persad, an assistant professor at the Jackson School.

The study was published in October 2020 in the journal *Climatic Change*. It focuses on 10 global climate models that have been identified to have the best performance at representing climate conditions in California and are already widely used in state decision-making.

In the paper, the scientists illustrated the effects on water supply during the next several decades in two case studies—Scott Valley in Northern California and Lake Oroville, which is about 80 miles north of Sacramento.

The team found that changes in extreme precipitation events caused a significant increase in the need for irrigation water throughout the Scott Valley, even when the overall total rainfall remained constant. In the case of Lake Oroville, the average water stored in the reservoir declined about 17% during the year, with losses greatest in September and October when the reservoir is at its lowest levels.

Although the study examined only California's water supply, the researchers said that similar analysis is worth pursuing in other regions with emerging water management challenges.

The study has been released in conjunction with a report from the Union of Concerned Scientists, where Persad previously held an appointment as a senior climate scientist.

‘Knickpoints’ Could Stall Glacial Thinning

Surface & Hydrologic Processes

The jagged terrain of Greenland’s mountains is protecting some of the island’s outlet glaciers from warm coastal waters, according to a team of researchers that included scientists from the Jackson School of Geosciences and NASA.

The scientists found that steep slopes in the bedrock under the ice form stabilizing areas the researchers termed knickpoints that prevent coastal thinning from reaching further inland.

The research was led by Denis Felikson, a NASA research scientist who started the work while earning a doctoral degree at the Jackson School. The results were published in December 2020 in *Geophysical Research Letters*.

Jackson School Professor Ginny Catania, a co-author, said that the research helps explain variability in glacier thinning observed by scientists.

“Some glaciers are thinning right next to others that are thickening,” she said. “Denis’ research has provided a framework for that understanding, and it’s very likely that all of the variability we observe in outlet glaciers is linked to variability in the bed topography between glaciers.”

The research shows that glacial knickpoints are surprisingly prevalent. Although that might be good news, the research also revealed vulnerability in northwest Greenland, an overlooked region of the ice sheet.

The scientists said that investigations of the bedrock near the coast is urgently required to learn how effective knickpoints are at holding back coastal warming, as is investigation of unprotected glaciers.

Catania and Felikson have already proposed an early warning system that will use machine learning to watch for instability in glaciers identified by the knickpoint analysis.

ABOVE: LEIGH STEARNS, A RESEARCHER AT THE UNIVERSITY OF KANSAS, ADJUSTS A TIME LAPSE CAMERA MONITORING THE FRONT OF KANGILLIUP SERMIA (ALSO KNOWN AS RINK ISBRAE), AN OUTLET GLACIER IN GREENLAND.

PHOTO: TIM BARTHOLOMAUS.

Texas Earthquake System Strengthens National Network

Solid Earth & Tectonic Processes

Now in its fifth year of operation, the Bureau of Economic Geology’s TexNet earthquake monitoring system manages more than 150 seismic stations throughout Texas and has been integrated into the country’s national monitoring system operated by the U.S. Geological Survey (USGS).

TexNet helps fill a major coverage hole in the national system, which had sparse coverage of the state. It is now part of the Advanced National Seismic System (ANSS), a network that provides real-time information about seismic activity to researchers and emergency responders.

The addition was made possible by TexNet reaching several milestones. These include establishing 24/7 operations at all monitoring locations, having a seismologist on duty around the clock, and creating a backup infrastructure hub to ensure the system will continue operating if the primary hub fails.

“We welcome this new partnership with TexNet, which has successfully demonstrated its ability to meet high ANSS monitoring standards,” said USGS acting Director David Applegate. “TexNet earthquake solutions will become the authoritative source for the state of Texas on the ***earthquakes.usgs.gov webpage***, which provides timely and accurate earthquake information to millions of users each month.”

TexNet was approved for state funding in 2015 to help determine what was causing an increase in

seismic activity in parts of the state. The network distributes earthquake information in less than 20 minutes from the time of occurrence for all events with magnitude of 3.0 or greater. The information is posted on the publicly available TexNet Earthquake Catalog ***(beg.utexas.edu/texnet-cisr/texnet/earthquake-catalog)*** and now the USGS ComCat catalog ***(earthquake.usgs.gov/earthquakes/map)***.

Before TexNet, only 18 public seismic monitors existed throughout the state. Now, there are more than 150, with a particular focus on areas exhibiting an uptick in seismicity. "TexNet is providing critical data and unbiased research to help guide industry and decision makers and make the investigation of seismic data and earthquake activity accessible for all," said Scott Tinker, the state geologist of Texas and bureau director.

The Railroad Commission of Texas, the state's oil and gas regulator, uses information from TexNet to understand, regulate and mitigate seismic hazards. The system's data and expertise are also used by other state, federal and local agencies as well as academic and research institutions throughout the world.

TexNet Manager Alexandros Savvaidis said plans include adding more stations in the Permian Basin area and the Eagle Ford Shale, more automation to decrease the time between a seismic event and when the information is posted, and to better illustrate when seismicity is occurring in clusters and how it is shifting across the state.

ABOVE: ASSISTANT PROFESSOR DANIELLA REMPE (IN WHITE HAT) AND COLLEAGUES INSTALL SPECIALIZED SAMPLING PORTS FOR COLLECTING WATER AND GASES IN FRACTURED ROCK.

PHOTO: WILLIAM E. DIETRICH.

Fractured Bedrock Overlooked Source of CO_2

Climate & Environment

The prevailing view of soil as the source of natural carbon dioxide emitted by landscapes could just be scratching the surface.

According to a study published in December 2020 in *JGR Biogeosciences*, CO_2 produced in bedrock fractures could account for up to 29% of CO_2 emitted by the land, depending on the season.

This finding does not mean that landscapes are emitting more CO_2 into the atmosphere than previously thought, but it does challenge the conventional wisdom about where greenhouse gas is being produced.

"This is paradigm shifting in terms of where the action is," said Daniella Rempe, an assistant professor at the Jackson School of Geosciences who co-authored the study. "Soils may not be the only key player in forests."

The study linked CO_2 production in the rock to the seasonal uptake of water by trees, a finding that suggests that trees rooting into bedrock and the microbial communities around them are the source of the CO_2.

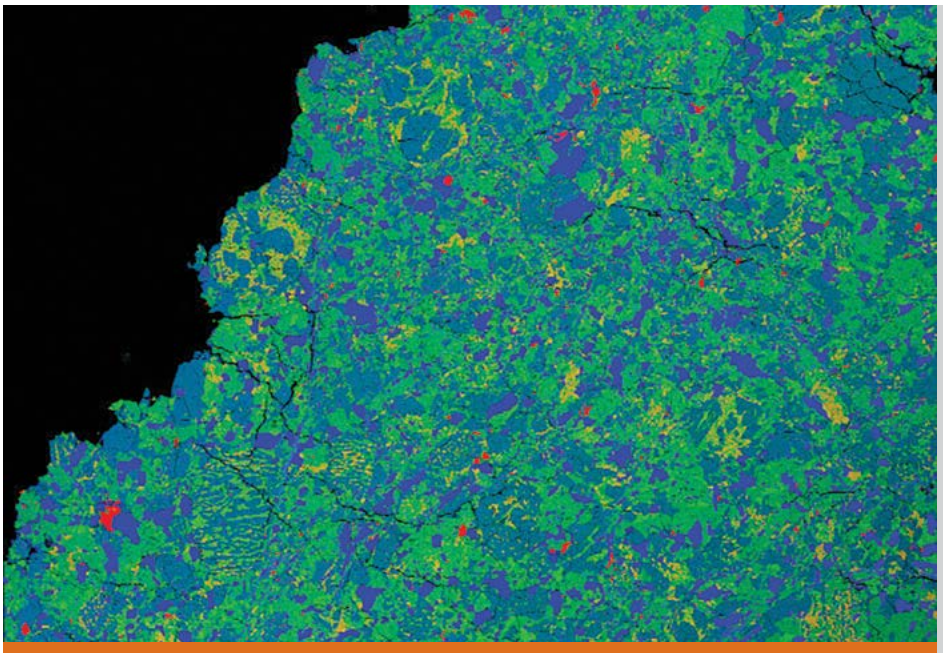
Jackson School graduate student Alison Tune led the research.

This study builds on a growing body of knowledge showing fractured bedrock as an ecologically important region.

The researchers are planning on investigating fractured bedrock in other places, including a local research site at the Jackson School's White Family Outdoor Learning Center, a 266-acre site in Dripping Springs, Texas.

"Fractured bedrock is really common in Texas, where the soil is really thin and there's lots of deep rooting," Tune said. "It could be an important part of the carbon cycle in these ecosystems, and it could be important to understand that as we go forward and as the climate changes over time."

Jackson School Professor Philip Bennett also co-authored the study, along with contributors at other institutions.



AN ELEMENTAL X-RAY MAP OF A PORTION OF THE PEEKSKILL METEORITE. DIFFERENT COLORS CORRESPOND TO DIFFERENT ELEMENTS.

Playing 'Asteroids' in the Early Solar System

Planetary Sciences & Geobiology

A new analysis of asteroid remnants, including a 30-pound meteorite that smashed into a parked car in Peekskill, New York, in 1992, shows that contrary to prevailing thought, the young solar system was a violent, chaotic place.

Researchers at the Jackson School of Geosciences and The University of Tennessee, Knoxville, measured how the rocks cooled from very high temperatures, up to 1,400 degrees Celsius. Previous studies had only measured cooling rates from temperatures near about 500 degrees Celsius.

The study was published in December 2020 in the journal *Geochimica et Cosmochimica Acta*.

The research began when co-author Nick Dygert was a postdoctoral fellow at the Jackson School. Dygert was using a scientific method—called a rare earth element (REE)-in-two-pyroxene thermometer—to study terrestrial rocks when he realized it could work for space rocks too.

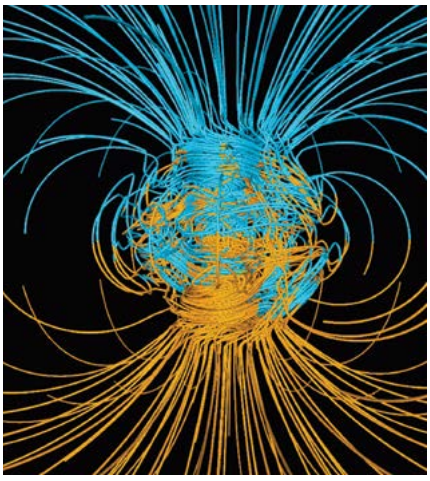
"This is a really powerful new technique for using geochemistry to understand geophysical processes, and no one had used it to measure meteorites yet," said Dygert, who is now an assistant professor at the University of Tennessee.

The results led the scientist to propose that asteroids formed in stages. If the early solar system was much like the old Atari game "Asteroids," rife with bombardment, large rocks would have been smashed to bits. Those smaller pieces would have cooled quickly. Afterward, when the small pieces reassembled into larger asteroids we see today, cooling rates would have slowed.

The biggest implication of the new study, Dygert said, is that these collisions characterized the early days of the solar system.

"They were violent and they started early on," he said.

The research was supported by NASA. The Smithsonian National Museum of Natural History supplied samples of meteorites for the study.



Age of Earth's Inner Core Revised

Planetary Sciences & Geobiology

By creating conditions akin to the center of the Earth inside a laboratory chamber, researchers have improved the estimate of the age of our planet's solid inner core, putting it at 1 billion to 1.3 billion years old.

The results place the core at the younger end of an age spectrum that usually runs from about 1.3 billion to 4.5 billion years, but they also make it a good bit older than a recent estimate of only 565 million years.

The experiments and accompanying theories help pin down the magnitude of how the core conducts heat and the energy sources that power the planet's geodynamo—the mechanism that sustains the Earth's magnetic field.

"People are really curious and excited about knowing about the origin of the geodynamo, the strength of the magnetic field, because they all contribute to a planet's habitability," said Jung-Fu Lin, a professor at the Jackson School of Geosciences who led the research.

ABOVE: A COMPUTER SIMULATION OF THE EARTH'S MAGNETIC FIELD, WHICH IS GENERATED BY HEAT TRANSFER IN THE EARTH'S CORE.

PLAYING ASTEROIDS: MICHAEL LUCAS. EARTH'S INNER CORE: NASA/GARY A. GLATZMAIER.

The results were published in August 2020 in the journal *Physical Review Letters*.

The Earth's core is made mostly of iron, with the inner core being solid and the outer core being liquid. The effectiveness of the iron in transferring heat through conduction —known as thermal conductivity—is key to determining other attributes about the core, including when the inner core formed.

Over the years, estimates for core age and conductivity have gone from very old and relatively low, to very young and relatively high. But these younger estimates have also created a paradox, where the core would have had to reach unrealistically high temperatures to maintain the geodynamo for billions of years before the formation of the inner core.

The new research solves that paradox by finding a solution that keeps the temperature of the core within realistic parameters. The work involved measuring the conductivity of iron under core-like conditions where pressure is greater than 1 million atmospheres and temperatures can rival those found on the surface of the sun.

The newly measured conductivity is 30% to 50% less than the conductivity of the young core estimate, and it suggests that the geodynamo was maintained by two different energy sources and mechanisms: thermal convection and compositional convection.

PHOTO: CAROL M. HIGHSMITH.

ABOVE: THE ENERGY INFRASTRUCTURE ALONG THE GULF COAST OFFERS OPPORTUNITIES TO CAPTURE AND TRANSPORT CO_2 FOR STORAGE.

Gulf Coast Carbon Hub

Climate and Environment

The stage is set for a new carbon storage economy to emerge along the Gulf Coast, according to a study led by the Bureau of Economic Geology, with the region offering ample opportunities to capture and store carbon.

Carbon capture and storage, or CCS, is a technology that keeps CO_2 out of the atmosphere by capturing emissions and storing them deep underground. It can help fight climate change by lowering industrial emissions now while renewable energy sources are being developed, said the study's lead author, Tip Meckel, a senior research scientist at the bureau's Gulf Coast Carbon Center.

"This is a viable way to reduce emissions in the near term," Meckel said. "It's feasible and has a reasonable economic structure that can support, retain and create jobs."

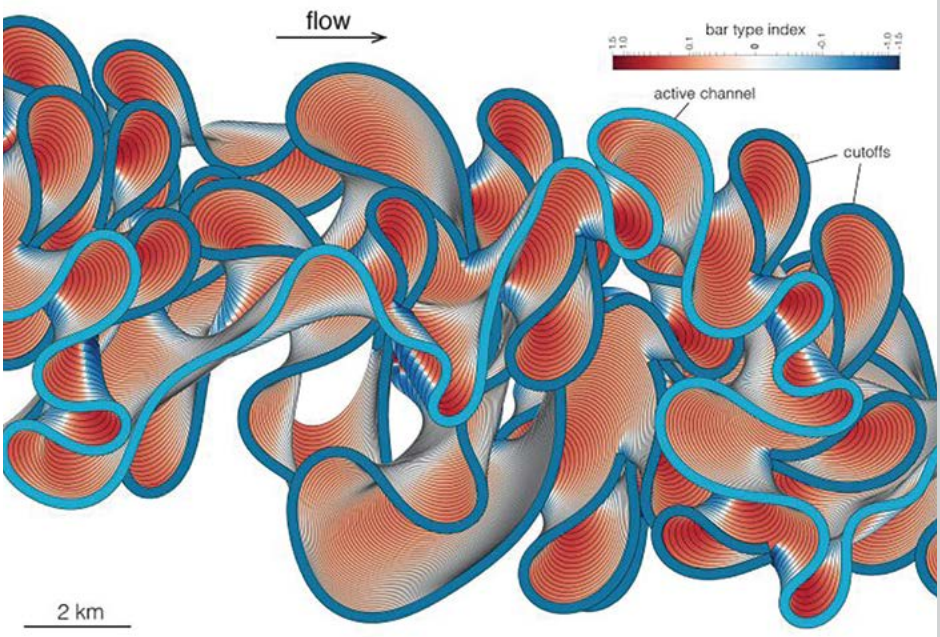
The study, which was published in May 2021 in *Greenhouse Gases: Science and Technology*, provides a high-level overview of policy incentives for CCS and how Texas and Louisiana's high concentration of industry and unique offshore geology make the region a particularly good spot to build up a carbon storage economy.

In the past, oil and gas companies primarily used CCS for enhanced oil recovery, which allows companies to get more oil out of depleted reservoirs by pumping in CO_2. Enhanced oil recovery has been in use for decades and has produced an existing network of pipelines for transporting CO_2 along the Gulf Coast.

However, the study shows that falling oil and gas prices and an increasing 45Q federal tax credit, which offsets tax liability for industries to different degrees depending on how the CO_2 is stored, is making carbon storage for its own sake more attractive.

While the geology and infrastructure of the Gulf Coast is a winning combination for boosting a carbon storage economy, the study said that another important fact is simply the amount of CO_2 produced in the region. Texas has the highest level of emissions of any state. Louisiana is second.

Capture and storage offers a way to stop a portion of those emissions right at the source, Meckel said. By doing that, the technology can help flatten CO_2 emissions as lower-carbon energy alternatives mature in the market.



Creating Counterpoints

Surface and Hydrologic Processes

It's not uncommon for crescent-shaped swaths of sand to dot the shorelines of meandering rivers. These swaths usually appear along the inner side of a river bend, where the bank wraps around the sandy patch, forming deposits known as point bars. When they appear along an outer bank, which curves the opposite way, they form counter-point bars, which are usually interpreted by geoscientists as an anomaly: a sign that something—such as a patch of erosion-resistant rocks—is interfering with the river's usual manner of sediment deposition.

But according to research led by the Jackson School of Geosciences, counter-point bars are not the oddities they're often made out to be. In fact, they're a perfectly normal part of the meandering process.

"You don't need a resistant substrate. You can get beautiful [counter-point] bars without it," said Zoltan Sylvester, a research scientist at the Bureau of Economic Geology who led the study.

The finding suggests that counter-point bars—and the unique geology and ecology associated with them—are more common than previously thought. Building awareness around that fact can help geoscientists be on the lookout for counter-point bars in geological formations deposited by rivers in the past and understand how they may be influencing the flow of hydrocarbons and water passing through them.

The research was published in the *Geological Society of America Bulletin* in March 2021. This is not the first time that Sylvester's research has revealed that river behavior can be governed by relatively simple rules. In 2019, he led a study published in *Geology* that described a direct relationship between bend sharpness and river migration.

ABOVE: A COMPUTER GENERATED GRAPHIC OF A RIVER'S MEANDERING PATH (IN BLUE) AND ASSOCIATED SEDIMENT DEPOSITS (RED).

Overcoming Hydrogen Hurdles

Energy Geosciences

The U.S. is counting on hydrogen to play a significant role in the low-carbon economy of the future, but fundamental questions about transportation, storage and cost need to be addressed in order to integrate hydrogen gas into the nation's existing infrastructure, according to a preliminary study from a new research program at the Bureau of Economic Geology.

That's because although hydrogen gas burns carbon free, it gives only about a third of the energy of natural gas per unit volume. That means the U.S. will need to make and store much more of it for heating, transportation, power generation and industrial uses.

The research offers a framework for solving these issues, presenting

ABOVE: HYDROGEN TANKS AT THE NATIONAL RENEWABLE ENERGY LABORATORY (NREL).

COUNTERPOINTS: SYLVESTER ET AL. HYDROGEN: WERNER SLOCUM / NREL.

an initial goal of replacing 10% of the nation's natural gas supply with hydrogen as a reasonable first target. That move could reduce U.S. greenhouse gases by 3.2%, based on 2019 emissions, and help meet the Department of Energy's goal of enabling a low-carbon economy in the U.S.

The analysis considers what it would take to scale up the use of hydrogen, including integrating hydrogen into the country's natural gas system, which is probably the most robust in the world, said lead author Mark Shuster, associate director of energy at the bureau.

"We know how to move gas. We're very experienced in it, particularly in the U.S., so it makes sense," he said. "You have a whole suite of potential uses for the hydrogen, but it's going to take some work, some research, and I think it's going to take probably some targeted incentives."

The paper, authored by scientists and economists at the bureau, was published in the *Oil & Gas Journal*.

Hydrogen can lean heavily on geologic storage instead of tanks or batteries, researchers said, with the gas stored in suitable underground formations and moved via pipeline. There are currently three such geologic storage locations in the country being used for hydrogen and many more for natural gas. The UT team pinpointed other potential storage areas across the country.

Most hydrogen is produced from natural gas. To help bridge the gap until low-carbon production technology can catch up, the study recommends ramping up hydrogen production using natural gas with carbon capture and storage technology, which keeps carbon out of the atmosphere by piping it underground into geologic formations.

"We can utilize natural gas right now, if you're prepared to move forward with carbon capture and storage, and give the electrolysis and related technologies a chance to catch up and become more economically viable," Shuster said.

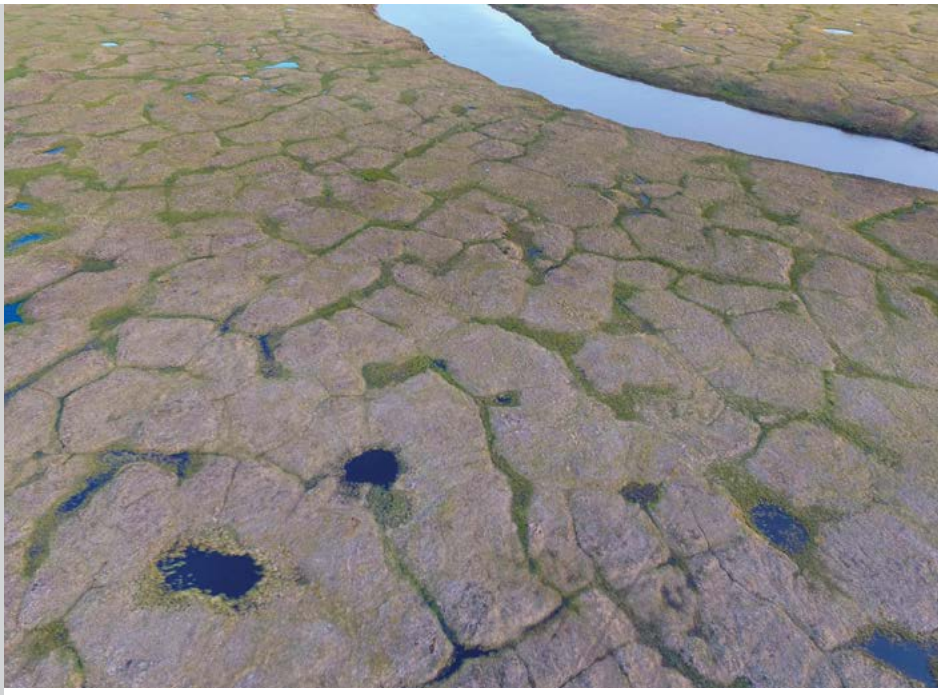


PHOTO: NATHAN SONDERMAN.

Alaska's Rapidly Thawing Coastal Permafrost

Climate & Environment

Scientists have long believed that permafrost in cold climates doesn't just stop where it meets the sea: It should extend from the tundra to below the seafloor.

However, research led by Micaela Pedrazas, who earned a master's degree at the Jackson School of Geosciences working with Professor Bayani Cardenas, has upended that paradigm. They found permafrost to be mostly absent throughout the shallow seafloor along a coastal site in northeastern Alaska. That means vast amounts of carbon can be released from coastline sources much more easily than previously thought.

The study was published in *Science Advances* in October 2020.

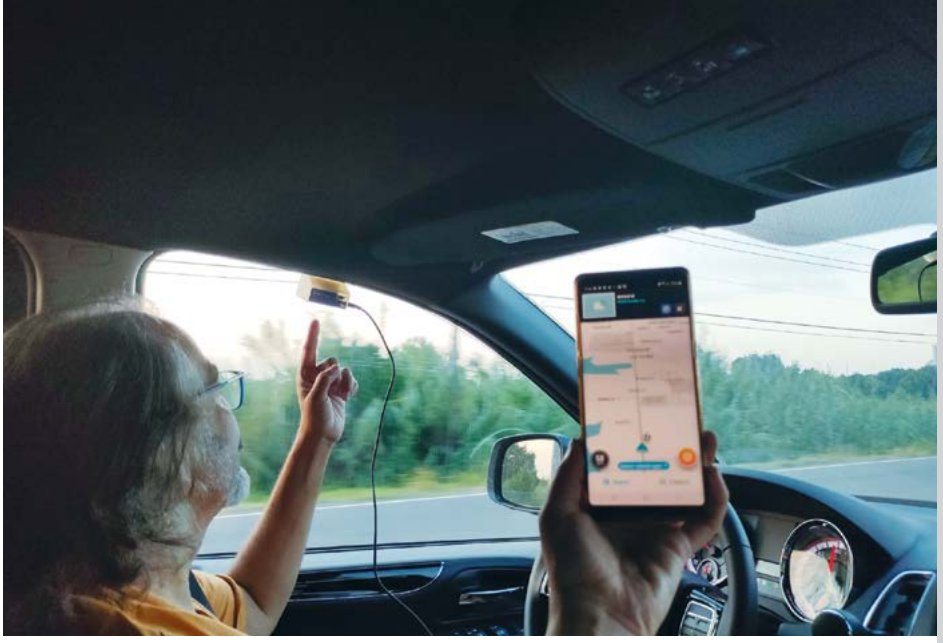
The researchers examined the subsurface beneath Alaska's Kaktovik Lagoon. Their results were unexpected. The beach and seafloor were entirely ice-free down to at least 65 feet. On the tundra, ice-rich permafrost stopped just below 16 feet.

As permafrost melts, it releases stores of methane and carbon dioxide into the atmosphere, contributing to climate change. The melting permafrost also has local impacts for Indigenous communities along the coast. As the permafrost thaws, it accelerates coastal erosion, which carves away at the land on which homes and infrastructure stand. In the Kaktovik region, erosion can be as great as 13 feet per year.

"Their cultural heritage and their welfare are integrated and intricately linked to their environment," Cardenas said. "There's an immediate need to understand what's happening in these lagoons."

The Kaktovik Inupiat Corporation and the U.S. Fish and Wildlife Service provided permissions and support for the research.

ABOVE: AN AERIAL VIEW OF ICE WEDGE POLYGONS NEXT TO KAKTOVIK LAGOON. THE POLYGONS ARE SIGNS OF PERMAFROST.



Mapping Austin Heat

Climate and Environment

Austin has hot summers. But that heat isn't felt the same way across the city, as anyone who has sweltered in a parking lot or cooled off beneath a tree knows.

The University of Texas at Austin is partnering with the City of Austin, community groups and East Austin residents to find out where hot temperatures are affecting people the most—and proposing solutions to cool down these places.

UT is one of four institutions selected by the National Oceanic and Atmospheric Administration to lead research projects focused on combating extreme heat in urban environments.

"This helps business and communities, and it is helping students to develop a purpose for their research," said project lead Dev Niyogi, a professor at the Jackson School of Geosciences and the Cockrell School of Engineering. "They are not simply trying to develop an analysis or a plot. It's a project where what we do means a better life for someone, if we do this right."

The two-year project builds on an Austin heat map created by the CAPA Heat Watch program last year and has three main goals: creating dynamic heat maps that depict how people experience the heat alongside actual temperature measurements; using those maps to develop strategies to cool down temperature hot spots; and, finally, presenting the data and potential solutions to community members and city decision makers.

The temperature map will include the entire city, but the project team will focus on collecting public input and making improvements in East Austin, where residents encounter hot spots more frequently.

To make sure temperature readings and community experiences are aligned, the project team will incorporate resident input from the very beginning, engaging in discussions about temperature hot spots in their communities and receiving feedback on temperature maps.

There are a number of ways to reduce heat in specific areas, from adding greenery to installing light-colored pavement. To make sure any proposed solutions hold up over time, the researchers will investigate how potential improvements will affect local temperatures in coming decades.

ABOVE, LEFT: PROFESSOR DEV NIYOGI COLLECTING TEMPERATURE DATA DURING LAST YEAR'S SAMPLING CAMPAIGN.
LEFT: A MAP OF AFTERNOON TEMPERATURES COLLECTED IN AUSTIN IN AUGUST 2020 AS PART OF THE CAPA HEAT WATCH PROGRAM. BLUE DENOTES THE COOLEST TEMPERATURES. RED DENOTES THE HOTTEST TEMPERATURES.

Hunting Hurricane Tracks in Louisiana

Marine Geosciences

Thanks to the Jackson School of Geosciences Rapid Response program, scientists arrived on the Louisiana coast in February 2021 to investigate how Hurricane Delta and Hurricane Laura affected Calcasieu Lake (locally called Big Lake).

Cornel Olariu, a research scientist at the Department of Geological Sciences, led the team, which included Research Professor Sean Gulick and engineering scientists Dan Duncan and Steffen Saustrup, both at the University of Texas Institute for Geophysics (UTIG).

ABOVE: RESEARCHERS DEPLOY A SEISMIC IMAGING DEVICE KNOWN AS A CHIRP AT CALCASIEU LAKE, LOUISIANA.

MAPPING AUSTIN HEAT: DEV NIYOGI/UT. HEAT MAP: CAPA STRATEGIES. HUNTING HURRICANE: SEAN GULICK.

Coastal lagoons such as Calcasieu Lake are a powerful defense against storms because they regulate the flow of river water and sediments, which helps stabilize the coastline. But when the hurricanes approached the U.S. coast, they caused the river to swell with rain and fill the lagoon. The hurricanes also drowned the lake with storm surge that inundated barrier islands.

The goal of the Rapid Response mission was to find out whether the storm's approach, arrival and departure left their marks in sediments left behind on the lakebed. The scientists also looked for microplastics that they think were dumped at the bottom of the lake by floodwater flowing in from the surrounding region as the storm carved its way inland.

Insights from their research will be important for identifying older hurricane deposits and understanding the wider environmental impact of coastal storms.

The team spent five days gathering cores from the lakebed and seismically mapping its subsurface aboard UTIG's research vessel, the R/V Scott Petty. Initial results showed how Hurricanes Laura and Delta carved scours through the lakebed hundreds of feet wide and churned up the normally flat layered sediments 5 to 6 feet down. The depth means that signs of Hurricane Rita's passing in 2005 probably overlap those of Laura and Delta in 2020.

The scientists are continuing their analysis of the cores and seismic images to confirm the findings and look for signs of even older storms in deeper layers of the lakebed.

PHOTO: SEAN GULICK.

ABOVE: BRANDON SHUCK (BLACK CAP) AND UTIG RESEARCHERS ON A 2018 OCEAN SURVEY NEAR NEW ZEALAND'S SOUTH ISLAND. DATA FROM THE CRUISE HELPED SHUCK PIECE TOGETHER HOW SUBDUCTION BEGINS.

Starting Subduction

Solid Earth & Tectonic Processes

Subduction zones are cornerstone components of plate tectonics, with one plate sliding beneath another back into Earth's mantle. But the very beginning of this process—subduction initiation—remains mysterious to scientists because most of the geological record of subduction is buried and overwritten by the extreme forces at play.

The only way to understand how subduction zones get started is to look at young examples on Earth. By using a combination of seismic imaging techniques, Brandon Shuck, a doctoral candidate at the Jackson School of Geosciences, did just that, leading research that helped create a detailed picture of the Puysegur Trench off the southwestern coast of New Zealand.

"This location in the south of New Zealand is one of the best places in the world to study how new subduction zones form because it's actively undergoing that transition, so we can capture how it's acting today and how it came to be in the past," Shuck said.

The results were published in *Tectonics* in April 2021. The study's co-authors include the Jackson School of Geosciences' Sean Gulick, Harm Van Avendonk, Steffen Saustrup and Thomas Hess.

At the Puysegur Trench, the Pacific plate to the east overrides the Australian plate to the west. The area is extremely tectonically active and has shifted regimes several times in the past 45 million years, transitioning from rifting to strike-slip to incipient subduction. The trench's well-preserved geological history makes it an ideal location to study how subduction starts.

The researchers contend that the differences in lithospheric density combined with existing weaknesses along the strike-slip boundary from the previous tectonic phases facilitated subduction initiation. The team concludes that strike-slip might be a key driver of subduction zone initiation because of its ability to efficiently bring together sections of heterogeneous lithosphere along plate boundaries.

This article is adapted from a piece originally published in EOS.

UTIG RESEARCHERS BHARGAV BODDUPALLI (LEFT) AND SHUOSHUO HAN (ALSO CO-CHIEF) DISCUSSING NAVIGATION CHARTS ABOARD THE R/V MARCUS LANGSETH.

Scientific Cruise Investigates Cascadia's Sleeping Fault

Solid Earth & Tectonic Processes

Late in the evening of Jan. 26, 1700, a mighty earthquake shook the northwest Pacific Ocean, unleashing a tsunami that wiped out coastal Native American and First Nations communities. The event was seared in the oral traditions of the few who survived. The fault that produced the earthquake—the Cascadia subduction zone—has remained silent ever since.

In June 2021, scientists went to the site of the earthquake aboard the R/V Marcus Langseth on a 41-day mission to image the fault and investigate how it might break in the future.

Co-led by Shuoshuo Han, a research associate at the University of Texas Institute for Geophysics (UTIG), the cruise sailed up and down the fault towing an 8-mile-long seismic antenna while additional sensors listened from the ocean floor and on land. Together, the instruments created the most detailed images yet of the subduction zone and the surrounding earth.

The power, speed and direction of an earthquake depends on the size of the fault, the stiffness of the plates, and the presence of smaller surrounding faults that might send the earthquake's energy upward, creating a whiplash motion in the earth that triggers a tsunami.

Those variables are what the scientists hope to uncover with the cruise's data.

"We cannot yet predict when the next big one will happen, but we can learn about the kind of earthquakes and tsunamis this margin produces and how we should prepare," said Han, who first visited the fault in 2012 on a preliminary survey as a graduate student.

Han was joined at sea by UTIG postdoctoral fellow Bhargav Boddupalli, who was part of the team that deployed the oceangoing instruments and helped process the data as it streamed in. According to Han, the preliminary data showed, for the first time, the full structure and shape of the fault. The next task is to analyze everything they have learned about the fault and the earthquakes and tsunamis it might generate.

The cruise was led by Columbia University's Lamont-Doherty Earth Observatory and included scientists from National Oceanic and Atmospheric Administration, Scripps Institution of Oceanography, University of California at San Diego, Woods Hole Oceanographic Institution, University of Washington, and Oregon State University.

Researchers Promote Innovative Hydrogen Science

Energy Geosciences

Researchers at The University of Texas at Austin pushed an innovative combination of in-situ combustion and carbon dioxide storage to turn untapped oil into clean hydrogen energy. Researcher Ian Duncan, who leads the Earth Systems and Environment group at the Bureau of Economic Geology, discussed the method at the U.S. Department of Energy's Hydrogen Shot kickoff symposium on Aug. 31 and Sept. 1, 2021.

"Our aim is to produce relatively cheap hydrogen while sequestering CO_2 elsewhere in the reservoir," Duncan said. "This would produce carbon-free hydrogen from an energy source that otherwise would remain unused."

U.S. Secretary of Energy Jennifer M. Granholm announced Hydrogen Shot in June as the first of the DOE's Energy Earthshots Initiative. The program's goal is to reduce the cost of clean hydrogen by 80% to $1 per kilogram in one decade. This is part of the DOE's plan to accelerate the development of abundant, affordable and reliable clean energy within the decade. Achieving this will help reach the goal of net-zero carbon emissions in the United States by 2050.

Duncan's research is part of the State of Texas Advanced Resource Recovery (STARR) program's work to mitigate the impact of the coming energy transition on the Texas economy.

"Approximately half the oil in reservoirs in the U.S. remains in the ground, and most will never be produced using current technologies and prices," Duncan said. "Texas is well-positioned to take advantage of

PHOTO: SHUOSHUO HAN.

subsurface hydrogen production as it has huge resources of oil, a well-developed oil field infrastructure, and an extensive network of pipelines and rights-of-way."

Duncan's team is developing new approaches using high-performance computing technologies available through the Texas Advanced Computing Center to simulate multiphase flow and thermal effects that are essential to hydrogen production. The team's research focuses on using in-situ, or on-site, combustion of oil within the natural reservoir as a heat source. That heat is used to drive the conversion of methane, carbon monoxide and other gases into hydrogen and carbon dioxide in a way that Duncan said emulates the industrial processes of gasification and steam reforming in refineries.

The summit convened stakeholders online to introduce the Hydrogen Shot program, solicit dialogue, and rally the global community on the urgency of tackling the climate crisis through concrete actions and innovation. The UT research team includes scientists from the bureau and the Hildebrand Department of Petroleum and Geosystems Engineering.

A FIELD IN THE CALIFORNIA CENTRAL VALLEY BEING FED VIA FLOOD IRRIGATION.

PHOTO: FLICKR/STATICANTICS.

Aquifer Accounting

Surface and Hydrological Processes

Jackson School of Geosciences scientists have created a balance sheet for water across the United States—tracking total water storage in 14 of the country's major aquifers over 15 years.

The results were published in *Environmental Research Letters* in August 2021, with the research examining the interplay between irrigation habits and climate on water.

The study found that irrigation can be managed more effectively in humid regions of the eastern half of the country where surface water is more readily available, a finding that could have implications for where the U.S. can grow food, according to the researchers. With longer-term droughts and intermittent intense flooding expected in the future, particularly in the arid western U.S., there is rising concern about overtaxing water resources in the region, especially for irrigated agriculture.

"It is important to understand the relationship between human water use and climate extremes to develop more sustainable water management practices in the future," said the study's lead author, Bridget Scanlon, a senior research scientist at the Bureau of Economic Geology, a research unit of the Jackson School.

The study also highlights how surface water plays an important role in replenishing groundwater, with these water resources helping dampen the impacts of irrigation.

To understand how water changed over time, the researchers used measurements from NASA's GRACE satellites taken from 2002 to 2017 to track the total amount of water stored in each aquifer area—including groundwater, soil moisture, surface water and snow.

By comparing the total water storage over time to climate and irrigation data, the researchers were able to describe how the water supply of each aquifer area was changing—and the role humans played in amplifying or dampening climate impacts on water storage.

The study was co-authored by Jackson School postdoctoral fellow Ashraf Rateb, bureau senior research scientist Alexander Sun, U.S. Geological Survey's Ward Sanford and Don Pool, UT Center for Space Research's Himanshu Save, Tsinghua University's Di Long, and the National Drought Mitigation Center's Brian Fuchs.

A SEISMIC STREAMER, WHICH IS USED TO IMAGE THE EARTH LIKE AN ULTRASOUND SCANNER, DURING SURVEYS ABOARD THE R/V MARCUS LANGSETH.

Slow Slip's Inner Workings

Solid Earth & Tectonic Processes

Slow slip earthquakes, a type of slow-motion tremor, have been detected at many of the world's earthquake hot spots, but it is unclear how they are connected to the damaging quakes that occur there. Scientists at the Jackson School of Geosciences have now revealed the earthquakes' inner workings using seismic CT scans and supercomputers to examine a region off the coast of New Zealand known to produce them.

The insights will help scientists pinpoint why tectonic energy at subduction zones such as New Zealand's Hikurangi subduction zone, a seismically active region where the Pacific tectonic plate dives—or subducts—beneath the country's North Island, is sometimes released gently as slow slip, and other times as devastating, high-magnitude earthquakes. The research was published in the journal *Nature Geoscience* as part of a special edition focused on subduction zones.

"Subduction zones are the biggest earthquake and tsunami factories on the planet," said co-author Laura Wallace, a research scientist at the University of Texas Institute for Geophysics (UTIG) and GNS Science in New Zealand. "With more research like this, we can really begin to understand the origin of different types of [earthquake] behavior at subduction zones."

The research used novel image processing techniques and computer modelling to test several proposed mechanisms about how slow slip earthquakes unfold, revealing the ones that worked best.

The study's lead author, UTIG research associate Adrien Arnulf, was able to extract information by programming algorithms on Lonestar5, a supercomputer at the Texas Advanced Computing Center, to look for patterns in the data. He said that the research is important because understanding where and when a large subduction zone earthquake could strike can happen only by first solving the mystery of slow slip.

"If you ignore slow slip, you will miscalculate how much energy is stored and released as tectonic plates move around the planet," Arnulf said.

For Roman-Era Stone Tools, Geology Mattered

Solid Earth & Tectonic Processes

Last year, an archaeology graduate student showed up at the Electron Microbeam Laboratory at the Jackson School of Geosciences with a box of rocks.

The rocks were from 16 stone tools found scattered among the ruins of Volubilis, a Roman outpost in Morocco that thrived during the 1st century A.D. Archaeologists identified the tools as grinding and mixing implements, but they were curious about the significance of their geology.

What sorts of rocks were in the stone tools and what could they reveal about the ancient Roman world?

ABOVE: UNDERGRADUATE LAUREN LOBUE PREPARING A GEOLOGIC SAMPLE FROM THE RUINS OF VOLUBILIS, AN ANCIENT ROMAN OUTPOST.

SLOW SLIP: ADRIEN ARNULF; ROMAN ARTIFACT: PHIL ORLANDINI.

Lab manager Omero "Phil" Orlandini and two undergraduate students, Lauren LoBue and Scott Culotta, were game to find out. They joined an interdisciplinary team of geoscientists and archaeologists that examined the tools from a cultural and geological perspective.

The team included Christy Schirmer, the archaeology graduate student; Jared Benton, an archaeology professor at Old Dominion University; and Derek Weller a geologist at the University of Tokyo.

The results were published in the *Journal of Archaeological Science: Reports* in August 2021.

The geoscientists discovered that each type of stone tool was made from a distinct rock type. Grain millstones were made from vesicular basalts, olive mills from clastic and fossiliferous limestones, and dough mixers from lower-energy limestone with almost no clastic material or fossils.

The study suggests that the rock types might relate to the function of the tool. For example, the many vesicles, or holes, in the basalt may have helped in grinding grain into flour and retained the millstone's rough texture.

What's more, the researchers determined that the stone was locally sourced. This finding challenges the prevailing idea that grain millstones were imported from Italy. It also raises the possibility that the tradespeople who used the tools were in communication with the craftsmen who made them.

The Jackson School team took the lead on analyzing the lithology of the rock samples. The students learned how to create thin sections and conduct X-ray diffraction SEM-CL to determine the minerals present in each sample. They presented their geological findings at the Jackson School's student research symposium.

"It wasn't anything I expected to be doing. It was an interesting project," said LoBue. "I like classics too, and this let me combine different interests."

PHOTO: US DEPT. OF DEFENSE/CPO MATTHEW BRADLEY.

A DAMAGED HOUSE AFTER THE TOHOKU EARTHQUAKE AND TSUNAMI THAT DEVASTATED JAPAN IN 2011.

Forecasting Quakes

Solid Earth & Tectonic Processes

Thorsten Becker, a professor at the Jackson School of Geosciences, is leading a five-year project focused on forecasting earthquakes. The goal is to develop computer models that can estimate the chances of an earthquake happening and its likely impact.

The project started in August 2021 and is funded by the National Science Foundation.

The project team includes scientists at the Jackson School's Institute for Geophysics (UTIG), the Oden Institute of Computational Engineering and Sciences, and supercomputers at the Texas Advanced Computing Center (TACC). UT scientists have teamed up with researchers at universities and national labs working on three of the world's earthquake hot spots: the U.S. Pacific Northwest, New Zealand and Japan.

The selected study sites are all subduction zones—places where tectonic plates meet. The differences between them will allow researchers to test their models and figure out what conditions need to be considered when deciding the likelihood of an earthquake happening.

"It's a little bit like calculating the probability of a pandemic," said Laura Wallace, a UTIG research scientist based in New Zealand. "You can't know when and where the next one will happen, but you can look at factors that make it more likely and model how it might unfold."

As part of the project, Jackson School outreach coordinator Dana Thomas is designing freshman-to-grad-school education programs to encourage students to become computational geoscientists. They include a bridge program for incoming college freshmen; paid summer research opportunities for undergraduates at historically Black colleges and universities, such as Fort Valley State University; and a summer school with TACC that will train students to use Frontera, the world's most powerful university-based supercomputer.

A Sunken River Valley Could Hold the Key to Protecting the Texas Coast

"Being on a ship and getting to do science: This is what I've wanted to do since I was a kid."

Solveig Schilling, Graduate Student, Jackson School of Geosciences
Grist, May 17, 2021

A Blue 'Red Planet?' Rain and Snow Storms May Have Soaked the Martian Surface, Say Scientists

"It had lots of rain or snowmelt to fill those channels and lakes. Now it's completely dry. We're trying to understand how much water was there and where did it all go."

Gaia Stucky de Quay, Postdoctoral Fellow, Department of Geological Sciences
Forbes, Aug. 21, 2020

Lingering La Niñas May Help Forecasters Spot Costly Weather Patterns Two Years Away

"This is one of the important remaining issues we need to address before promoting the implementation of long-range (up to two years) ENSO forecasts."

Yuko Okumura, Research Scientist, Institute for Geophysics
Washington Post, Dec. 10, 2020

Offshore Drilling Set To Begin off Florida Alarms Environmentalists

"It would be the United States that would have to come and take care of the remediation, take care of stopping the spill. So certainly, we need something on paper that says who's going to be in command."

Jorge Piñon, Director,
Jackson School of Geosciences Latin America and Caribbean Energy Program
NPR, Dec. 4, 2020

Alaskan Coastal Permafrost More Susceptible to Climate Change Than Previously Understood, Study Finds

"Their cultural heritage and their welfare is integrated and intricately linked to their environment. There's an immediate need to understand what's happening in these lagoons."

Bayani Cardenas, Professor,
Department of Geological Sciences
Oceanographic Magazine, October 2020

TOP: SCOTT TINKER, THE DIRECTOR OF THE BUREAU OF ECONOMIC GEOLOGY, APPEARED ON 'GOOD DAY AUSTIN' TO TALK ABOUT TEXNET, THE STATEWIDE EARTHQUAKE MONITORING NETWORK;
BOTTOM: AFTER CLIMBERS TRAGICALLY DIED IN THE ALBORZ MOUNTAINS OF IRAN, THE BBC SPOKE WITH DEPARTMENT OF GEOLOGICAL SCIENCES CHAIR DANIEL STOCKLI TO LEARN MORE ABOUT THE HAZARDOUS CONDITIONS.

OPPOSITE PAGE:
TOP: KXAN INTERVIEWED DOCTORAL STUDENT MARIEL NELSON (PICTURED) AND BUREAU OF ECONOMIC GEOLOGY RESEARCHERS ABOUT FALLING ROCKS AT HAMILTON POOL;
BOTTOM, LEFT: THE JANUARY 2021 ISSUE OF SCIENTIFIC AMERICAN SPOTLIGHTED JACKSON SCHOOL OF GEOSCIENCES' RESEARCH ON THE FAMOUS 'JURASSIC PARK' DINOSAUR DILOPHOSAURUS. THE COVER STORY IS BY MATTHEW BROWN, THE DIRECTOR OF THE JACKSON SCHOOL'S VERTEBRATE PALEONTOLOGY COLLECTIONS, AND ALUMNUS ADAM MARSH;
BOTTOM, RIGHT: DEPARTMENT OF GEOLOGICAL SCIENCES PROFESSOR DEV NIYOGI SPOKE WITH 'PBS NEWS HOUR' IN FEBRUARY 2021 ABOUT SEVERE WINTER WEATHER.

Where To See Northern California's Most Spectacular Waterfalls

"California's whole water infrastructure is built around the idea of having this natural reservoir of snowpack. Since 1915, the western U.S. snowpack has declined by more than 20%. Climate models project that in the next 50 years, California could be left with just a third of its current snowpack."

Geeta Persad, Assistant Professor,
Department of Geological Sciences
National Geographic, March 3, 2021

Jackson School News: jsg.utexas.edu/news

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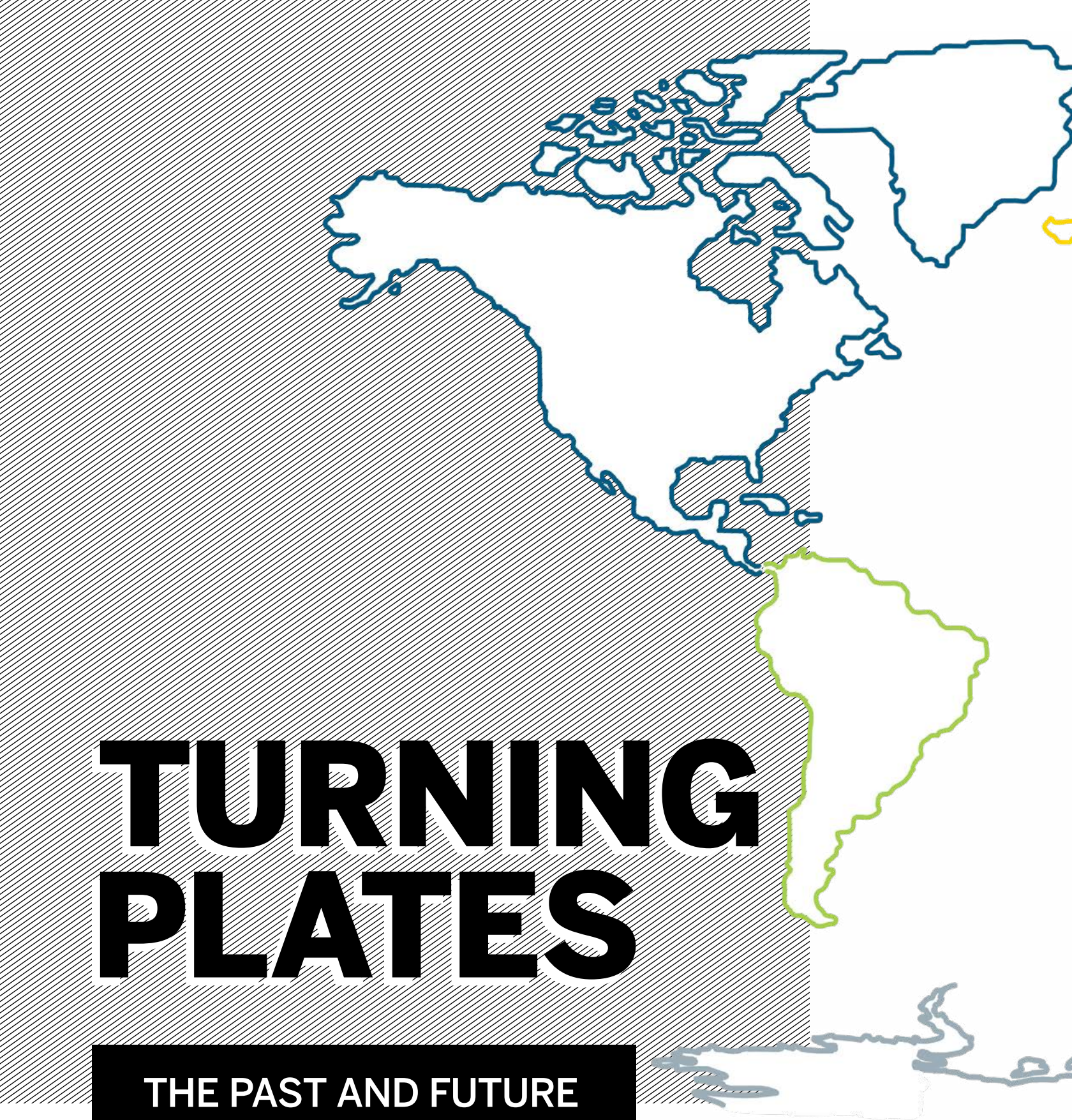


TURNING PLATES

THE PAST AND FUTURE OF UTIG'S OLDEST INDUSTRIAL GROUP

BY JULI BERWALD

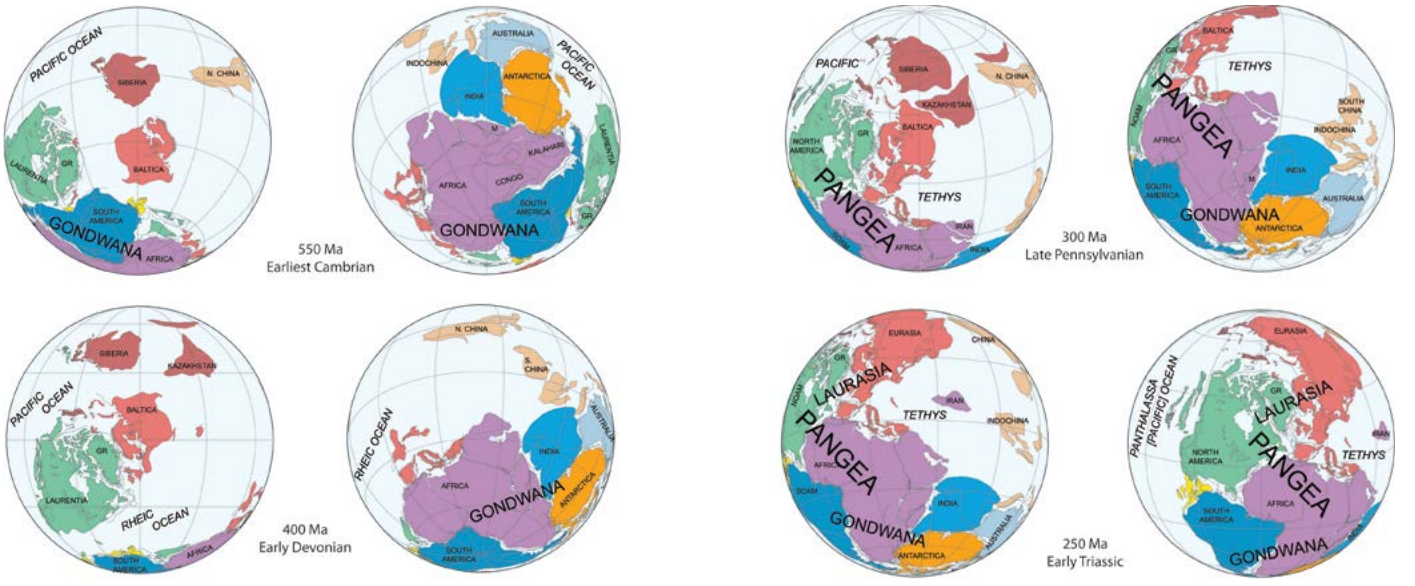
In the center of the image rests the world as we know it: seven familiar continents; five recognizable ocean basins. Then, the timestamp at the bottom clicks back 10 million years and it all shifts ever so slightly. The Atlantic Ocean pinches closed. The Pacific gapes wider. Another 10 million years and Australia slips toward Antarctica. Europe, Greenland and Canada threaten to collide. By 60 million years ago, they do.

Clicking back through time 100 million years nearly obliterates the South Atlantic. Two hundred million years ago, the North Atlantic is gone too. The continental plates coalesce into the giant landmass Pangea, a place where lush forests and swamps gave rise to the dinosaurs, as well as fossil fuels.

Click backward another 50 million years and the ancient Tethys Ocean to the east is delineated from the massive Pacific by the spinning pieces of future southeast Asia and northern Australia.

March back another 100 million years and Pangea dissolves. The plates twist toward the south, uniting into another supercontinent. By 450 million years ago, they've morphed again, separating into eastern and western landmasses that both turn northward toward the equator.

Watching the animation, it's impossible not to feel a bit theatrical, to see the Earth as a stage on which the continents dance and spin. But what underlies this mind- and land-bending choreography is geology, and it has been the focus of more than three decades of research conducted by the PLATES project at the University of Texas Institute for Geophysics (UTIG), a research unit of the Jackson School of Geosciences.



Starting the PLATES Spinning

Around 1983, research scientists Lawrence Lawver and Chris Scotese, with Professor John Sclater and then master's student Lisa Gahagan, began developing the tools to map the movement of the continents by looking at the seafloor. They named the project PLATES, not because it was an acronym, Lawver said, but because it was the clearest description of the focus of the work.

Lawver, a fourth-generation Texan, grew up in northern California, well aware of the tectonic activity around him. His doctoral work at the Scripps Institution of Oceanography elucidated fault lines and heat flow in the Gulf of California.

At first, Lawver recalled, seafloor topography was measured from sensors deployed from ships moving in straight lines at sea. It was like trying to color in a page using a single crayon line every few months. With the advent of satellites, first SeaSat and then GeoSat, data could be collected in thick broad strokes, like using a wider and much faster paintbrush. The satellite coverage revealed a menagerie of topography: fracture zones, active spreading centers, abandoned spreading centers, and features that were not tectonic, like sediment drifts.

These features helped understand seafloor movement.

"That gave us the railroad tracks on which to reconstruct the continents," Lawver said, "but one also needed the time basis as well."

If the continents were trains, you needed to know where they were on the tracks at any time.

In the late 1950s scientists had discovered that the magnetic pole of Earth isn't stable; it wobbles and repeatedly flips over time. When new rock forms, the magnetic bits of it align with the planet's current magnetic field and are frozen in place when the rock cools. The frozen magnetic signature in any rock acts as a geologic timestamp.

For years, Lawver and Gahagan, who became an associate research scientist at UTIG after completing her master's, collected every measurement of these magnetic anomalies that they could get their hands on. They digitized that data and slowly built a robust timetable. Then, they put the continental plates on the tracks and built the software to show how they moved.

PLATES Basics

PLATES is UTIG's oldest industrial consortium, with support from Exxon, Mobil, Total, Equinor, Hess, Conoco Phillips, Shell, BHP, Apache, Unocal, Chevron and BP, among others, including some companies that have now merged.

Ian Norton, who arrived at UTIG from South Africa, moved to ExxonMobil, and then joined the PLATES project in 2007. He explained that industrial groups were so supportive because PLATES helped guide exploration.

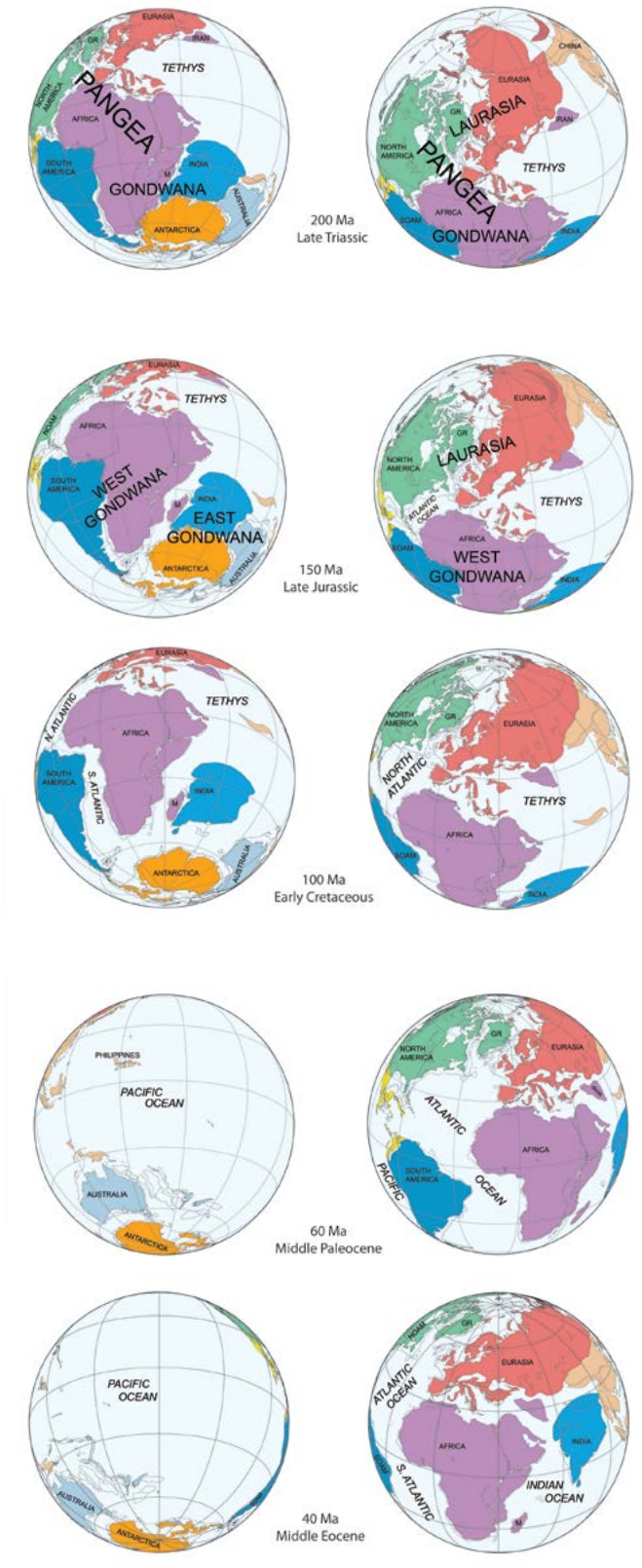
"If you find oil on one side [of an ocean basin], you are more than likely to find it on the other," he said.

And it was more than just tectonics that industry found so valuable, he added. PLATES provided a critical database of bathymetry, earthquakes and magnetic anomalies that gave geological context to exploration. Each year for 30 years, PLATES updated their rotation files, refining the precise turns of the planet's plates as more data became available. They also published a thick atlas of Earth's tectonics.

Besides aiding mineral, oil and gas exploration, PLATES played a key role in basic science. Some of the most powerful advances involved illuminating the details of when and where oceanic gateways and land-based bridges opened and closed.

Ian Dalziel, whose scientific career began in Scotland, joined PLATES in 1985. For both Dalziel and Lawver, one of the highlights of the project was unraveling the genesis of Antarctic glaciation. Antarctica has been resting at the southern pole for at least the past 100 million years. Yet, as recently as 35 million years ago, birds flitted among its forests.

With PLATES, they showed that when Australia and South America pulled away from Antarctica 34 million years ago, a seaway opened encircling the entire southern hemisphere. Coupled with the spinning Earth, a circumpolar current began to flow, whipping up the winds, depressing temperatures and sinking the southern continent into the deep freeze of today.



ABOVE: GLOBAL RECONSTRUCTIONS SHOWING THE ASSEMBLY AND BREAKUP OF EARTH'S SUPERCONTINENTS GONDWANA AND PANGEA FROM HALF A BILLION YEARS AGO UNTIL TODAY.

GLOBES: UTIG PLATES PROJECT.

Insights similarly come from understanding when continents came together, as when North America and South America collided at the isthmus of Panama just 3 million years ago. That cut off flow between the Atlantic and Pacific, allowing for the formation of the Gulf Stream and its modulating effect on the weather of Europe.

"Those gateways, which you can reconstruct using PLATES, have been very critical in the large-scale changes in Earth's climate," Dalziel said.

These gateways also shed light on how life moved around on the continents. Recently Lawver and Dalziel collaborated on a study trying to unravel how monkeys, which originated in Africa, arrived in South America. Differing hypotheses suggest that they traveled over a land bridge spanning the South Atlantic, or traveled from Africa through India, Madagascar, Sri Lanka and Antarctica before reaching South America.

Combined with fossil evidence, PLATES indicates the most likely route was floating on natural rafts of vegetation broken off from the Niger Delta or the Congo River. Fist-sized primates could have sailed the equatorial current across a much narrower South Atlantic Ocean in a couple of months before climbing ashore in a new world.

Turning PLATES Deeper into Time

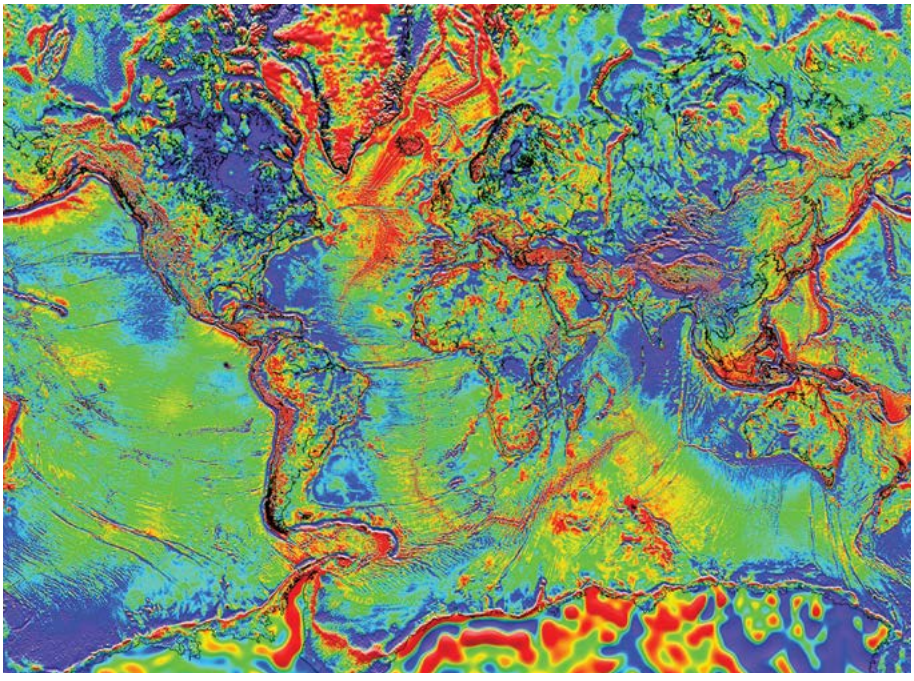
Using the seafloor's magnetic anomalies as a timetable works until around 180 million years ago. But then, the tracks dead-end. Subduction destroys the older seafloor and with it the rocks' magnetic timestamps. So, reconstructing the choreography of deeper time requires different tools: continental rocks.

Like the seafloor, continental rocks bear the magnetic imprints of their formation. The minute grains of magnetic material orient vertically downward at the magnetic north and south, horizontally at the equator, and at angles in between, depending on the latitude of the rock when it formed. But that leaves longitude a mystery. So tectonic plate reconstructions older than 180 million years require matching rock types and isotopic fingerprints across continents and then working to fit the pieces together geometrically.

Dalziel advanced this ancient work, which can be just as much art as science. He pointed out, "It's often a matter of geologic judgment, you could almost say taste, like it or not. What is really important?"

In January 1995, the cover of Scientific American sported a newly pieced together supercontinent that was 750 million years old named Rodinia. Within the pages of that issue, Dalziel wrote an article about discovering geologic signatures that support an ancient connection between the southwest United States and East Antarctica.

Accompanying graphics generated from the PLATES project show that after the breakup of Rodinia, North America traveled counterclockwise around neighboring continents like South America, as if in a game of duck-duck-goose. Here and there, the plates collide, exchanging the fragments of rock that are today's clues to reconstructing those ancient paths. Indeed, a bit of Texas is now lodged in Argentina.



TOP: A SATELLITE MAP OF EARTH'S GRAVITY GIVES TECTONIC CLUES OF PAST CONTINENTAL ARRANGEMENTS. AREAS OF STRONGEST GRAVITY ARE RED, THE WEAKEST IN BLUE. **BOTTOM:** LARRY LAWVER (LEFT TOP), IAN DALZIEL (LEFT BOTTOM) AND COLLEAGUES DURING A 2014 FIELD EXPEDITION TO SOUTH GEORGIA ISLAND IN THE FAR SOUTHERN ATLANTIC OCEAN.

The Wide Reach of PLATES

Between 2000 and 2018, PLATES received hundreds of requests for reconstructions. More than a quarter were from colleagues at the Jackson School, but other academic institutions, television shows and museums also asked for data. The walls of the Smithsonian Institution's Museum of Natural History and Edinburgh's Dynamic Earth museum both have PLATES exhibitions. The "Texas through Time" animation, which superimposes the state on the North American continent as it rounds the planet, along with other educational modules, has been used by educators for years.

"One of the most interesting was in 2002," Lawver said. "We got a request for a book in Japanese on baobab trees."

When asked about the highlights of working on PLATES, Larry Lawver spoke of the people involved in the project. About a dozen graduate students worked on PLATES through the decades and later scattered throughout the world, carrying their expertise with them. Some have had academic success; others shifted their attention to industry. A lot of undergraduates have spent time in the lab as well.

A couple of years ago, Lisa Gahagan retired from UTIG. Soon after, Lawver also retired and was conferred the title of senior research scientist emeritus.

Their retirement has brought PLATES to a transition that Dalziel, who is still active at UTIG, hopes will herald a new phase of the project.

In March 2019, Professor Thorsten Becker from UTIG proposed PLATES-4D, a project to merge the surface tectonic movement with processes in the mantle below the Earth's crust.

Another important change that Dalziel has been seeking since the project held a 30-year anniversary symposium in 2019 is to attract experts from other disciplines at the Jackson School, such as paleobiologist Julia Clarke, who might bring new insights on plate reconstructions.

Last year, Becker began working with a new postdoctoral fellow, Eivind Straume, to spearhead the PLATES-4D effort. Straume has already begun building ties across campus, working with Becker's graduate student, Edward Clennett, to link plate reconstructions with the deep earth, and the Oden Institute's Patrick Heimbach to show how plate movements could have affected climate and ocean circulation around Africa and Europe 70 million years ago when early hominids were on the rise.

"What we've been doing with PLATES so far is looking at three dimensions — two dimensions of the Earth's surface and time. You usually think of four dimensions as adding time. In this case, you're adding the fourth dimension as depth, and that's really the driving mechanism for plate tectonics," said Dalziel. "A theme of the Jackson School is studying the earth as a system. And that's exactly where it's headed."

Like the morphing of the continents around our planet, from one formation to the next, the PLATES program, too, is poised to morph into its next incarnation.

SATELLITE MAP: UTIG PLATES PROJECT. GROUP: IAN DALZIEL.

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"We want those smart kids who will make a difference to become students at the Jackson School."

-Ed Duncan, B.S. '79, M.A. '87, and his wife, Karen

The couple created a gift through their estate plan to attract top faculty and students to the Jackson School of Geosciences.

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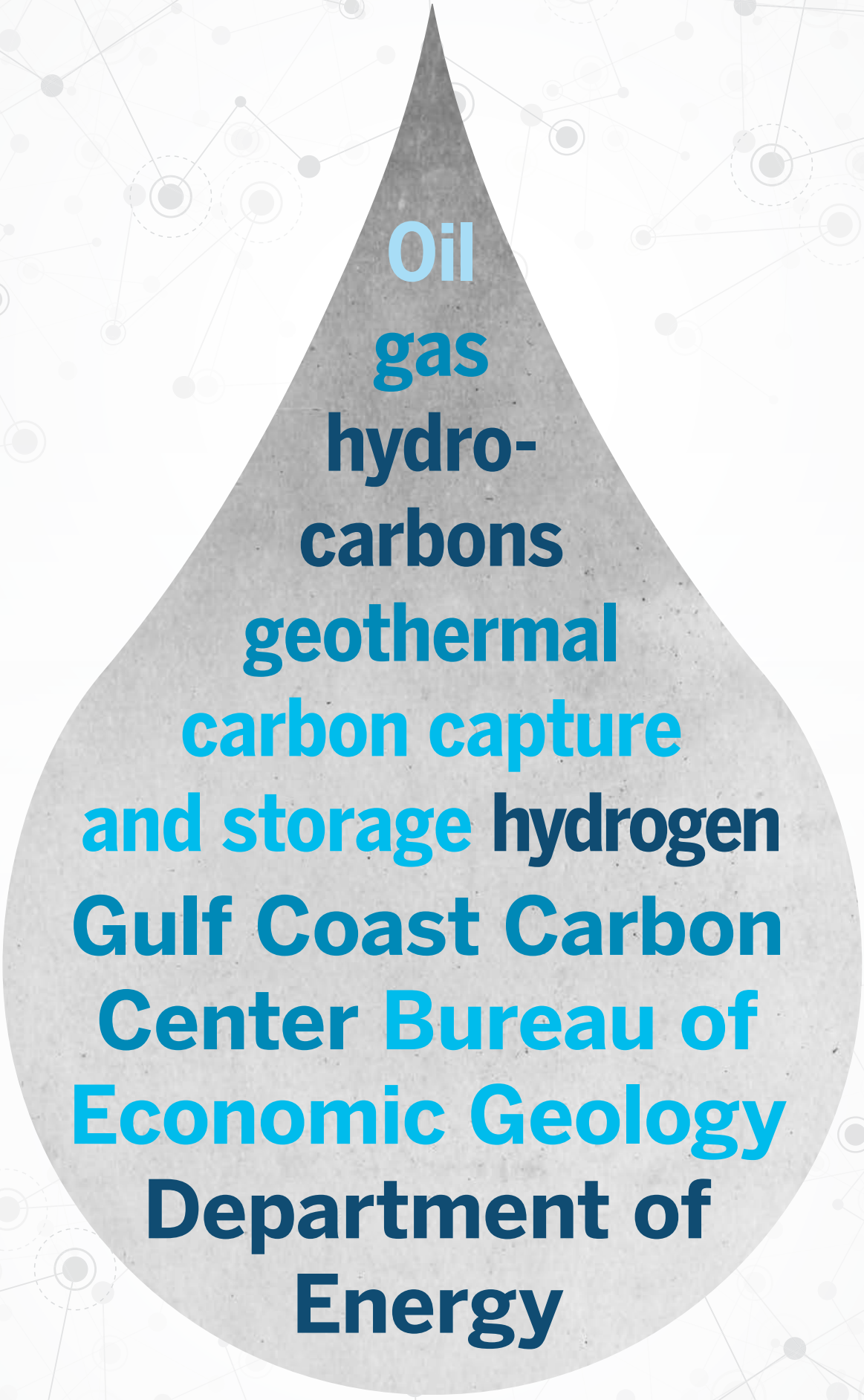
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POWERING *the* ENERGY TRANSITION

BY MONICA KORTSHA

TEXAS OIL & GAS EXPERTISE IS DRIVING INNOVATION IN LOW-CO_2 ENERGY

THE BUREAU OF ECONOMIC GEOLOGY'S CORE RESEARCH BUILDING HOLDS MORE THAN 2 MILLION BOXES OF ROCK CORE AND CUTTINGS. **PHOTO:** BUREAU OF ECONOMIC GEOLOGY.

For decades, the energy industry has recruited some of the best minds in geosciences and engineering to go after oil and gas—to find it, get it out of the ground, and transport it around the world.

The century-long pursuit for petroleum has sparked technological innovations. It has advanced humanity's knowledge of the planet's geological history and the processes that shape it. And it has led to a world that runs on hydrocarbons, requiring a vast and diverse energy infrastructure, from power plants and pipelines to gas stations and offshore drilling platforms.

But as society grapples with climate change, an energy transition is underway that is expanding low-carbon energy sources, reducing greenhouse gas emissions from hydrocarbon combustion, and cleaning up the impacts of fossil fuels and other energy sources on the environment.

But far from leaving the oil and gas industry behind, it's leveraging what it has built to new ends. And from oil fields out west, to refining infrastructure along the coast, there's much to leverage across Texas.

At the Jackson School of Geosciences' Bureau of Economic Geology, geoscientists are using their experience and expertise in energy research to provide the data needed to drive the energy transition forward.

"There are many possibilities, because we work extensively with government and industry in these spaces," said bureau Director Scott Tinker, a leading voice on the energy transition. "It's a remarkable opportunity for us, the Jackson School and Texas to continue to lead the global energy research conversation."

The bureau was founded in 1909 as the State Geological Survey of Texas, a dual role it fills as a research unit of the Jackson School. This directive, along with organizing research around topical and industry-funded consortia, has helped orient science at the bureau around the state's natural resources and the industries that rely on them.

As funders have started to make energy transition moves, a number of scientists at the bureau are leading research that is focused on reducing greenhouse gas emissions now and sustainable energy production in the future.

Some of the most active areas of research are centered around capturing CO_2 from industrial emissions and permanently storing it underground; ramping up hydrogen production and integrating the carbon-free gas into the nation's natural gas supply; and advancing geothermal energy in Texas and beyond.

"The subsurface is the subsurface," said Mark Shuster, the bureau's associate director of the Energy Division. "We see a lot of potential and synergies—and oil and gas companies do too—taking these skills and applying them to new areas that are growing, such as hydrogen, geothermal and carbon storage."

CARBON CAPTURE AND STORAGE

The energy transition is diversifying energy sources. But for now and in the near future, fossil fuels still power the world. Carbon capture and storage technology is poised to play an influential role in the transition because it enables industry to continue using hydrocarbons while reducing CO_2 emissions.

The technology works by capturing CO_2 right at the source of combustion, and compressing, moving and injecting the gas directly into the subsurface for permanent storage, allowing industry to reduce emissions while providing energy to the world.

Susan Hovorka has been leading research on the technology at the bureau's Gulf Coast Carbon Center for the past 20 years. For most of that time, conversations came from others within a relatively niche scientific community. But in recent years, she said, interest has exploded.

She points to the American Association of Petroleum Geologists hosting a special program on the technology in March 2021 as a sign that carbon storage had entered the mainstream conversation.

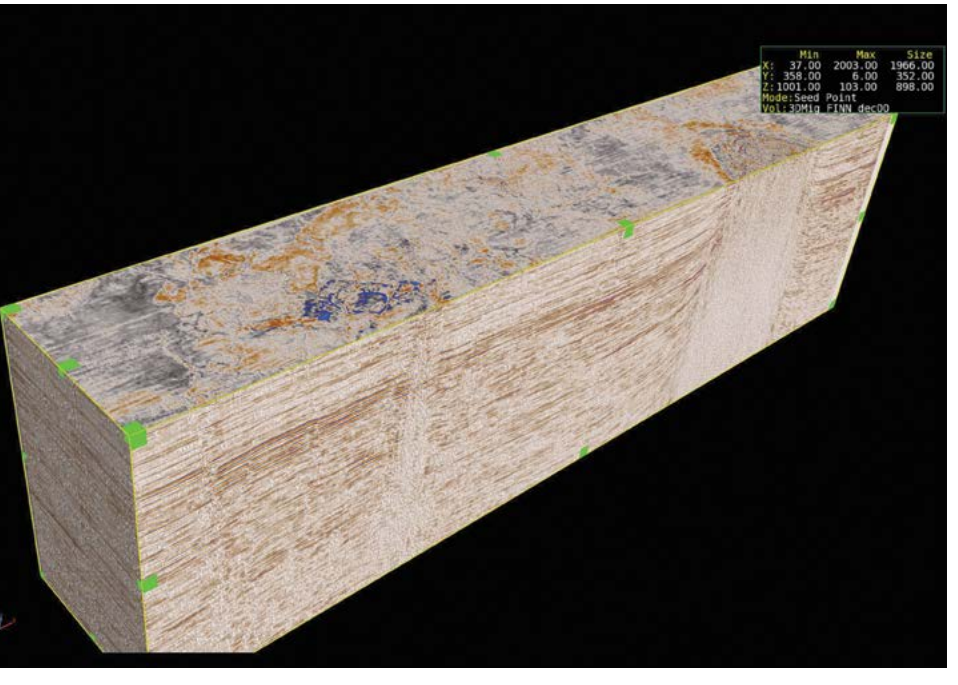
"There has been real growth and interest from professional societies," said Hovorka, who chaired a session on best practices on carbon capture and storage at the conference. "I feel we're in good company."

As a concept, carbon capture and storage is not new to the oil and gas industry. Since the 1970s, oil companies have been producing and capturing CO_2 from natural and industrial sources and injecting the gas into depleted oil reservoirs to increase production, a technique called enhanced oil recovery.

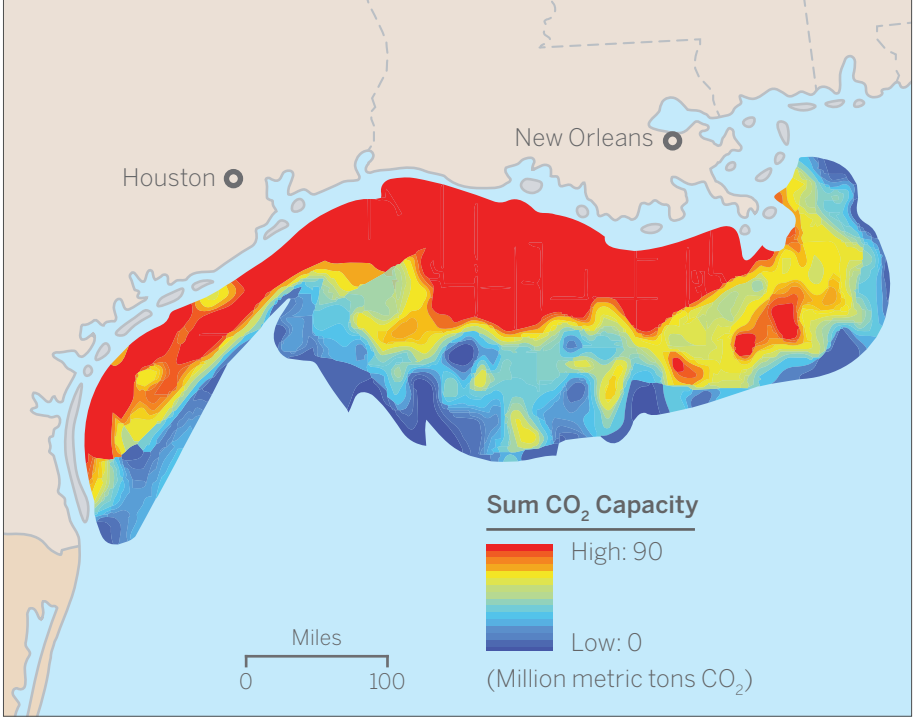
But while the energy industry has helped advance both the capture and injection technologies, until the Gulf Coast Carbon Center got involved with research, there was little field-based data on how CO_2 behaved in the subsurface, Hovorka said. That's largely due to the inherent low risk associated with enhanced oil recovery: the volumes of CO_2 injected into the subsurface are usually relatively small compared with other reservoir fluids; the increased pressure that comes from adding CO_2 is stabilized by removing the hydrocarbons released from rock pores; and the CO_2 is kept from migrating by the same geology that trapped the oil in the first place.

But if the goal is to store CO_2 underground to keep it out of the atmosphere, getting a handle on CO_2 in the subsurface is the essential first step to ensuring that the gas is stored safely and permanently.

LEFT: 3D SEISMIC DATA COLLECTED BY THE GULF COAST CARBON CENTER AT SAN LUIS PASS NEAR GALVESTON.
RIGHT: SUSAN HOVORKA SITS BETWEEN A CO_2 SUPPLY TANK (BACKGROUND) AND AN OBSERVATION WELL (FOREGROUND) AT THE FRIO BRINE PILOT EXPERIMENT SITE. SHE IS AT THE APPROXIMATE EDGE OF THE CO_2 PLUME, WHICH WAS INJECTED 5,050 FEET BELOW THE SURFACE.



3D DATA: TIP MECKEL. TANK: SUSAN HOVORKA.



THE WESTERN GULF OF MEXICO'S CO_2 STORAGE POTENTIAL. THE GULF COAST CARBON CENTER ESTIMATES THE TOTAL STORAGE CAPACITY OF THE REGION TO BE 559 BILLION METRIC TONS.

PHOTO: GULF COAST CARBON CENTER.

In September 2004, researchers at the center took the first steps in demonstrating that CO_2 could be safely stored underground by leading the Frio Brine pilot experiment, the first CO_2 storage field test in the United States outside of an oil and gas context.

Funded by the Department of Energy and bringing together collaborators from national labs, universities and industry, the experiment injected a total of 1,850 tons of CO_2 into brine-bearing sandstone of the Frio Formation near Dayton, Texas, with researchers closely monitoring how the gas behaved in the subsurface during two injections. They first injected 1,600 tons of CO_2 5,050 feet below the surface over 10 days, with scientists monitoring the plume for 18 months. The second injection took place in 2006, two years after the first, with scientists introducing about 250 tons of CO_2 into a hydraulically separate formation about 390 feet deeper than the first injection site over five days.

The project was a clear success, said Hovorka. The integrated suite of seismic imaging, geophysical monitors and chemical tracers worked in tandem to provide a clear view of CO_2 in the subsurface. The experiment helped refine models for CO_2 behavior. And, critically, there were no leaks detected at the surface, as confirmed by techniques developed by the research team.

The Frio experiment helped gather important scientific information about storing CO_2 underground. But it also benefited from broad expertise of the oil and gas industry, too, Hovorka notes. The research team included scientists from Schlumberger and BP. The property where the experiment took place belonged to Texas American Resources Company, an independent oil company owned and operated by Jackson School alumnus Don Charbula. Hovorka also credits the UT legal team's oil and gas experience with getting the project greenlighted by university officials.

"Because UT was able to understand that the risks were acceptable, and because we had alumni in the oil business, we were able to take this nice step forward for everybody," Hovorka said.

Frio is just one example of the Gulf Coast Carbon Center leveraging oil and gas expertise to conduct fundamental science. One of the most significant research findings came from analyzing Gulf of Mexico well logs first collected by oil and gas companies and later compiled by the Gulf Basin Deposition Synthesis (GBDS) program, a research group at the University of Texas Institute for Geophysics, another research unit of the Jackson School.

Well logs record the geological properties of a well. Oil and gas companies used this information to determine where to drill for oil. The GBDS group used it to create maps of the geological history of the Gulf of Mexico. And in 2011, Hovorka and the Gulf Coast Carbon Center team used the same information to estimate the CO_2 storage capacity available along the offshore Gulf of Mexico.

They calculated 559 billion metric tons, tripling the known U.S. offshore storage capacity at the time.

The Department of Energy took notice when Hovorka mentioned the findings to an assistant secretary after a talk, which was followed, in 2013, by Hovorka and Tinker meeting with Secretary of Energy Ernest Moniz in Washington, D.C., to present the concept of offshore CO_2 storage. This led to others taking note, too.

"This was all ours, 100 percent ours," Hovorka said. "We were the ones who brought interest in the offshore back to the U.S. and DOE got interested, and industry got interested, and the state got interested, and so we did something important."

Hovorka made her initial storage estimates by poring over paper copies of the well log data with a master's student and a magic marker, but the capacity estimate has not significantly changed over the years, she said. What has improved is knowledge of the geological formations that make up that space, with bureau Senior Research Scientist Tip Meckel leading seismic surveys using state-of-the-art technology that captures detailed reservoir features in 3D. The scope of research has also expanded. From regulations to infrastructure to engineering, all aspects of carbon storage in the Gulf of Mexico are subjects of study, with the center serving as an organizing hub for partnerships with other universities, national labs and geophysical companies.

As awareness of carbon capture and storage has grown, the center hasn't just benefited from oil and gas data and partnerships with industry. It has become a place for scientists with oil and gas experience to apply knowledge directly to carbon storage research.

"We get hundreds of applications, hundreds of letters of interest every

year," Hovorka said. "There are all kinds of motivations, but many come specifically from people who have oil and gas backgrounds who want to shift their emphasis."

Arnold Oseiy Aluge and Melianna Ulfah are two examples of such scientists. They both got involved with research at the Gulf Coast Carbon Center while earning master's degrees from the Jackson School's Energy and Earth Resources (EER) program. Oseiy Aluge earned an undergraduate degree in chemical engineering from the University of Lagos in Nigeria. During his studies, he held a research internship with Shell, where he worked on converting waste plastics to synthetic crude oil. Ulfah spent the first three years of her post-undergraduate career working offshore of Indonesia as a geophysicist at Total and Pertamina, the country's national oil and gas company.

Both Oseiy Aluge and Ulfah enrolled in the EER program with carbon capture in mind. The projects they ended up taking led them in two different directions: Oseiy Aluge analyzed different economic scenarios that could help make carbon capture and storage in depleted reservoirs offshore of Louisiana profitable, even when oil prices are low. Ulfah conducted research on how the number of CO_2 injection wells and their placement influences the amount of gas a geologic unit can hold, with Ulfah using the results to make leasing acreage recommendations in a final report.

Now, both Jackson School alumni as of spring 2021, they're continuing to work in energy, Oseiy Aluge as a power market analyst at McKinsey, Ulfah as a fellow at Lawrence Livermore National Lab, where she is looking into the CO_2 storage potential of Northern California's basins.

"Coming from a background of oil and gas, working as an oil and gas professional, it really makes me look at my life and my time at UT as contributing to the energy transition while also transitioning myself from oil and gas to cleaner sources of energy," said Ulfah.

And it's not just early-career professionals making the transition. Research scientist associate Alex Bump, the newest addition to the Gulf Coast Carbon Center's research staff, joined the group in 2019 after spending 16 years in global exploration at BP, where he worked on over 50 basins on five continents and served as head of discipline for structural geology and tectonics. His research still draws heavily on that experience. But instead of exploring frontier basins for oil and gas, he is now repurposing those skills to study CO_2 storage plays. He said that as he climbs the learning curve himself, he is working to bring others along with him, designing training in carbon capture and storage for petroleum geoscientists and helping oil companies, data brokers and others identify new business opportunities in carbon storage.

The center has been characterizing the Gulf Coast for decades, steadily growing a knowledge base. In May, Meckel, Hovorka, Bump and Ramón Treviño, a bureau program manager, published a paper in *Greenhouse Gases: Science and Technology* that pulls together research on geology, infrastructure and policy to provide a high-level overview of why the Gulf Coast is on its way to becoming a carbon storage hub.

Meckel, the lead author of the paper, said the study is meant to serve as a road map, offering policymakers and decision-makers in the energy industry a primer on what the Gulf Coast has to offer for carbon capture and storage. Recent laws passed by the Texas Legislature this year show that the state is taking steps to set up a carbon storage economy.

SCIENTISTS AT THE GULF COAST CARBON CENTER REVIEWING SEISMIC DATA. RESEARCHERS AT THE CENTER COME FROM AN ARRAY OF PROFESSIONAL BACKGROUNDS, INCLUDING THE ENERGY INDUSTRY.

PHOTO: SUSAN HOVORKA.

In June, Texas Gov. Greg Abbott signed into law HB 1284, giving the Texas Railroad Commission similar regulatory authority over CO_2 injection wells as it has over oil and gas wells. With that in place, the Railroad Commission is now seeking to become the primary regulator of CO_2 wells, a function currently fulfilled by the federal government. And in May, the Texas General Land Office started accepting lease proposals for CO_2 storage in state lands, with lease revenue benefiting the Texas Permanent School Fund, just as oil and gas leases do.

"We are setting ourselves up for success," Meckel said of the recent policy decisions. "We are going to be able to use a very useful state resource to help our industry decarbonize, and in the end, the benefits are also going to come back to basically every school district in Texas."

The Gulf Coast Carbon Center's work on carbon capture and storage is playing a major role in developing a critical technology that can help society get a handle on CO_2 emissions now while other energy technologies are developed to help carry the load that hydrocarbons do today. A key part of that effort is finding fossil fuel alternatives.

"We see a lot of potential synergies — and oil and gas companies do too — taking these skills and applying them to new areas that are growing." - Mark Shuster

At the bureau's newly founded $GeoH_2$ group, researchers are investigating how the same infrastructure that shuttles natural gas across the country can help jump-start a new hydrogen energy industry.

HYDROGEN

About 40% of electricity in the country is generated from natural gas, which produces CO_2 emissions. The natural gas is transported across 3 million miles of pipeline with 4.25 trillion cubic feet of geological storage in use to help hold it all.

At the $GeoH_2$ group, scientists are working on what it would take to integrate hydrogen, which produces only water as a byproduct, into the country's already robust natural gas system.

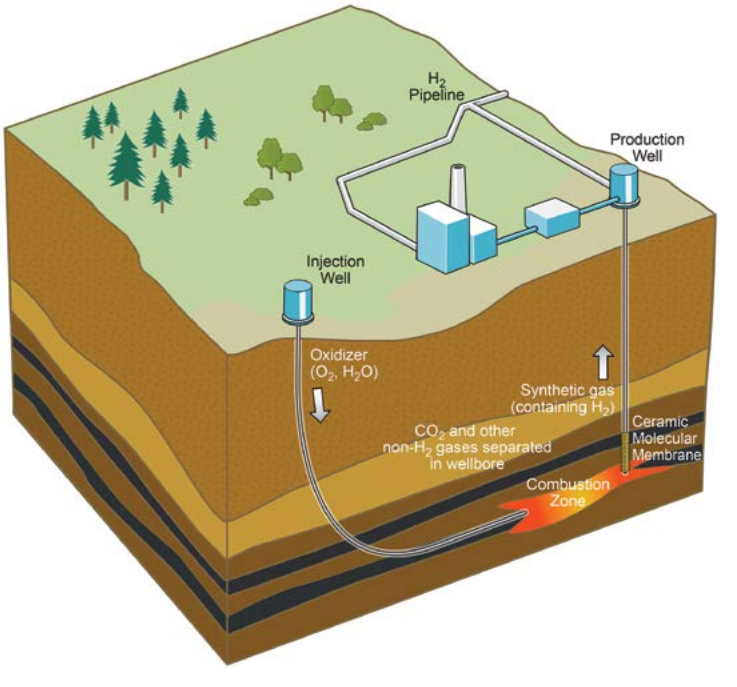
In May 2021, the group published a paper in the *Oil and Gas Journal* overviewing the natural gas infrastructure potentially available

for hydrogen gas. It presents an initial goal of replacing 10% of the natural gas supply with hydrogen, a concentration that wouldn't require widespread infrastructure changes to accommodate for the introduced hydrogen.

"We know how to move gas. We're very experienced in it, particularly in the U.S., so it makes sense," said Shuster, the associate director of the bureau's Energy Division. "You have a whole suite of potential uses for the hydrogen, but it's going to take some work, some research, and I think it's going to take probably some targeted incentives."

The oil and gas industry is responsible for building the natural gas infrastructure that fuels a large portion of the country. But the industry is also the primary consumer of hydrogen, which it uses to produce petrochemicals. The only three geologic storage sites for hydrogen in the United States are

ABOVE: MARK SHUSTER, ASSOCIATE DIRECTOR OF THE ENERGY DIVISION AT THE BUREAU OF ECONOMIC GEOLOGY.
LEFT: A SEISMIC IMAGE OF THE SPINDLETOP SALT DOME IN THE TEXAS ENERGY MUSEUM.
RIGHT: A SCHEMATIC SHOWING THE STEPS OF IN-SITU HYDROGEN PRODUCTION.



SHUSTER: BUREAU OF ECONOMIC GEOLOGY. SEISMIC IMAGE: BETH RANKIN/FLICKR. SCHEMATIC: BUREAU OF ECONOMIC GEOLOGY.

A REFINERY IN PORT ARTHUR, TEXAS. THE OIL AND GAS INDUSTRY ARE EXPERTS IN STORING AND TRANSPORTING HYDROGEN FOR PETROCHEMICAL PRODUCTION. MUCH OF THIS ACTIVITY HAPPENS ALONG THE GULF COAST.

hollowed-out cavities in salt domes along the Texas Gulf Coast, all used to store gas for petrochemical processing.

The GeoH$_2$ group is drawing on industry data and insight in handling both these gases to inform its own research on integrating hydrogen into the existing natural gas system.

Initial research is studying geologic storage of hydrogen. Geologic storage is how large quantities of natural gas are stored, with the gas being kept in salt domes, saline aquifers and depleted oil and gas fields. But of this storage repertoire, only salt domes are currently a proven storage option for hydrogen. Sticking to salt domes for geologic storage of hydrogen greatly limits where the gas can be stored, and storage volume. And because it takes three times as much hydrogen to provide the same power as a similar unit of natural gas, maximizing storage volume is a key part of making hydrogen power possible.

J.P. Nicot, a senior research scientist with the GeoH$_2$ group, is investigating whether hydrogen can be stored in the same types of formations as natural gas. Hydrogen behaves differently from natural gas, Nicot said. It's more buoyant, flows more easily, and it can participate in different types of chemical reactions with the rock, fluid and microbes in a storage site. Computer simulations of actual storage sites that swap the injection of natural gas or CO_2 for hydrogen show just how much these properties matter.

Mojdeh Delshad, a research professor in UT's petroleum engineering department, gave two examples of these simulations during the GeoH$_2$ group's first public presentation on July 15, 2021. One showed the Gulf Coast Carbon Center's Frio Brine pilot experiment, with the hydrogen plume extending further and rising higher in comparison to the CO_2. The other swapped a simulation of a natural gas storage site in Colorado. Here, the hydrogen migrates away from the caprock that keeps the natural gas secure and helps pressurize it for more efficient production.

"Regardless of all the experiences we have, [hydrogen] storage is challenging, and we require additional R&D to have a future that's safe and successful storage in geological settings," Delshad said.

Nicot said that field experiences are a necessary step in that R&D process. He said that small-scale, well-monitored hydrogen storage experiments, conducted in a manner similar to the Frio Brine pilot project, could go a long way in advancing hydrogen storage research—and getting hydrogen into the marketplace faster.

"You're not going to convince a company to do it for real only with models," he said, adding that the bureau is well positioned to lead field testing. "We have done that sort of experiment with CO_2 and with regular gas, so we know how to do it."

Figuring out where to store hydrogen is important. But another key aspect of hydrogen as it relates to the energy transition is the matter of making the gas. Currently, about 98% of hydrogen is produced by reacting natural gas with steam, which produces a mix of hydrogen and CO_2. To make hydrogen a truly environmentally acceptable fuel option requires capturing and storing the CO_2 emissions.

Several potential options for doing that exist, from ramping up carbon capture and storage technology to boosting the efficiency of bioreactors, where oxygen-starved algae make hydrogen instead of CO_2, or electrolysis, which uses electricity to liberate hydrogen molecules from water.

Senior research scientist Ian Duncan and his team within the GeoH$_2$ group are in the early stages of investigating a method that extracts hydrogen directly from crude oil in depleted reservoirs while keeping all other emissions in the ground.

Called in-situ hydrogen generation, it works by turning a reservoir into an underground chemical processing plant, catalyzing the same reactions that generate hydrogen from natural gas in industrial processes carried out at the surface. The hydrogen is separated using selective ceramic membranes and brought to the surface. Other emissions, including CO_2, are kept in the ground or injected back into the subsurface.

In 1985, BP, conducting experimental studies of in-situ combustion of oil (a standard enhanced oil recovery approach) at the Cold Lake heavy oil field in eastern Alberta, unexpectedly produced hydrogen and carbon dioxide in small but irregular volumes. More recently, the Canadian startup Proton Technologies has been in the early stages of producing hydrogen in-situ from oil sands reservoirs in Saskatchewan. But by and large, the technology has received little research attention, especially in the United States.

PHOTO: CAROL M. HIGHSMITH.

LEFT: OIL FIELDS NEAR MIDLAND, TEXAS. NEW TECHNOLOGY COULD HELP CONVERT OLD, UNUSED OIL AND GAS WELLS INTO GEOTHERMAL WELLS.

BOTTOM: KEN WISIAN STUDIES A ROCK SAMPLE THROUGH A MICROSCOPE IN THE BUREAU OF ECONOMIC GEOLOGY MINERAL STUDIES LAB.

Duncan is working to change that, providing an overview of the technology and its potential at the GeoH$_2$ meeting. He noted that with 50% of oil discovered in the United States still in the ground, there is a large energy supply for which to put in-situ hydrogen production to work.

"The potential for low-cost [hydrogen] integration with integrated CO_2 storage has promise," Duncan said at the closing of his presentation. "It's going to be difficult. It's going to be complicated. It's going to be a challenge, but the prize will be large."

Duncan and his research team are also investigating how excess energy produced by wind turbines and solar arrays can be put to use making hydrogen via electrolysis. The hydrogen could then be drawn upon to generate electricity when the sun isn't shining, or the wind isn't blowing—overcoming renewable energy's intermittency problem.

In-situ hydrogen generation has the potential to turn hydrocarbons into a source of carbon-free fuel. And advances in electrolysis could do the same with water. But for the time being, producing hydrogen means grappling with the problem of CO_2 emissions during the production phases.

Geothermal energy doesn't have that problem. Thanks to hydraulic fracturing technology, this source of energy has the potential to go from working only in geologic hotspots to almost anywhere in the world.

The bureau is partnering with a Houston-based geothermal company to demonstrate the technology's promise by building a geothermal power generator near the heart of Houston.

GEOTHERMAL

Texas is not a conventional geothermal prospect. Aside from a region of elevated temperatures along the Gulf Coast—which fueled an experimental 1 megawatt power plant for six months in the 1970s—Texas rocks just don't bring the heat that most methods of geothermal energy production rely on.

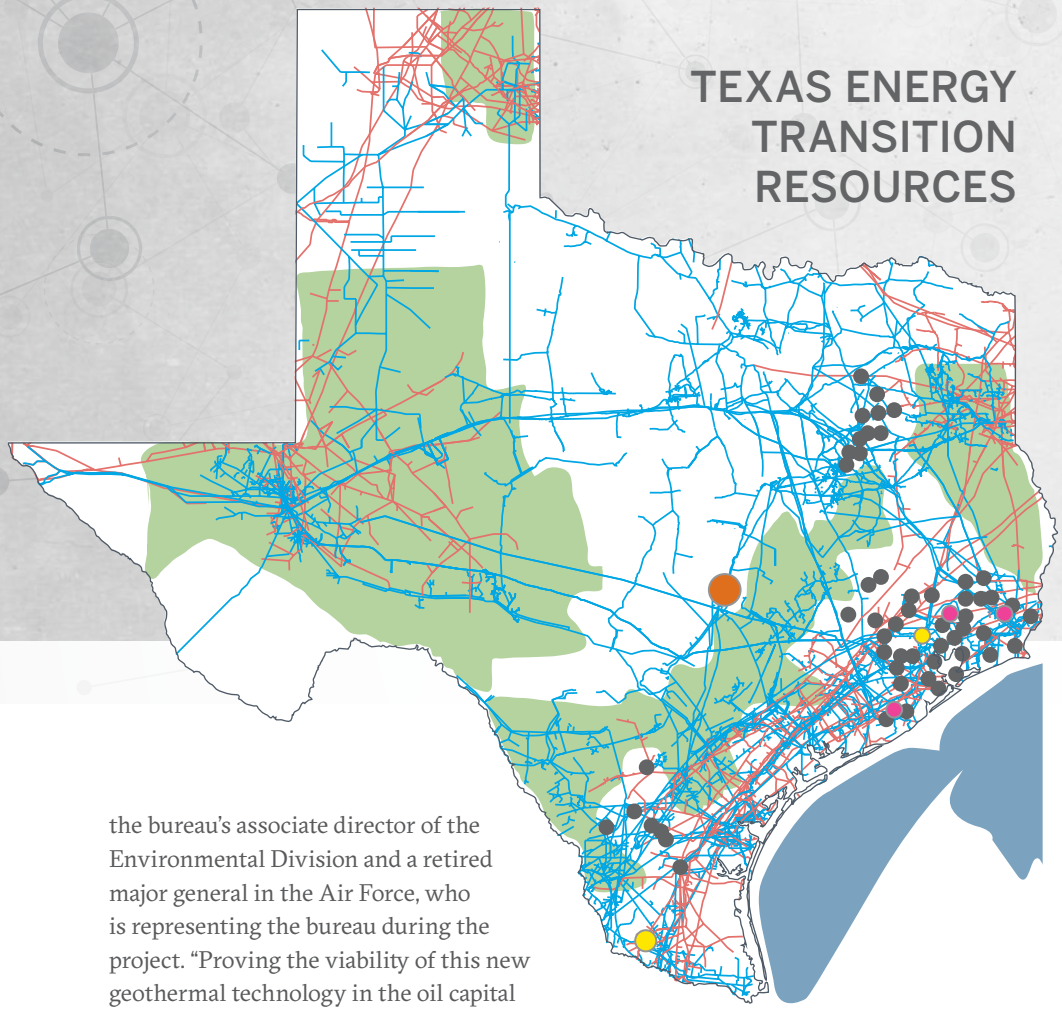
But for the next generation of geothermal technology, that's not a problem.

That's because it can transform the relatively low temperatures regularly encountered by oil and gas wells, about 100-250 degrees Celsius, into enough energy to run a small power plant. And it works by adapting hydraulic fracturing technology and other technology advancements to boost heat exchange between the rocks and circulating fluids that bring the heat to the surface.

For the past two years, the bureau has been helping mentor and support startups working to adapt techniques that began in the oil and gas industry to the geothermal sector as part of UT's Geothermal Entrepreneurship Organization (GEO). In May 2021, it partnered with one of those startups, Sage Geosystems, on a project to bring geothermal power to Ellington Field Joint Reserve Base in Houston.

"It has good potential to be the project that really breaks ground in this new paradigm in the U.S. and definitely in Texas," said Ken Wisian,

OIL FIELDS: FORMULANONE/FLICKR. MICROSCOPE: NUZHA ZUBERI/REPORTING TEXAS.



the bureau's associate director of the Environmental Division and a retired major general in the Air Force, who is representing the bureau during the project. "Proving the viability of this new geothermal technology in the oil capital of the world—Houston, Texas—will get the kind of attention that it wouldn't get if it were done in conventional geothermal zones in the western U.S."

Wisian's background couldn't be better for the project. He earned a Ph.D. in geothermal geophysics while serving in the U.S. Air Force, and from 2009 to 2011, he was commander at Ellington Field.

Before work gets started at Ellington, the bureau and Sage are testing the geothermal technology in South Texas, converting an abandoned exploratory gas well in Starr County drilled by Shell in 2008 into a field test site. The well reaches 19,000 feet into the subsurface, but the Sage system does not need to go that deep. The plan is to run the experiment at 12,000 feet, collecting data on fluid flow, pressure and temperature, which will help determine the effectiveness of Sage's proprietary technology and the construction plans for the Ellington Field well.

But old oil and gas wells could do more than serve as test sites. Through its "Wells of Opportunity" initiative, the Department of Energy is supporting research that is repurposing these old wells to tap geothermal energy. Sage's chief operating officer, Cindy Taff, said that the company and the bureau are planning to continue development of the Starr County well into an energy producing well—and potentially could leverage knowledge gained from that to transform other old wells in the area.

From existing infrastructure to drilling and completion technology to subsurface expertise, there is much overlap between the worlds of oil and gas and geothermal. Sage's leadership team all have oil and gas backgrounds, with Taff having spent 36 years in the petroleum industry and serving as vice president of unconventional wells and logistics for Shell's global operations before joining Sage.

"Geothermal is such a natural segue from oil and gas to renewable," Taff said. "You're drilling a hole in the ground, but instead of going for oil and gas, you're going for heat."

At Sage, that expertise has resulted in three proprietary geothermal designs: HeatRoot, which collects heat via downward-oriented fractures; HeatLoop, where multiple lateral wells are connected with a fracture network or through lateral wellbores; and HeatFlood, which uses hot, produced fluids to heat a working fluid in a downhole heat exchanger.

Each design uses supercritical CO_2 as a circulating or working fluid to collect the heat from the subsurface and use it to power an electricity-generating turbine.

At Sage and other geothermal companies, what geothermal design works best depends first and foremost on the underlying geology. The bureau helped advance knowledge of what the state's geothermal landscape looks like by leading mapping campaigns in the 1970s and 80s. Wisian said that new geothermal technology calls for new assessments. He is working with the UT Energy Institute on a Mitchell Foundation-funded project that will do just that for the entire state, drawing on well logs, rock cores and other data to conduct a new analysis.

"It's appropriate to do a new assessment of Texas, particularly with an eye towards these new technologies," Wisian said. "The potential of geothermal anywhere changes the picture, and it needs to be evaluated in that context."

MAP: ESRI/GULF COAST CARBON CENTER/SAGE GEOSYSTEMS/AMERICAN GEOSCIENCES INSTITUTE.

The well at Ellington Field is projected to generate about 3 MW of power for a secure micro-grid on the base. That's plenty to power Ellington. But it's less than 1% of the 830 MW capacity of the natural gas-powered Deer Park power plant just a couple of miles from the base.

What low-temperature geothermal wells lack in sheer megawatts produced, they make up for in scalability, Taff said. The specially designed CO_2 turbine is relatively small—about the size of a large desk—with most components able to be kept underground. If a customer needs more geothermal power, it can keep adding wells. This build-as-you-go approach creates an energy system that can grow with power needs. It also makes for a more resilient power grid. If one well goes offline, it doesn't affect the rest.

If the Ellington Field project is successful, it will be among the first—if not the first—to demonstrate geothermal technology working in lower-temperature rocks, according to Taff. However, she said that when it comes to its impact in the energy transition, the true measure of success for geothermal will be cost. The electricity produced by geothermal needs to be affordable to consumers.

The fact that low-temperature geothermal is working in the same depth and temperature domains as oil and gas, using the same drilling techniques and equipment, can help keep those costs low—as well as provide work for what's been oil and gas sector jobs, Taff said.

"We can basically use the off-the-shelf drilling techniques, off-the-shelf drilling equipment, and people in the oil and gas industry know how to drill," she said. "You don't have to train them. You don't have to invent anything new, and that makes wells cheaper."

The opportunities for oil and gas expertise in geothermal energy was the key message at Pivot 2021, a four-day, public, online conference on geothermal energy hosted by GEO in July and attended by more than 14,200 people in 103 countries, with Taff and Wisian taking part in panels.

PHOTO: GPA PHOTO ARCHIVE.

DOWNTOWN HOUSTON. THE ENERGY EXPERTISE AND EXPERIENCE IN THE CITY, AND TEXAS AS A WHOLE, CAN HELP MAKE TEXAS AN ENERGY TRANSITION LEADER.

In her opening remarks, GEO's executive director, Jamie Beard, explained how the term "pivot" applied to the energy transition.

"A pivot is a transition, but it's just a lot faster," she said, quoting GEO principal investigator and internet entrepreneur and engineer Bob Metcalfe. "Pivot is all about engaging the right minds to get geothermal development going at exponential growth during the next decade."

TEXAS TOGETHER

Texas is in a good position to do that for geothermal. But as the diverse research streams at the bureau show, it doesn't stop there. When taken together, a new energy landscape starts to emerge across the state, branching from the infrastructure of the oil and gas industry.

But in addition to refineries, pipelines and other structures, the oil and gas industry has brought another critical resource to Texas: people, many of them geoscientists. The state's public universities play an important role in educating them to navigate the rich energy landscape across the state.

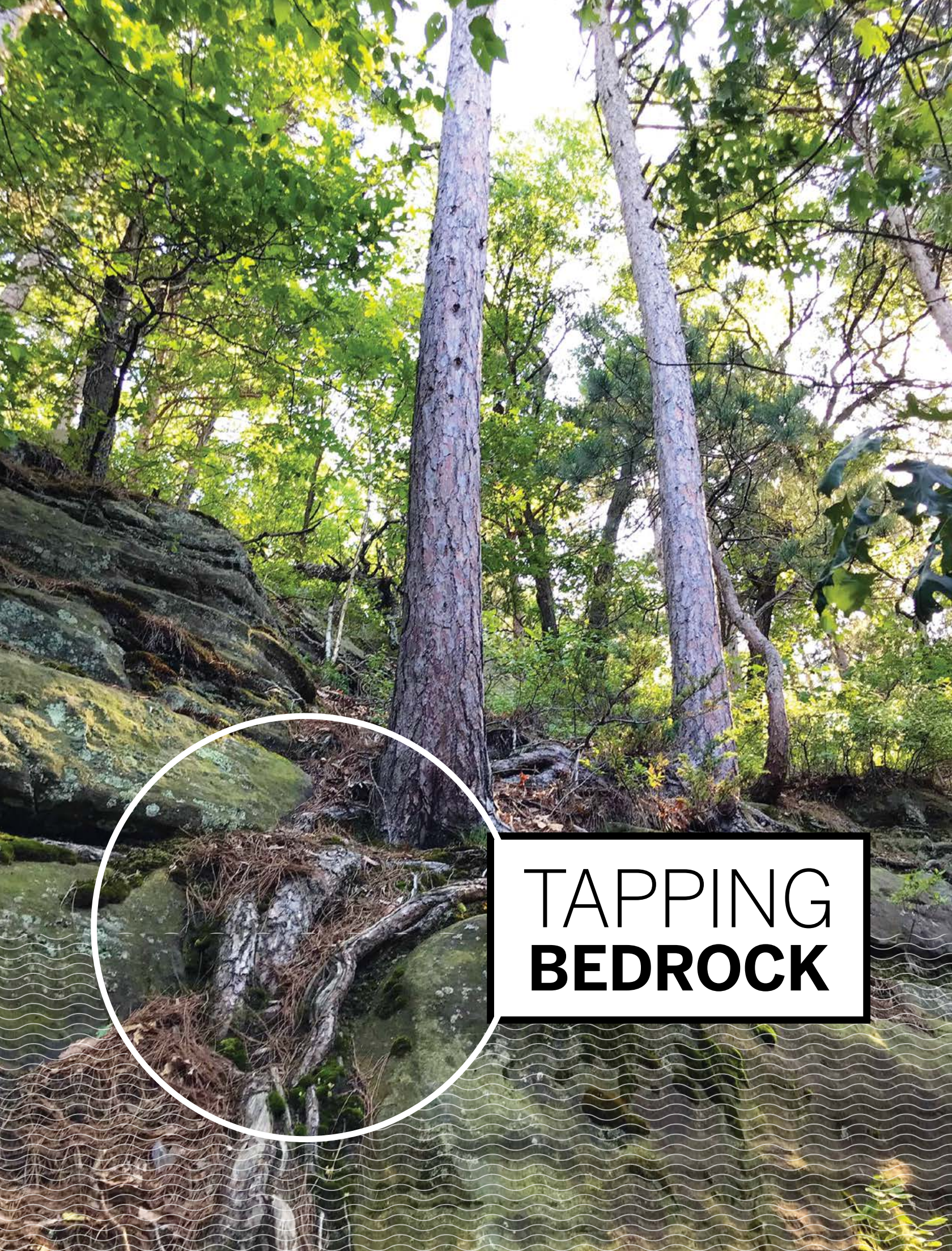
"The Texas geoscience workforce pipeline is unparalleled," Meckel said. "People come from all over the world to go to UT and Texas A&M to learn energy science."

As scientists at the bureau conduct energy transition research, they're training the next generation of geoscientists to take on the energy challenges facing society. In some ways, this work is continuing to do what they've always done: fundamental earth science with an eye toward application and serving the state of Texas. In other ways, Meckel said, it's allowing for whole new opportunities for growth in the geosciences, at the bureau and in the energy industry as a whole.

"I grew up in Houston, and I have great friends all along the Gulf Coast, and you know that every time a hurricane comes, we don't just build back. We want to build back stronger and use the opportunity to get somewhere you weren't before," he said. "I feel that this is where we are in the energy transition."

As the energy transition continues, most of the conversation has focused on strategies for reducing CO_2. Tinker said that although this is an important goal, policymakers and companies must not lose sight of the fact that sustainable energy production is more than just carbon. It's also providing safe, reliable energy access for all populations around the world, while also preserving the environment and investing in natural resources.

"The energy transition must continue to lift the world from poverty to prosperity, which takes a lot of energy," he said. "It must also clean up the impacts of all forms of energy on the environment. That includes emissions from combustion of fossil fuels, but also mining impacts to produce and dispose of materials for wind turbines, solar panels, batteries and more at scales never seen before. Geoscientists are needed in every phase."



TAPPING **BEDROCK**

NEW RESEARCH IS REDEFINING INTERACTIONS BETWEEN GEOLOGY AND THE WATER CYCLE

BY ANTON CAPUTO & MONICA KORTSHA

You can't squeeze water from stones. But tree roots can tap them. It's a phenomenon that has been documented for more than a century and one that's easy to observe. We have all seen seemingly thriving trees perched on rocky outcrops.

The scene is mostly treated as a curiosity in the scientific community, with soil being accepted as the de facto source of water for most trees.

But emerging science being spearheaded by researchers at the Jackson School of Geosciences is painting a different picture. Using remote sensing and on-the-ground fieldwork, scientists are finding that trees are routinely accessing significant amounts of water stored in bedrock. This is happening across diverse climates and biomes throughout the continental United States and, probably, the world. What's more, the trees are turning to water in bedrock more frequently than scientists previously thought, with data showing that they use it as a regular source of water, not just an emergency reserve.

It's a paradigm shifting finding that overturns long-held assumptions about where trees get their water. Scientists say the dynamic seems to be particularly important in some drought-prone areas of the country such as California and Texas.

The science also demonstrates the need to account for rock moisture—the water clinging to cracks and pores in otherwise dry underground rocks—when making predictions about how forests will respond to climate change.

"[Rock moisture] is a critical part of the water supply for plants and trees," said Daniella Rempe, an assistant professor at the Jackson School who is leading research on rock moisture in the environment and co-authored a study offering the first estimate of how frequently forests tap bedrock across the continental United States. "This impacts a number of fields in the earth sciences. We need to start incorporating this water into our conceptual models."

The study was published in *Nature* in September 2021. It was led by Jackson School undergraduate Erica McCormick, who graduated with a bachelor's degree in geology in 2020 but stayed on as a research assistant in Rempe's lab during the COVID-19 pandemic while she waited to travel to Australia to pursue a Ph.D.

LEFT: FOREST ROOTED INTO SANDSTONE BEDROCK IN GOVERNOR DODGE STATE PARK, DODGEVILLE, WISCONSIN.
PHOTO: RACHEL BREUNIG.

RIGHT: ERICA MCCORMICK IN ONION CREEK AT THE JACKSON SCHOOL'S WHITE FAMILY OUTDOOR LEARNING CENTER IN MAY 2019.
PHOTO: JACKSON SCHOOL.

The researchers found that trees tapping bedrock is far from rare: It's happening across the country, with the scientists detecting the behavior in about 24% of forests and shrubland—an area greater than the size of Texas—during the 14-year study period of 2003-2017, about 36% of trees tapped into bedrock every year.

To Rempe, finally putting numbers to a phenomenon that everyone suspected was happening to some degree is a big first step in the emerging research. But she's most proud of the fact that the notable finding was possible only because of the research—both in the field and with data sets—of Jackson School students and postdocs. Co-authors include Jackson School graduate students Alison Tune and Logan Schmidt and research associate Dana Chadwick. David Dralle, a research hydrologist with the U.S. Forest Service, and Jesse Hahm, an assistant professor at Simon Fraser University and former Jackson School postdoc, were also part of the team.

RIGHT: JESSE HAHM, A STUDY CO-AUTHOR, ALONGSIDE A TREE ROOTED INTO BEDROCK ON MAYNE ISLAND, BRITISH COLUMBIA.

BOTTOM: ERICA MCCORMICK INSTALLING SENSORS ON A BALD CYPRESS TREE ALONG WALLER CREEK IN AUSTIN.

ERICA: UT AUSTIN. TREE: CLAIRE WILKIN.

"Little pieces of the project were attacked by different lab group members over the years, but it didn't come together until Erica combined her extensive literature review with a new method for estimating water storage," Rempe said. "It's a big accomplishment for the group."

McCormick and the team used a combination of public data sets that track precipitation, soil depth and water storage, snow cover and evapotranspiration (the amount of water evaporating from the land surface and transpiring from plants) in forests across the country. They concentrated on areas with shallow bedrock (less than 1.5 meters underground) and eliminated all areas that offered another source of water to trees aside from bedrock and soil, like a nearby stream. The remote sensing data came from satellites. The scientists also compared the results with ground measurements taken in past studies from sites in Texas and California.

What they found was that the numbers didn't add up. There simply wasn't enough water in the soil in many places to account for the amount of moisture being released into the atmosphere through evapotranspiration. Moisture from bedrock had to be making up the difference — which could be significant. The researchers found that forests in California alone take up about 16.2 million acre-feet of rock moisture each year, a volume about equal to the storage capacity of all the state's human-made reservoirs and nearly three times that of the state's annual domestic water use.

McCormick said the study's results should be a wakeup call for hydrologists and others trying to predict and manage water supplies.

"If you are trying to figure out how much water there will be in a stream at the end of summer, how much water will actually recharge groundwater when it rains, you have to account for where water gets stored," she said. "By assuming that trees are just using soil, you could be missing a huge component."

TREE ISLAND: PEXELS.

TREES ROOTING INTO ROCK IS NOT AN UNCOMMON SIGHT. IT HAS EVEN MADE IT INTO STOCK PHOTOS. BUT BEDROCK HAS LONG BEEN OVERLOOKED AS A POTENTIAL SOURCE OF WATER.

Rempe has already demonstrated how important rock moisture can be for forests facing drought. In a 2018 study, she found evidence that rock moisture helped trees at field sites in Northern California survive a severe drought that killed 100 million trees across the state from 2010 to 2015. As climate change is expected to intensify both rain and drought, getting a handle on the storage capacity of rock moisture in bedrock and how much trees depend on it is important for projecting the long-term fate of forests, Rempe said.

"We have conceptual models for how the subsurface impacts a plant community, but we don't have the volumes and the timescales of this reservoir to incorporate into our predictions," she said.

The latest study is an important first step in that regard. However, the researchers were very conservative with their methods, Rempe said. They excluded all areas where spotty data or uncertain sources of water could muddy the numbers. And at this point the researchers only definitively say trees are using rock moisture in areas where annual rainfall did not cover the amount of water evapotranspired from a forest in a year.

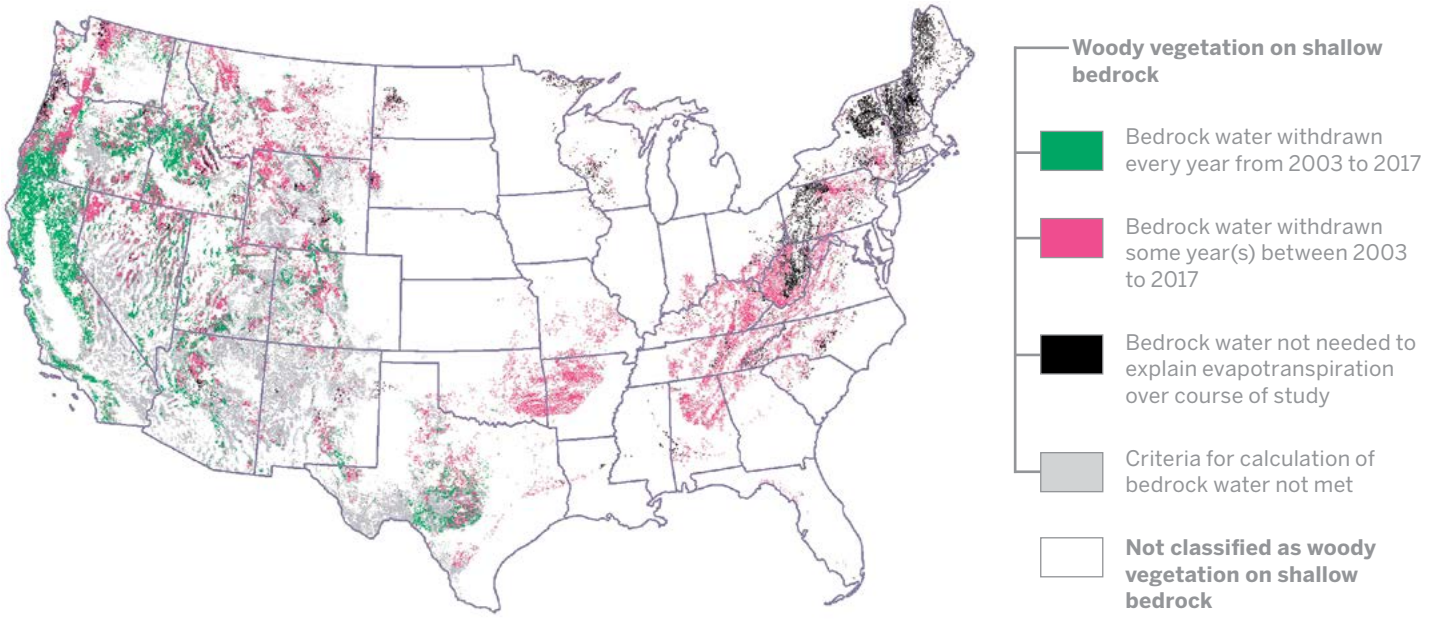
DANIELLA REMPE (RIGHT) INSTALLING EQUIPMENT FOR MONITORING GAS IN BEDROCK FRACTURES WITH ANDY MANNING OF THE U.S. GEOLOGICAL SURVEY IN RED WELL BASIN, NEAR CRESTED BUTTE COLORADO.

This approach means that the countrywide estimates presented in the study are the bare minimum. Rempe said she estimates that the actual extent of trees tapping into bedrock and the volumes accessed could be double what was reported.

Her estimate is informed by data collected from individual field sites in Central Texas and California that show rock moisture outshining soil as a water source. For example, at six sites in California and two in Central Texas, more than 50% of water evaporated from trees came from rock moisture. At most of these sites, the rocks held significantly more water than soil—up to 10 times as much.

To Susan Schwinning, a professor of plant ecology at Texas State University who was not involved with the research, the study is a huge leap in knowledge, proving what was once thought to be odd behavior to be essential.

"It's taken 100 years to come from this anecdotal evidence—'oh, wow, tree roots can actually go that deep'—



REMPE: DANIELLA REMPE.

to understanding that this is probably, in many places, an important part of defining ecosystem dynamics," she said. "If you're working in climate change research or earth system sciences, you will have to think seriously now about how to modify models."

The future of the research is wide open. The study area was limited to the continental United States, but the researchers are confident the findings are applicable in other parts of the world.

McCormick spent nearly two years of her undergraduate work conducting the literature review for the paper, which led researchers to conclude that, in general, whenever trees can put roots down into bedrock, they do. The study cites 65 papers, but she pored over about 300 spanning more than a century, looking for any mentions of tree roots tapping bedrock. What she found was evidence of trees tapping bedrock from a wide assortment of publications, covering nearly every type of environment and documented on five continents.

"Most of the papers I have read were about something totally different like avalanches or something, and I'd be looking for that one sentence to see if they mention if a root was in a rock," she said. "It was a lot of work."

McCormick is going to pursue a Ph.D. and plans to continue the work in graduate school as she tries to emulate her mentor.

"My goal is to be a mini-Daniella someday," she said. "I want to be a professor."

Rempe wants to continue to take the work into the field in Texas, Colorado and California. This will probably provide some great opportunities for students to do fieldwork and, in some cases, not that far from campus. Rempe said that the monitoring program being set up at the White Family Outdoor Learning Center—a 267-acre Hill Country ranch donated by Leslie P. and Dianne White that the Jackson School is using as part of its Texas Observatory network—is a perfect spot for some of the research. Her group has already documented plants and trees drawing significant amounts of water from bedrock at the site and hopes to document how different Texas trees compete for this deep resource.

Rempe has already tried tracking the water from rocks to trees by injecting isotopic tracers into the bedrock at a site in California and plans to do the same at the White Family Outdoor Learning Center soon. Her pilot experiment in California failed because her team underestimated how much water trees were using from bedrock, and the tracer was not strong enough. She was recently awarded funding from the National Science Foundation to try again with a stronger tracer label.

The idea is to start putting a finer point on how bedrock water and trees interact, and what that means for the wider environment.

"We've literally barely scratched the surface when it comes to understanding water storage," she said. "As the West and Southwest are predicted to experience more prolonged drought, this deeper storage will be important to understand."

REMPE: LOGAN SCHMIDT. TREE: ERICA MCCORMICK.

ABOVE: DANIELLA REMPE DRILLING HOLES NEAR THE UPPER SLATE RIVER.
RIGHT: AN OAK TREE ROOTING INTO BEDROCK AT THE JACKSON SCHOOL'S WHITE FAMILY OUTDOOR LEARNING CENTER.


BLUE
SKY

CHANGING THE WORLD WITH HIGH-RISK, HIGH-REWARD RESEARCH

BY CONSTANTINO PANAGOPULOS

Sometimes, to make a discovery, a scientist must take a chance on an idea, let it free into the sky and see where it lands.

At the University of Texas Institute for Geophysics (UTIG), visionary thinking is recognized and encouraged among its researchers and indeed supported through its new Blue Sky funding program. Under the program, a team of scientists has traveled to Alaska to try out an eccentric, but promising, idea to monitor ice sheets by listening to them. Another has attempted to geo-fingerprint sand as a way of solving an illicit trade problem. Yet another is working with the City of Austin to preserve the city's lakes from climate wear and tear.

"The idea behind Blue Sky is to empower our research scientists by providing the freedom to flex their creative muscles and investigate a new idea that may lie outside of their research direction, without knowing if it's going to work," said UTIG Director Demian Saffer. "It's for high-risk, high-reward research, the kind of serendipitous discoveries that could change how we approach long-standing problems or think about the world."

Saffer launched UTIG's Blue Sky Program in 2020 to fund unconventional research ideas. Unconventional doesn't mean far out, cowboy science (the projects are peer reviewed by a science committee), it means pursuing new directions, investing in new capabilities and doing science for the sake of discovery.

A common riff among earth scientists is that you only get federal science grants when you've already done two-thirds of the research, or you know what you're going to find. That's largely a misconception, but it's true that federal agencies must produce science while protecting tax dollars. Inevitably, opportunities will be missed.

It's those opportunities that Saffer is aiming for with UTIG's Blue Sky Program.

"It's how slow earthquakes were discovered," he said, referring to a kind of slow-motion tremor that was discovered in 2001 when scientists set out to investigate earthquake faults using GPS sensors.

"No one went looking for slow earthquakes. They just thought to use this new technology to look at places where earthquakes happen. What they found has totally changed how we think about the earthquake cycle."

Exploration is a hallmark of UTIG. The institute's in-house capability for expeditionary science is second to none. It has its own engineers and technical personnel, a nimble (and much envied) administrative team, and warehouses stuffed to the roof with field equipment: things like ocean bottom sensors, portable solar-powered seismometers, a one-of-its-kind portable coring drill rig, airborne ice-penetrating radar systems, advanced computing clusters, and UTIG's own research vessel, the R/V Scott Petty.

ICE DRIFTS ACROSS THE FJORD FACING ALASKA'S HUBBARD GLACIER.
PHOTO: MARCY DAVIS.

This and more have for decades given UTIG's researchers the flexibility and freedom to pursue research without the need to charter or seek funding for specialized equipment. That means lower research costs and quicker turnaround.

In many ways, the institute was the perfect setting for the Blue Sky Program, but for many, the idea they could spend time on projects that weren't in their primary line of research took a little getting used to.

Saffer faced similar problems when he launched the program's first iteration at Penn State University in 2018, where he was then the head of the department of geosciences. Eventually, however, the ideas started to flow.

Among the Penn State projects was a collaboration between geologists and archaeologists to link tectonics with human evolution, and another to make a high-resolution map of the subsurface by plugging in to abandoned underground fiberoptic cables.

"Those were very cool projects, but at UTIG we're equipped for a different scale of science," he said. "That means thinking about how to tackle pieces of really fundamental, big questions, like how fast are sea levels rising, or how do we solve sand piracy, or why is climate change affecting our drinking water?"

Saffer wants to empower scientists to be creative without fear of being penalized. His only expectation is that research projects offer either a new collaborative partnership or strengthen an existing one.

For Jackson School of Geosciences Associate Dean for Research David Mohrig, the Blue Sky projects funded so far are perfect examples of research that tackle urgent societal challenges, a key mission of the school.

"I like that these projects let scientists engage with their creativity and push their research a few steps beyond the point assigned to a normal grant or contract. It's also a great opportunity to get more students involved in research and to get them thinking as full-fledged earth scientists," he said.

UTIG's Blue Sky Program funding can be used directly to support research costs, or it can be used to fund research fellowships for undergraduate students. The program has an annual pool of $75,000 and is funded by the Jackson School to run until 2024; beyond that, Saffer hopes to attract the support of donor or endowment funding.

Since its launch, the program has supported efforts to model icy worlds, unravel the origins of plate tectonics, map the ocean floor, digitize 15th century ship logs and create a code of conduct for the institute's researchers.

Among these are three with very different scopes, purposes and outcomes, but they embody the program's philosophy of collaborative high-risk, high-reward research.

One is a collaboration with The University of Texas at Austin's Department of Mechanical Engineering to develop new technology that can monitor glaciers under water. Another is a multi-institution effort to build and test a national forensic database for sand. And another is a partnership with the City of Austin to survey its lakes and find ways of preserving them.

The Acoustics of a Glacial Fjord

"Is that coming this way?" Matt Zeh asked. The engineering graduate student's attention was fixed on the cable he was feeding into the water, but he kept an anxious eye on the ice suddenly spreading toward him and his UT colleagues across the bay.

Zeh had reeled out just 50 feet of line when a chunk of ice the size of a building broke away from the glacier and crashed into the water, setting off a small ice wave that threatened to snap the mooring line or worse, smash the floating sensor it was attached to.

Sixty feet, 50 feet.

The barrel-like sensor bobbed cheerfully on the shimmering blue water as the icy swell rushed toward it.

Twenty feet, 10. Chunks of ice had surrounded the floating sensor. He heard a clang.

"Come on, get under there!"

At the last gasp, the sinking line yanked the instrument underwater. Zeh breathed a sigh of relief as a cheer went up around the small boat. One down, three to go, he told himself.

The sensors that Zeh and his UT colleagues were busy deploying opposite Alaska's Hubbard Glacier were underwater microphones that will remain anchored in the turbulent fjord for the next 12 months. When they are retrieved in August 2022, the sounds they will have recorded are hoped to be a goldmine of information about the most active part of a glacier and could help refine global sea-level rise projections.

The project's lead investigator Ginny Catania, a Jackson School professor and UTIG senior research scientist, said that few had attempted what they were doing because glacial fjords are such dynamic environments.

"You have icebergs and meltwater from the glacier bringing in cold fresh water, which is very different in density to the ocean water. So we first want to understand how sound propagates in this kind of environment over time. Then we want to know if we can get ice volume losses and melt rates from the sounds," she said.

The idea is to measure the sound of melting glacial ice, count the number of icebergs calving away from the glacier, and listen for the changing pitch of subglacial meltwater currents. By placing the sensors strategically around the fjord, sounds can be triangulated.

The system is the brainchild of Zeh, Catania, and engineering professor Preston Wilson, supported by funding from UTIG's Blue Sky Program.

If it works, it could provide continuous, low-cost monitoring for ocean glaciers and reveal processes that aren't visible from the surface.

At least that's the idea.

The problem is that no one really knows how soundwaves move, or propagate, in a glacial fjord. Even the U.S. Navy has struggled to understand the acoustics of these kinds of water environments—it's why Zeh's doctoral research in underwater acoustics is also funded by the Office of Naval Research.

Unlike the open ocean, glacial fjords are a mess of warm, salty seawater and cold, fresh water. They are also incredibly loud; the team described it like being surrounded by waterfalls and fireworks (the icebergs). That's largely because glacial ice pops as it melts.

"It sounds like Rice Krispies in a big bath of soda," Zeh said. The popping comes from air pockets trapped in the ice during snowfall, which become pressurized on the glacier's relentless march to the sea.

Along with turbulent underwater currents and jostling icebergs, the environment is a nightmare for underwater acoustics.

But the researchers think they can cut through all the noise. After mooring the four sensors, the team calibrated their equipment by driving the boat around the fjord while making controlled noises and measuring salinity and temperature (both of which affect sound propagation). This way of mapping the acoustic environment helps triangulate and isolate sounds, which they'll correlate with melting events recorded from land.

If all goes to plan, they'll have developed a new technological capability for the wider glaciology community, but there's still a long way to go and much uncertainty.

"There's been only a few studies in the past that listened to how glaciers sound in the submarine environment, which all ran into the problem that it's a very loud and dynamic environment," Catania said.

The measurements, models and sensor arrays mean that this time should be different, but they won't know until they return next summer to pick up the recordings.

Until then, all they can really do is wait.

Even if they don't hit pay dirt, Catania and Zeh have no regrets about the project. For Catania, it's enough to have pulled off an against-the-odds field expedition with a resourceful and capable team: "the kind of people who'll fix a broken propeller with duct tape, ice and a piece of plywood over lunch."

Zeh, meanwhile, is happy to be part of something that could make a difference in the world. Among his favorite experiences from the trip was being on a tiny spit of land near the glacier called Haenke Island, where they'd been setting up a timelapse camera. Nearby but unseen, a newborn iceberg crashed into the sea. Its sound rolled over him like thunder.

"There's only very rare moments in life when you take the time to sit and really listen to your environment," he said. "Out there on that island, in that moment, I heard the environment for what it was. It gave me reassurance that my Ph.D., what we're doing, all of this is real. It matters."

LEFT: UNDERWATER ACOUSTIC SENSORS ON THE WAY TO THEIR DEPLOYMENT SITE OPPOSITE HUBBARD GLACIER.
ABOVE: (L-R) MATT ZEH, DAN DUNCAN AND GINNY CATANIA ON HAENKE ISLAND PREPARING INSTRUMENTS (INCLUDING A TIMELAPSE CAMERA) THAT WILL MONITOR HUBBARD GLACIER FROM LAND AND HELP CORRELATE MELTING EVENTS WITH UNDERWATER ACOUSTIC DATA.

SENSORS: GINNY CATANIA. ISLAND: MARCY DAVIS.

Forensic Sand

It's summer 2018 and Zach Sickmann is looking to occupy his mind on the flight back to Austin from San Francisco. Scrolling through NPR's finance channel, he stops at a podcast about sand sustainability.

There's still sand in his hair from scouring the California coast looking for an anomaly that had abruptly restricted river sand flowing into Monterey Bay. He'd traced that to a nearby sand mine, but why were economists suddenly interested in the stuff?

The podcast told the story of a case in Jamaica in which thieves carted away an entire beach in dump trucks. When investigators traced the stolen sand to a beach resort, they called in geologists to prove the sand had come from the same beach. The techniques they used are as familiar as a rock hammer to Sickmann, who is a sedimentologist and postdoctoral fellow at UTIG.

The podcast had described a crisis in global sand piracy in which entire Indonesian islands had disappeared overnight. Surely, he reasoned, there must be experts like him working on solving the problem. He imagined an entire wing of the Hoover Building bustling with FBI geologists employed to help break the illicit sand trade.

It turns out there wasn't even one.

The thing about sand is that it's everywhere. It's the glass on your screen, it's the silicon in microchips, it holds up our buildings, and it's in the concrete paving our roads. It's by far the most mined, transported and utilized commodity worldwide, and the good stuff is running out fast. That's why a rising number of sand miners are going to environmentally damaging—and often illegal—lengths to get at low-cost, high-quality sand.

Inspired by that fateful podcast, Sickmann is today working on a proof of concept for a global sand fingerprint database that could help protect the world's rivers and coastlines from illegal mining. To do that, he is building a pilot database in Central Texas and testing whether it works on store-bought ready-mix concrete. If the concept works, authorities could trace any sand regardless of where, and in what, it ends up.

The plan, which is funded by UTIG's Blue Sky Program, is relatively straightforward. The first stage is to catalog samples from local sand mines and learn where processing plants source their sand. Next, he'll test how well sand retains its fingerprint when it ends up in commercial products such as concrete. The tests range from sifting and measuring sand grains, to zapping zircons with lasers at the Jackson School's formidable geochronology lab.

Importantly, he now has a team of collaborators: Aurora Torres, an ecologist at Université catholique de Louvain (Belgium) and Michigan State University; Raissa Ferron, associate professor of civil engineering at UT's Cockrell School of Engineering; and Daniel Stockli, a professor at the Jackson School and chair of its Department of Geological Sciences.

Torres was the only other scientist he found who was actively working on the problem and who understands the societal impact of the crisis better than most. Ferron is an expert in concrete materials who has useful industry connections and her own UT lab, where they can slice concrete thin enough to put under a microscope. Stockli is an expert in the chemical analysis techniques used to find where sand comes from, and his geochronology lab is one of the best equipped in the world.

Early signs are positive. The Central Texas database was completed in August 2021 and had begun testing to figure out whether the concept could work on a global scale.

The tricky part, said Sickmann, is still to come. For the concept to be successful, it will have to work outside of Central Texas in places like Asia and Africa

PHOTO: MATT MALKOWSKI.

OPPOSITE PAGE: UTIG POSTDOC ZACH SICKMANN COLLECTS SAND SAMPLES FOR ANALYSIS DURING A FIELD STUDY IN CALIFORNIA'S SAN FRANCISCO BAY IN 2021.

TOP, LEFT: THE BACK OF SICKMANN'S TRUCK ALSO SERVES AS A MOBILE LAB WHERE HE PREPARES SAND FROM DIFFERENT SITES FOR ANALYSIS.
BOTTOM, LEFT: SICKMANN WASHES A SAND SAMPLE FROM LLANO, TEXAS, BEFORE COMPARING IT WITH A LOCALLY BOUGHT BAG OF CONCRETE.
ABOVE: SAMPLES OF SEPARATED SAND TAKEN FROM SITES IN TEXAS AND SAN FRANCISCO.

where sand production is not commonly reported but where illegal sand mining and sand piracy are major economic and ecological problems.

To lay some groundwork, Sickmann and Torres recently attempted to put a figure on how much sand was being stripped from the River Ganges, which flows from India into Bangladesh. With no official production figures, or none that they knew of, they instead turned to Google Earth to locate sand mines, then calculated how much sand was leaving them by measuring the shadows cast from excavation tracks and onshore sand stockpiles. After some clever modelling in MATLAB, they figured that over the course of 2020, about 50 million cubic meters of sand was removed from just the Bangladesh section of the river, enough to fill the Houston Astrodome 40 times over.

"I'm having to wrangle so much information about things that aren't my area of expertise," Sickmann said. "It's not just what concrete is and how it's made. It's things like learning about sediment supply networks in Asia, or how sand is pumped onshore from mining vessels, or what the average height and length is of a typical dump truck in Bangladesh. It's about 3 meters, by the way. In all honesty, it can get stressful doing this. My brain is fried from trying to figure out how to make all this work, but in the long run I think it's going to be worth it."

The work has a way to go before it can be used to effectively regulate the global sand trade and protect the world's rivers and coastlines, but if the immediate project only serves to attract attention to a growing problem, it will have made an important first step to avert future crises.

SICKMANN: INESSA YURCHENKO. SAND: ZACH SICKMANN.

Saving Austin's Lakes

Floating on Lady Bird Lake among kayaks, paddleboards and Austin's gleaming downtown, the iconic urban waterway is an idyllic setting for a lazy, summer day.

The city is rightfully proud of its inner-city lake. Its waters and lakeshore trails are enjoyed by thousands each year. But in 2019, the lake was afflicted by an outbreak of harmful cyanobacteria —blue-green algae that produce toxins when conditions allow them to bloom. The algae were so toxic that some dogs who drank the lake water died.

Outbreaks of dangerous algae remain a problem for the City of Austin, which manages Lady Bird Lake and the adjoining Lake Austin. It's a problem that is likely to get worse because it's connected to the city's rapid urban development and climate change.

To tackle the problem, UTIG and the City of Austin are giving the lakes— which are artificial water bodies created by damming the Colorado River—a first-of-its-kind health checkup by taking high-resolution subsurface CT scans and performing biopsies of the normally benign algal mats that line the lakebed.

The checkup will tell the city the extent of the algae problem, its underlying causes and how to treat it.

Project co-lead Marcy Davis has lived near the lakes for as long as she's been a UTIG engineering scientist. For her, the project is a way to put her skills to use protecting her community. The chance to do that in partnership with a local organization is also why she sought UTIG Blue Sky funding for the project.

"For years, when we've tested equipment, we've put the boat on Lake Austin for a day or two and ended up mapping most of it at different periods," she said. "It just seemed right that we should put our data to use."

Over time, Davis had noticed the lakebed was changing. She didn't know what the changes meant, so she reached out to Brent Bellinger, a senior environmental scientist with the Watershed Protection Department at the City of Austin.

Davis' email was almost perfectly timed. It reached Bellinger not long after the 2019 toxic algae bloom had put a big question mark over the lakes' changing biogeochemistry. When he saw the capabilities Davis and the institute offered, it was almost too good to be true.

"With technology like this, we can tackle questions I just didn't have the tools to answer before," he said.

The yearlong project made its first comprehensive lake survey in early September 2021, when the lakes' algae were at their most active. The team, which included UTIG engineering scientist Dan Duncan and Jackson School doctoral student Naoma McCall, deployed a full suite of geophysical instruments on each lake, cut sections from algal mats and took samples from lakebed sediments. A second survey will happen in the winter when algae are expected to be dormant.

The surveys will show how much the algal mats grow between seasons and the effect they're having on the ecology of the reservoirs. Along with the cores, they will also reveal what's feeding them and when.

The main culprit, said Bellinger, who'd seen similar issues in the Great Lakes when he worked for the U.S. Environmental Protection Agency in Minnesota, is likely to be excess nutrients carried by river sediments; the nutrients feed the algae, and enough nutrients will put them into overdrive. The problem is made worse when zebra mussels, an invasive species of mussels from Eurasia, are present because they filter the water, allowing more sunlight to reach algae on the lakebed. The more sediments and zebra mussels in a lake, the more likely

SONAR: INSTITUTE FOR GEOPHYSICS. ALGAE: BRENT BELLINGER.

OPPOSITE PAGE, LEFT: DAN DUNCAN PILOTS THE R/V SCOTT PETTY OVER LAKE AUSTIN WHILE THE MULTIBEAM SONAR RECORDS BEDFORMS.
OPPOSITE PAGE, RIGHT: BENIGN GREEN ALGAE COVERS AN ANCHOR PULLED FROM AUSTIN'S LADY BIRD LAKE.

ABOVE: MARCY DAVIS, BRENT BELLINGER (ON DECK), DAN DUNCAN AND NAOMA MCCALL (BEHIND GLASS) ON THE FIRST DAY OF LAKE SURVEYS.
LEFT: TOM MILLER DAM AND THE COLORADO RIVER AFTER HISTORIC RAIN IN FALL 2018. REDBUD ISLE, WHERE TOXIC ALGAE OUTBREAKS OCCURRED THE FOLLOWING SUMMER, IS VISIBLE ON THE LEFT.

BOAT: INSTITUTE FOR GEOPHYSICS. DAM: MARCY DAVIS.

that the algae will bloom.

According to Bellinger, the flow of sediments is connected to the region's accelerating urbanization and increasingly frequent weather extremes.

In the summer of 2018, a long drought baked the surrounding hills until they were hard. When the rains finally came, the water had nowhere to go but overland, picking up soil and pollutants from the surrounding countryside and washing it into the river, turning it the color of chocolate milk. The dirt, debris and silt in the reservoirs overwhelmed water treatment plants and left a million residents under a boil water notice for seven days. The following summer, lakes were hit by toxic algae blooms.

The rainfall that autumn was historic, but the pattern of drought and deluge is common to Texas and one that climate scientists say will only get worse as the world warms. The problem is made worse by urban development because buildings and paved roads channel rainwater and debris straight into lakes and rivers. That means more and dirtier water going into rivers, more algae, more severe flooding, and more harm to water quality.

The city mitigates the problem through engineering projects, land purchases and public campaigns to slow the flow: things like water conservation efforts, growing buffer vegetation and reducing lawn irrigation. The partnership with UTIG means the city has access to technology that can help guide its actions and make them more effective.

Bellinger said he is hopeful for the future because despite the recent issues, Austin's lakes are in excellent health. He should know. He's worked major research projects in the Florida Everglades, the Great Lakes and Lake Tanganyika in East Africa.

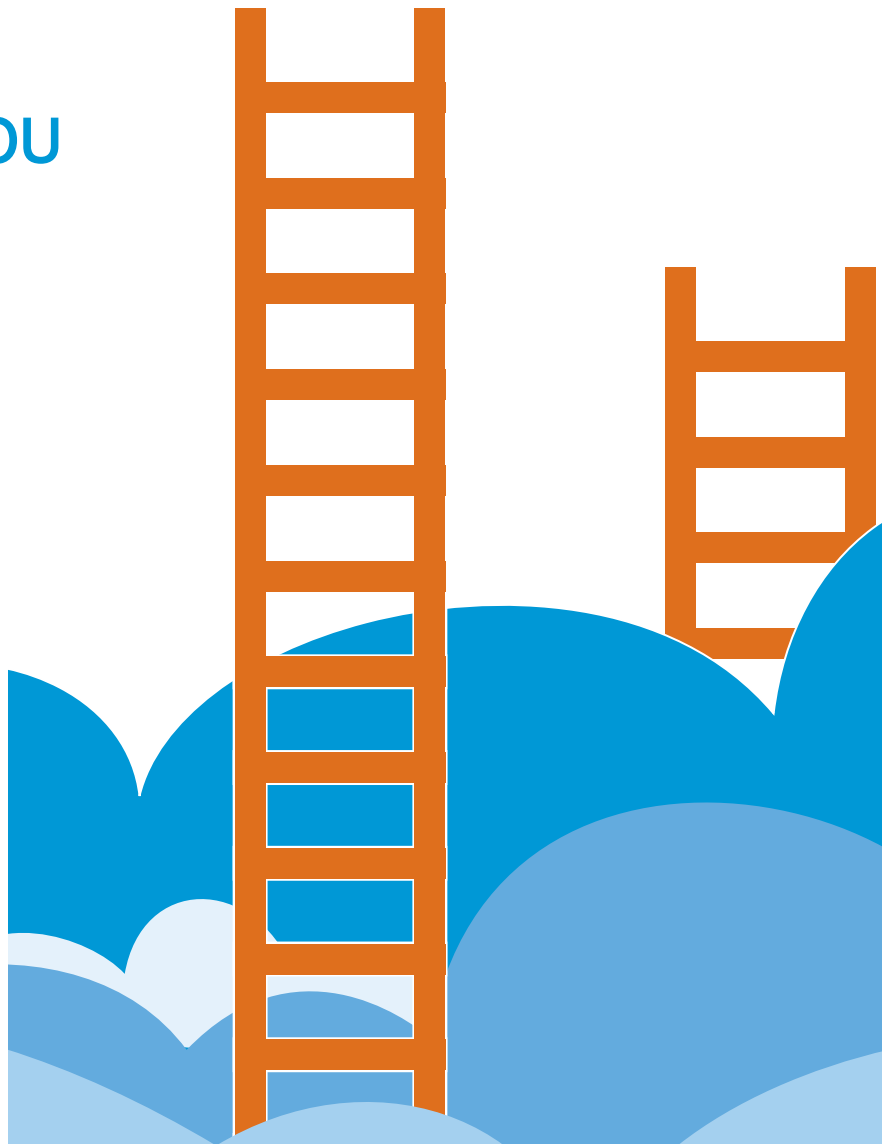
The project will be funded under UTIG's Blue Sky Program until 2022. If all goes well, Davis and Bellinger hope to continue surveying Austin's lakes with support from the City of Austin and The University of Texas at Austin Research Collaborations, a new program designed to facilitate research collaboration between UT and the city.

"I feel like I really lucked out with this UTIG collaboration because we're learning about the health and condition of the reservoirs—which is essential to protecting them—in a way we've never done before. So, let's ask some questions. Let's see what this technology can do," he said.

THE GEOSCIENCES ADVANTAGE

JACKSON SCHOOL OF GEOSCIENCES ALUMNI ARE FINDING OPPORTUNITIES AND CLIMBING CAREER LADDERS IN FIELDS AND SETTINGS THAT MAY SURPRISE YOU

BY ANTON CAPUTO



When most people think of the geosciences, they think of oil and gas, and with good reason. The ties between the industry and the science are long and proud. But the truth is that a top geosciences education prepares students for much more than a career in a single industry. And with most of the major challenges facing modern society having geosciences at their core, employers are beginning to wake up to the reality that geoscientists can be valuable assets.

From climate change and the energy transition to finding sustainable supplies of clean water and dealing with hurricanes, earthquakes and floods—geoscientists have expertise that no other discipline can offer. Add to the mix the fact that modern geoscientists are trained to handle massive data sets and high-tech tools, and the education becomes a foundation for a wide variety of potential career opportunities. On the following pages, you will find some great examples of Jackson School of Geosciences alumni who have used their hard-earned degrees and expertise to forge career paths that might not seem obvious at first glance. Finance, insurance and software are just a few of the examples.

Climate Translator

Kelly Hereid Ph.D. '12

"It is really an area where the rubber meets the road with climate impacts and climate adaptations."

-KELLY HEREID

Businesses and industries all over the world have begun coming to grips with a new reality: Climate change is going to affect their bottom line in any number of ways, and in many cases, they don't have the tools or the expertise to figure out how.

That's where someone like self-described "climate translator" Kelly Hereid comes in.

Hereid, who graduated with a doctorate from the Jackson School of Geosciences in 2012, is the director of catastrophe research and development at Liberty Mutual Insurance. It's a profession that a geosciences education is perfectly suited for, Hereid said, a fact that businesses were just recognizing when she entered nearly a decade ago.

"Now they very heavily recruit climate scientists because they have come to realize this is an important part of their risk management strategy," she said.

Hereid started her career in reinsurance, which is the industry that handles the biggest disasters by spreading risk among insurance companies. As a doctoral student at the Jackson School, she had no inkling of what her future had in store. Hereid did paleoclimate work on ancient coral to determine how El Niño and La Niña were affected by past climate and how the weather patterns might react to future climate change.

Hereid thought that academia may well be in her future. But after shopping her CV at the annual meeting of the American Geophysical Union, she was seemingly randomly contacted by someone in the industry asking whether she was interested in reinsurance. That sent Hereid scrambling to Google to figure out what exactly reinsurance was. Once she did, everything changed. Hereid quickly realized it was one of the first sectors that would be affected by climate change.

"It is really an area where the rubber meets the road with climate impacts and climate adaptations," she said. "The kind of risk management decisions that happen in the insurance or reinsurance industry fundamentally shape how our society will experience climate impacts from hurricanes and wildfires and floods."

She started her career with Chubb Insurance, the world's largest publicly traded property and casualty insurance company, where she served as an analyst before working her way up to senior research scientist and assistant vice president.

When she began, the industry was struggling to figure out how climate change might increase the frequency and strength of hurricanes, storm surge, flooding and a host of other variables that could make a disaster even more dangerous and monumentally more expensive. And she found that people throughout the business world were talking about climate risks, but lacked a toolkit to assess the strengths and weaknesses of climate models when applied to business problems.

Her job involves breaking down and reassembling catastrophe models, the tools that insurers and reinsurers use to manage the biggest and most severe disasters, and helping her colleagues understand how they should make business decisions based on the tools. These tools can help determine, for instance, how damaging a megadisaster like Hurricane Andrew would be if it were to hit again today.

Hereid, who is on the Jackson School's Geology Advisory Council, is tireless in her outreach to students about the relevance of a geosciences degree to modern business. Her No. 1 tip for those looking to break in is to learn how to succinctly communicate complex scientific topics to a diverse audience.

"I came in with a broad geoscience education where I can say something coherent about earthquakes, volcanoes, sea levels and hurricanes or whatever because I have some fundamental understanding of how the Earth's systems work," she said. "That really gave me a leg up."

The results, she said, can be quite fulfilling.

"I think just opening people's eyes to seeing that there is something you can do with geosciences that will legitimately help us adapt to climate change, that's what gets me out of bed in the morning," she said.

Coastal Protector

Kelly Brooks B.S. '09

"When I realized that we had a state agency that was dedicated to coastal resources, that really spoke to me."

-KELLY BROOKS

Growing up in South Texas, Kelly Brooks fell in love with the Texas coast, visiting often to surf, fish or just hang out with her family. So it's sort of poetic that years later, she is using her geoscience expertise to protect that same coastline.

Brooks, who earned a bachelor's degree from the Jackson School of Geosciences in 2009, is a project manager in the Texas General Land Office's Coastal Resources Division. In that role, she works with coastal communities, nonprofits and state and federal agencies to nourish beaches, restore and protect habitat, and generally protect the state's critically eroding coast.

She traces many of the skills she uses on a daily basis to her days at the Jackson School and fondly recounts being a "guinea pig" in the inaugural Marine Geology and Geophysics field course in 2008.

"I learned about geophysics, data collection and data processing and interpretation, really the full gamut," she said.

In addition, Brooks also learned how to design and plan her own surveys, a combination of skills that comes in handy for her current role, particularly when designing surveys for the new Texas General Land Office (GLO) initiative to map sediment and develop a sediment management plan for coastal projects.

"If you have those technical skills, it really helps the agency develop projects that are a more effective and efficient use of state funds," she said.

For instance, because of her geophysics knowledge, she can help the agency's Energy Resources Division with seismic permitting.

Brooks didn't go directly into coastal protection. After finishing a master's at Texas A&M University focused on geophysical oceanography, she took a position at Berger Geosciences in Houston, where she did third-party assessments of shallow hazards in the Gulf of Mexico—a burgeoning field in the wake of the Deepwater Horizon disaster. But she was itching to move back to Austin to be closer to family, so she decided to look at state agencies. That was her introduction to the GLO.

"When I realized that we had a state agency that was dedicated to coastal resources, that really spoke to me," she said.

In some ways, Brooks has gone full circle to her undergraduate Jackson School days. She now works with the Bureau of Economic Geology on coastal LiDAR surveys and with the Institute for Geophysics on a project to help find and catalog offshore sand resources.

Ultimately, she said she enjoys her role in managing restoration projects and guiding communities on how best to protect the Texas coast.

"You get to implement these large-scale projects, and you go back and visit and you see how much good they have done," Brooks said. "It's really great."

Jack of All Trades

Kiran Sathaye Ph.D. '16

"What I have found is that five to 10 years into the industry that jack of all trades thing starts to become very valuable."

-KIRAN SATHAYE

If Kiran Sathaye has learned one thing in his professional career, it's that you have to be adaptable.

Sathaye, who graduated from the Jackson School of Geosciences with a Ph.D. in 2016, is a technical sales adviser at Novi Lab, a company that specializes in software for unconventional oil and gas operators. Novi has proved to be a good spot for Sathaye to follow his passion for the energy industry and data science. He has already filled several roles during his three years there—data scientist, chief geophysicist, and now sales—and wouldn't be surprised if there are more in his future.

"In our company, the roles and needs that existed in 2019 are not the same that exist in 2021," he said. "That's just due to the maturation of the company. In a setting like that, you are going to find yourself either having to find a new company or change the way you contribute to success."

Sathaye proved adaptable even before Novi. That's how he got into software in the first place. Sathaye entered the Jackson School in 2011 with every intention of going into oil and gas, but as he neared the second half of his doctoral work, he saw signs of a significant downturn in the famously volatile industry.

Sathaye, who earned an undergraduate degree at the University of California, Berkeley, had contacts in the software industry back in California. After a few phone calls, he tweaked his doctoral project to use data tools more oriented to the software industry and graduated with a job offer from Snapchat as a data engineer. After a year and half at Snapchat, he did a short stint as a software engineer at Tala, a company specializing in microloans and operating mostly in Kenya. One thing he learned along the way was that those who major in physical sciences, like the geosciences, are well suited to process data in ways that are relevant for all sorts of businesses.

But Sathaye still wanted to work in the energy industry. So when he was contacted about a possible position at Novi Labs, Sathaye went for it. He finds the growing company a good fit, and as a self-described "jack of all trades," he likes the opportunity Novi has given him to flex different professional muscles.

He recommends students keep that in mind as they progress. In his experience in business, it's important to develop soft skills as well as technical

skills, Sathaye said, and avoid locking in too much on any single identity. For instance, as a data expert, he said that knowing specific tools is important to get a first job, but from there you really have to be willing to adapt and constantly learn.

"What I have found is that five to 10 years into the industry that jack of all trades thing starts to become very valuable," he said. "The important thing is to qualitatively understand numbers and understand how data is structured. The tools are going to be constantly changing."

Investment Banker

Indre Altman M.S. '20

"Honestly, the EER program was a lot more challenging than I anticipated, but in a very positive way."

-INDRE ALTMAN

Indre Altman's path through the geosciences took a conventional route for the first few years. She was introduced to the science as a high school student in the Jackson School of Geosciences GeoFORCE program. This led to her majoring in earth and oceanographic sciences at Bowdoin College in Maine, which fit the bill for the Houston native's desire to explore the northeast.

It was an internship during her senior year with Asia Pacific Partners in Mongolia where things started getting unconventional and put her on a path that would eventually lead to the investment banking industry.

Altman worked as a mining research intern. Her job was to brief the CEO on contracts and geotechnical reports and write a primer on the Mongolian mining industry. But what really caught her eye were the unique challenges that came with doing business in Mongolia, from the culture and politics to the logistics, financing and fundraising.

"I started to develop an interest in other areas of the mining and energy sectors," said Altman, who double majored in government and legal studies at Bowdoin.

Looking to expand on these growing interests in graduate school, but still wanting to improve her technical geosciences education, she found the Jackson School's interdisciplinary Energy and Earth Resources (EER) program a natural fit. She graduated from EER with a master's degree in 2020 and a job at Lazard as an investment banking analyst specializing in the energy industry.

Altman had been considering investment banking since about the time she started graduate school. She was drawn to the industry because of the strategic role it plays in helping companies grow and remain resilient. Because she wasn't in a business school, she had to find ways to plug herself into the industry's recruitment.

"The best advice I can give to people who want to recruit from something in business or finance is to really utilize LinkedIn, friends or other recruiting networks to get those conversations going," she said.

That's exactly what Altman did, turning a distant connection into a meeting over coffee with someone at Lazard. From there, she leaned on a friend from high school and fellow UT student who was getting into the industry to prepare her for the challenging interviews.

The work paid off. She landed an internship with Lazard and then the analyst position. She now spends her days modeling transactions and helping administer and manage the logistics of business deals. She said the industry isn't for everyone, but that it is great for those looking for a fast-paced, competitive environment, and that it recruits from all manner of backgrounds.

The EER program—with its fingers in geosciences, engineering, management, finance, economics, law and policy—really prepared her for the challenge, she said.

"Honestly, the EER program was a lot more challenging than I anticipated, but in a very positive way," Altman said. "Because it is interdisciplinary, there is a big learning curve in multiple areas. And for all of those, you have to master a different way of thinking."

Hydrogeologist

Chuck Abolt M.S. '15, Ph.D. '19

"It seems like the people who are most successful at the lab are those who are most able to adapt..."

-CHUCK ABOLT

Chuck Abolt's introduction to Los Alamos National Laboratory came in 2014 during a Jackson School of Geosciences hydrogeology field camp in New Mexico's Valles Caldera at a field site that bordered the lab. He found the area beautiful and the idea of working at the lab intriguing, particularly when he discovered it did permafrost work similar to his own graduate research.

Two internships and a couple of degrees later (Abolt earned a master's

from the Jackson School in 2015 and a Ph.D. in 2019), Abolt now finds himself finishing the second year of a three-year postdoctoral fellowship at Los Alamos. His work involves two projects on Arctic permafrost: One focuses on using satellite data to determine where permafrost is thawing most rapidly; the other uses computer simulations to predict how quickly permafrost will thaw over the next 100 years.

Abolt's move to the national lab didn't happen by accident. Shortly after he was introduced to Los Alamos, he discovered that the lab uses cutting-edge codes for simulating thawing and freezing through a program called the Advanced Terrestrial Simulator (ATS). He immediately downloaded ATS and began using it in his work.

"That way, when I reached out to the lab, I could say, 'Hey I already have a little bit of experience using this. It's a component of my dissertation and I would love to benefit from your expertise if you could take me on for the summer,'" he said.

This sort of hustling attitude wasn't a first for Abolt. After high school, he majored in Spanish and biology at Duke University and thought seriously about pursuing a Ph.D. to become a Spanish professor. But shortly after graduating in 2012, he concluded that he didn't love humanities research and wasn't sure about his career prospects. He did some online research and came up with a list of valuable degrees that included hydrogeology, which piqued his interest.

Lacking any background in the subject, he emailed professors and researchers at the Jackson School to see whether they could offer advice or, ideally, take him on as a master's student. The most promising response came from Michael Young, a senior research scientist at the Bureau of Economic Geology.

"I told him, I have a humanities background, and I'm pretty good at technical writing. Maybe I can edit some of your manuscripts or something like that,'" Abolt said. "In the meantime, I read a bunch of textbooks in geology to prepare before I got started in the master's program."

It worked. Young employed Abolt as a technical research assistant and was his adviser for his master's and Ph.D. work.

Two years into his career, Abolt said he is certain he made a good choice. He would like to stay on as a staff researcher at Los Alamos after his postdoc, which he points out is more common at the national laboratories than at a university. To do so, he said he's going to have to expand his research out of his current comfort zone. But he said that Los Alamos is the perfect setting for doing so because of its concentration of experts and the supportive environment. For example, he recently started working on a project about small earthquakes in New Mexico.

"It seems like the people who are most successful at the lab are those who are most able to adapt and are undaunted about doing research that is unrelated to anything they have done," he said. "As different projects and different funding sources come in, you can really make yourself useful."

Environmental Insurer

Dana Carstens B.S. '16

"I get to learn about some really unique locations and I really enjoy putting my geology background to use in an atypical way."

-DANA CARSTENS

Not long ago, Dana Carstens was unaware that the field in which she now works even existed. As an environmental broker for Willis Towers Watson, Carstens negotiates environmental pollution coverage with underwriters on behalf of her clients.

It may seem like an odd place for a geoscientist to end up, but to Carstens, the fit is perfect. She's far from alone in this particular niche of the insurance industry.

"Most of the people I work with are geologists or environmental scientists," she said.

The sites her clients are looking to insure often have long and complicated industrial histories that could leave a legacy of contamination. Understanding how to pore through environmental reports to find a site's environmental history and comprehend its geological attributes including subsurface flow, soil and water quality and aquifer characteristics are all vital when trying to place and negotiate environmental insurance policies.

It took a few stops before Carstens ended up in environmental insurance.

Carstens comes from a family of oil and gas professionals, but she didn't want to go that route. She earned an environmental science bachelor's through the EVS program at the Jackson School of Geosciences and followed that with a master's in geology from Tulane University in 2018. She loved geospatial and hydrology work and considered going for a Ph.D. and a career at a federal agency like the National Oceanic and Atmospheric Administration, but the specter of five more years of school didn't sit well. She had heard about environmental consulting in school and thought that might be the right fit.

"In your head it sounds like an exciting career path," she said. "I just kind of assumed that's where I would end up."

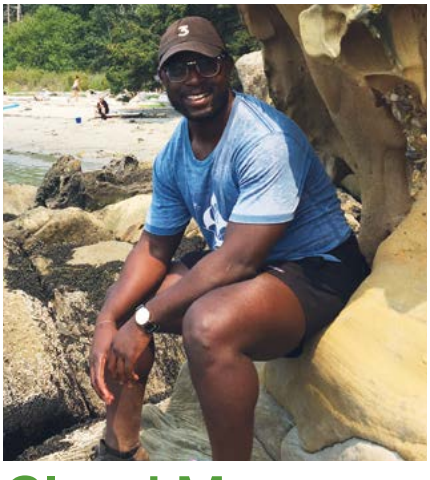
She was right. Carstens secured a job as a geologist with the environmental consulting firm Roux after earning a master's, working to remediate pollution on old industrial sites through groundwater and soil monitoring. She enjoyed putting her geology, geographic information system (GIS) and geospatial skills to work, but said that ultimately consulting was probably not a good

long-term fit. Everything changed when her company's insurance practice leader moved to her office.

"He ended up taking me under his wing, and he introduced me to the environmental insurance world," Carstens said.

At Roux, the insurance group worked with underwriters to perform loss control evaluations on a portfolio of properties to identify pollution risks and how these risks can affect the company's insurance program. She moved to Willis Towers Watson in January 2021 after someone from the company reached out to her on LinkedIn. Moving there has allowed Carstens to work in environmental insurance full time. She now uses her technical knowledge from school and her previous consulting experience to negotiate with underwriters for better coverage on behalf of her clients.

"I get to learn about some really unique locations, and I really enjoy putting my geology background to use in an atypical way," Carstens said. "I'm very happy with my choice."



Cloud Manager

Yomi Olufowoshe B.A. '12

"I thought, 'Let's explore this industry a bit to identify what about it piques my interest.'"

-YOMI OLUFOWOSHE

Yomi Olufowoshe's career path is a lesson in what can be achieved by following opportunity, and of the unexpected places a good geosciences education can take you.

Olufowoshe is an account manager at Google, working with large international clients in the retail, consumer package goods and energy services industries. His duties include helping customers determine how to best use cloud services to increase revenue and market share, reduce costs and solve their toughest challenges.

"It's not necessarily what I envisioned," he said. "But it feels right."

It was a bit of a winding road for him to get there, but Olufowoshe clearly doesn't mind taking a chance.

For instance, as a high school athlete in Alberta, Canada, Olufowoshe could picture himself at either The University of Texas at Austin or the University of Southern California. Trying to decide between the two, he left his fate up to the outcome of the 2005 National Championship game. So Vince Young's last-minute end zone dash brought both the crystal football and Olufowoshe to the Forty Acres.

He came with a lifelong interest in geology, but his plan was to pursue an education in medicine and become a cardiac surgeon. That all changed during his junior year when he took Jackson School of Geosciences Professor Chris Bell's Life Through Time class, which reawakened his passion for the geosciences.

Because of the late change, Olufowoshe didn't have much time to map out his postgraduation plans. As an undergraduate, he had heard that a master's degree was needed to forge a career in the geosciences, but he wanted to get some experience under his belt before he made any other big decisions.

"I thought, 'Let's explore this industry a bit to identify what about it piques my interest,'" he said.

It was a late internship opportunity with Landmark, the software arm of Halliburton, that set him on his path. Landmark liked him so much that they offered Olufowoshe a full-time job in the quality assurance department. His job entailed looking for bugs and defects in the software before it was released and working with the development team to fix and document the issues.

This gave him the opportunity to apply geological concepts he studied in school while testing the software, sometimes with eye-popping results.

"The interpretation I had done in class was all by hand," he said. "The first time I was able to do a full correlation just by clicking through with a mouse, my mind was blown."

Olufowoshe filled several roles at Halliburton, transitioning from his position in quality assurance to a product manager and then to a global sales role where he dealt with large oil companies and international accounts. Eventually, he was stationed in Italy where he helped with training and served as liaison between Eni and Landmark.

Olufowoshe's journey up the ladder at Landmark eventually got the attention of Google. He discussed multiple potential roles with the company before accepting his current position, which he started in April 2021.

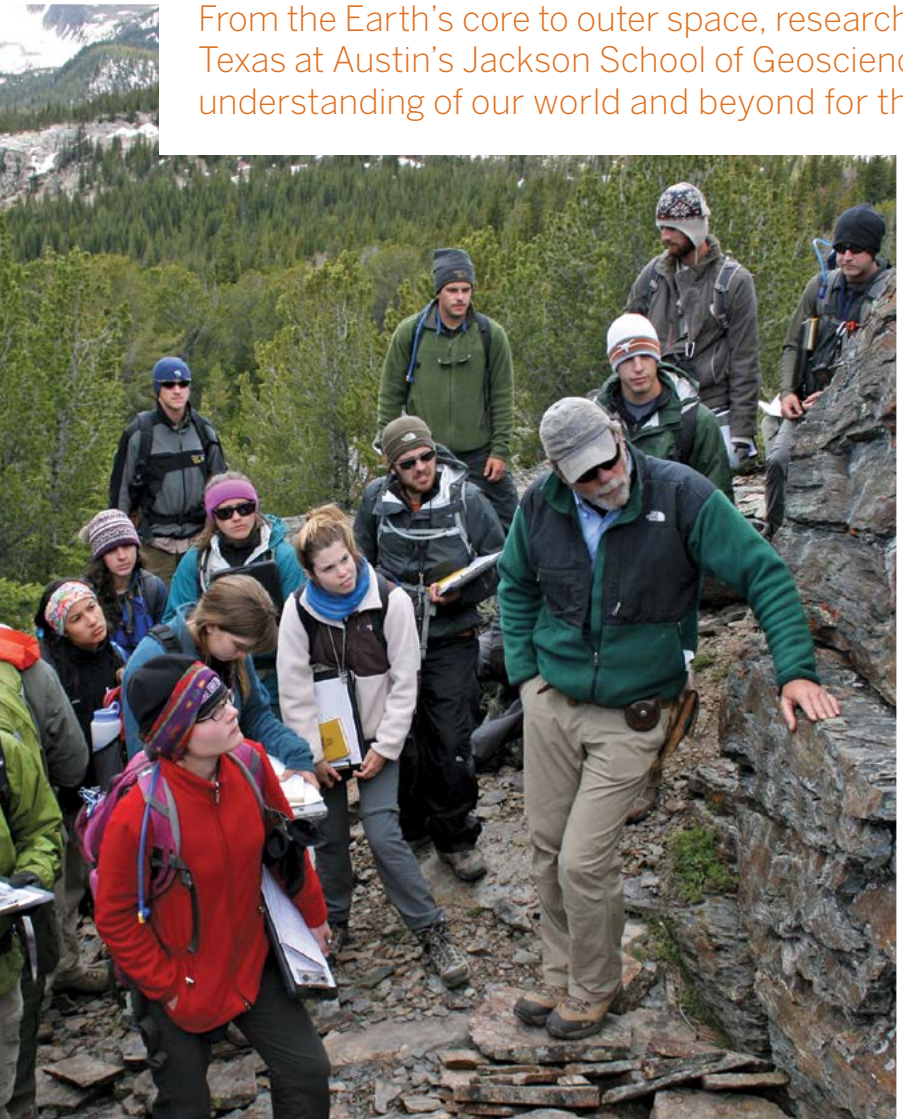
Olufowoshe is still extremely active in the Jackson School. He serves on the Geology Foundation Advisory Council, has been a GeoFORCE mentor, and regularly talks with students. He's a proponent of all that a geosciences education has to offer, particularly the ability to think critically and solve problems.

He also encourages students to get to know professors and scientists and to take every research opportunity available. Those relationships, he said, can reveal new horizons.

"When I was in school, you were really only shown a few options career-wise," he said. "There are so many opportunities that are available, and without that exposure, you really don't know what's out there waiting for you."

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

Zoomerama Carries on Outreach Tradition

In October 2020, the Bureau of Economic Geology hosted the Austin Earth Science Zoomerama, a video conferencing series that enabled middle and high school students to connect with geoscientists from a range of disciplines during the COVID-19 pandemic.

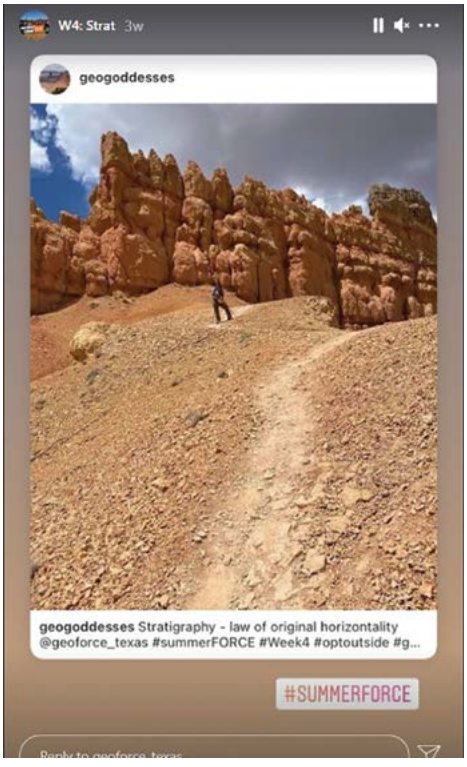
The Zoomerama was held in place of the bureau's annual Austin Earth Science Week Career Day, which was canceled for the first time in 20 years due to the pandemic. Although students were unable to visit in-person, the Zoomerama brought the geoscientists directly to them through 13 sessions that covered topics in geosciences and explored geosciences careers.

Bureau Information Geologist Linda Ruiz McCall led the program, which featured presentations from UT and Jackson School of Geosciences researchers, as well as professionals from industry, government agencies, geological societies and non-profits.

The presentations and program materials are available at ***beg.utexas.edu/outreach/earth-science-week-career.***

TOP: LINDA RUIZ MCCALL, AN INFORMATION GEOLOGIST AT THE BUREAU OF ECONOMIC GEOLOGY, INTRODUCING A SPEAKER FOR THE BUREAU'S ZOOMERAMA PRESENTATION SERIES DURING AUSTIN EARTH SCIENCE WEEK.
BOTTOM: JESSICA GORDON, A CONSERVATION PROGRAM COORDINATOR FOR AUSTIN'S WATERSHED PROTECTION DEPARTMENT, DEMONSTRATES HOW DIFFERENT LANDSCAPES INFLUENCE WATER ABSORPTION.

PHOTOS: JACKSON SCHOOL.



Staying Connected With #SummerFORCE

This summer, the Jackson School of Geosciences' GeoFORCE program helped students stay in touch and keep their geoscience skills fresh with a social media challenge: #SummerFORCE.

The nine-week challenge took place through the social media platform Instagram. It encouraged members of the GeoFORCE community to post a photo related to the geology topic of the week and tag it with #SummerFORCE. Each challenge received up to a dozen entries, and one winner each week received a small prize. All 45 entries were also entered into a grand prize drawing.

GeoFORCE is an outreach program for middle and high school students from underserved communities in Houston, Austin and Southwest Texas that takes participants on summer field trips to geologic landmarks as part of a summer academy. However, due to the COVID-19 pandemic, academies have been virtual since 2020.

GeoFORCE coordinator Jasmine Gulick and student assistant Katherine Garcia, who is a GeoFORCE alumna, came up with the #SummerFORCE challenge as a way to build community while students were learning from a distance during the summer.

"When we learned we would be having virtual academies, we started brainstorming ways to connect with students and alumni, and also be able to see everyone's adventures that they went on, even if it wasn't with us," Gulick said. "We've had a lot of fun sharing and being part of the challenge."

Garcia said that she enjoys using images and artwork to make the geosciences more accessible and engaging. She helped start the Instagram account for the earth and environmental department at her undergraduate alma mater Franklin & Marshall College and simplified scientific figures from peer-reviewed geosciences publications so they can serve as better teaching aids for her classmates.

She said she plans to stay involved with geoscience outreach as she joins the Jackson School as a master's student in the Energy and Earth Resources program this fall.

"I want to find ways to engage professors with diversity initiatives that work and that can reach disadvantaged communities," Garcia said.

In addition to summer academies where students experience and learn about geological landmarks firsthand, GeoFORCE provides guidance on preparing and applying for college. All these activities are made possible due to generous support from sponsors, including an ongoing $750,000 match gift from an anonymous donor.

ABOVE: THE #SUMMERFORCE SOCIAL MEDIA CAMPAIGN CHALLENGED PEOPLE TO SHARE GEOLOGY POSTS ON INSTAGRAM. THREE ENTRIES ARE SHOWN ABOVE. YOU CAN SEE THESE AND OTHERS ON THE GEOFORCE INSTAGRAM PAGE (@GEOFORCE_TEXAS).

PHOTOS: GEOFORCE.

Mount Bonnell Gets GeoSign

The beautiful vistas of Austin's Mount Bonnell now come with a geological perspective.

On May 5, 2021, the Bureau of Economic Geology installed a GeoSign atop the Austin landmark that explains the geological history and processes that shaped the local high point over millions of years.

The sign is the latest addition to the bureau's Texas GeoSign Project, which has been working since 2016 to build a network of geological information signs across Texas to engage and educate people when they visit parks, highway rest areas, and other public locations with distinctive geology.

"As the State Geological Survey, a large part of the Bureau of Economic Geology's mission is outreach to Texas citizens to help broaden their understanding of the incredible geological features of our state," said bureau Director and Texas State Geologist Scott Tinker. "This amazing new GeoSign will be a wonderful source of geologic information for Mount Bonnell visitors for many years to come."

In addition to covering the geological history of Mount Bonnell, the GeoSign also highlights the Balcones Escarpment, the Balcones Fault Zone, and the groundwater found in the fault zone.

ATX Science Olympiad Online

The University of Texas Institute for Geophysics (UTIG) continued to support Science Olympiad for Central Texas by advising the program and sponsoring tournaments throughout 2020 and 2021.

Science Olympiad is a science competition for middle and high school students. It is organized in Austin by ATX Science Olympiad, an undergraduate-led nonprofit organization that hosts two annual Science Olympiad tournaments at UT.

In fall 2020, ATX Science Olympiad hosted its first online "invitational" tournament, attracting over 150 teams —more than twice that of in-person tournaments—from across the nation. The spring 2021 regional tournament for Central Texas schools was also held online.

Aside from tournaments, ATX Science Olympiad hosted two virtual initiatives in 2020 and 2021: "Coaches Clinic," a training workshop for Science Olympiad team coaches; and "Scaffolding Success," a new STEM mentorship program for K-12 students organized with UT's College of Pharmacy.

ABOVE, LEFT: THE GEOSIGN AT THE TOP OF MOUNT BONNELL HELPS PUT THE BREATHTAKING VIEWS IN A GEOLOGICAL CONTEXT.

ABOVE, RIGHT: THE ATX SCIENCE OLYMPIAD LEADERSHIP TEAM, CONSISTING OF VOLUNTEER UNDERGRAD AND GRADUATE STUDENTS, DURING A REGULAR VIRTUAL TEAM MEETING.

Expanding Learning: A Virtual DeFord Series Focuses on Diversity

During the past academic year, the Jackson School of Geosciences' DeFord Lecture Series brought new research to a broader community through two major changes: thoughtful coordination by faculty members to diversify the speakers and topics, and technology that delivered content to more people.

The DeFord Lectures are the signature seminar series at the Jackson School's Department of Geological Sciences, taking center stage in the department most Thursday afternoons. Although talks now highlight cutting-edge research by geoscientists who traverse the globe, the forum started about 80 years ago as a way for graduate students to present their work. The series is funded by a series of endowments, and this year, the talks were bookended by two prominent scientists: Lisa White, the assistant director of the University of California Museum of Paleontology, who spoke about linking social justice to exhibits; and Dawn Wright, chief scientist at Environmental Systems Research Institute (ESRI), who spoke about mapping and modeling the seafloor.

For the past five years, associate professor Elizabeth Catlos has organized the list of speakers.

"I am more of a coordinator," said Catlos. "The list of each year's potential lecturers is really a grassroot effort involving proposals from all faculty."

Coordinator or leader, the DeFord series under Catlos has become a showcase of diversity in research, ideas, and the geoscientists themselves. During the past few years, nearly half of the lectures have been by female researchers. Much of this evolution was enabled after discussions with Samuel Moore, the school's former director of outreach and diversity; and Sharon Mosher, former dean of the Jackson School, who worked with Catlos and others to find speakers within the restrictions of the endowments that fund the series. Charles Kerans, former department head, also played a role in the oversight for the endowment of the lecture series.

And during 2020-21, as White's and Wright's lectures attest, the focus shifted to increasing the racial diversity of speakers.

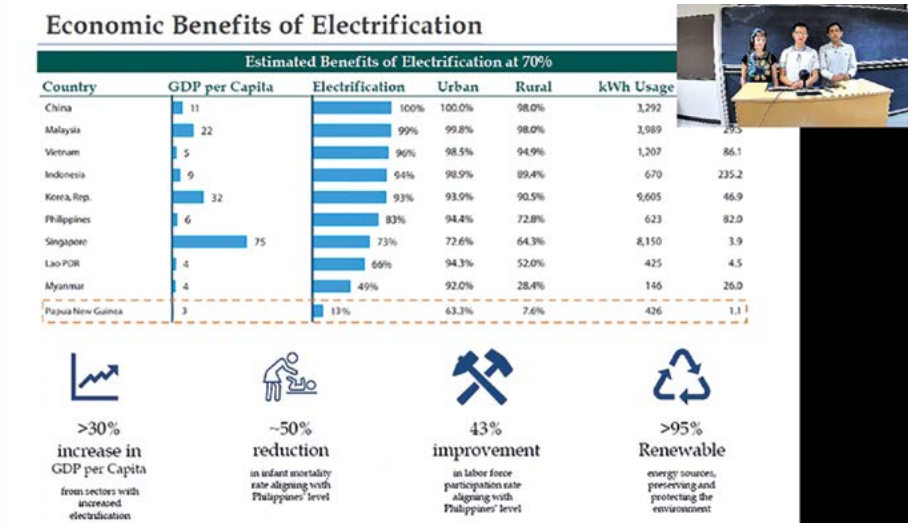
"Diversifying the series has been a departmental effort, and this year's cohort is the most diverse I have seen," said Catlos. "The last year was our most diverse speaker series since I have been part of the DeFord.'"

In addition to the diversity of speakers, the research presented last year also represented a diversity of approaches and fields. For example, several talks tackled climate change, with different researchers presenting different angles. This includes extreme events by ETH Zurich's Sonia Seneviratne, carbon capture by BP's Chris Walker, global energy poverty by the Bureau of Economic Geology's Scott Tinker, and soils as carbon sinks by University of California, Merced's Asmeret Asefaw Berhe. There were also a number of talks on hydrology, including presentations on the Eel River watershed by Tulane University's Nicole Gasparini and nutrients in coastal freshwater by West Virginia University's Deon Knights.

The second major change to come to the 2020-21 DeFord Lecture Series: all were presented virtually, over Zoom. The COVID-19 pandemic forced a shift on campus to online education, which in turn opened the seminars to people who typically could not sit in a lecture hall on campus at 4 p.m. CT each Thursday. And for those who could not tune in from afar, recordings are archived on the Jackson School's YouTube channel, where many presentations have had hundreds of views.

ABOVE: THE 29 DEFORD SPEAKERS WHO PRESENTED DURING THE FALL OF 2020.

PHOTO: JACKSON SCHOOL.



Switch Energy Alliance Holds First International Energy Competition

More than 900 university students from 37 countries, 6 continents and 171 universities took part in the inaugural Switch Energy Case competition. The competition was held during fall 2020 and challenged participants to come up with plans for increasing access to energy in three countries where large swaths of the population live in energy poverty.

The competition was run by the Switch Energy Alliance (SEA), a nonprofit promoting energy education and awareness founded by Scott Tinker, the director of the Jackson School of Geosciences' Bureau of Economic Geology.

"We were blown away by the response," said Tinker. "Of the many remarkable moments, perhaps the most powerful was when teams needed to withdraw because they could not keep the electricity on for sustained periods of time to coordinate their efforts and record their presentations. They were examining energy poverty while living in it."

The primary goal of the competition is to get university students thinking about sustainable and equitable energy transition around the world. Students work in teams and can come from any academic discipline. Each team is assigned an energy professional mentor to help guide them.

For the 2020 competition, 250 teams were tasked with proposing a plan for increasing people's access to energy in one of three countries – Haiti, the Democratic Republic of Congo, and Papua New Guinea.

The teams shared their energy transition plans in 10-minute-long videos. From the initial 250 teams, 18 advanced to the semifinals, and seven made it to the finals, which involved a short presentation followed by questions from a panel of three judges.

Team "In the Greens" took first place and the $4,000 grand prize with their energy transition plan for Papua New Guinea. The team was from The University of Texas at Austin and was comprised of Riley Anderson (College of Liberal Arts and College of Natural Sciences), Zeke Kang and Satvik Kolluri (both McCombs School of Business). Team UNDB from Algeria took second place, and team Hyperion from Venezuela took third.

The presentations and videos for the seven finalists are available at: ***switchon.org/case-competition/2020-energy-poverty***.

ABOVE: THE FIRST-PLACE TEAM "IN THE GREENS" PRESENTING THEIR ENERGY TRANSITION PLAN FOR PAPUA NEW GUINEA.

Energy Across Borders

This summer, the Jackson School of Geosciences teamed up with universities in Mexico and Canada to start the North American Energy Dialogue, a discussion series on the increasingly interdependent energy landscape of the two nations and the United States.

The dialogue brings together a panel of energy experts to discuss hot topics in energy policy over Zoom. The 2021 discussions were well attended, with about 400-500 viewers tuning in to each of the hourlong talks, according to dialogue coordinator Jorge Piñon, the director of the Jackson School's Latin America and Caribbean Energy Program.

Most panels include researchers, policy makers, and industry affiliates. Piñon said that the short format and varied expertise are intended to spark ideas and promote further discussion.

"We leave a lot of questions unanswered, and that's on purpose," Piñon said. "Because that's what generates debate."

This year's discussions included talks on COVID-19's impacts on energy policy, how the Biden administration's energy and environmental policies may affect energy trade, and an overview of Mexico's energy landscape. The energy transition was another topic of discussion. Two discussions on carbon capture and storage featured Bureau of Economic Geology research associate Katherine Romanak as a panelist.

Piñon said that the dialogues are working just as intended, with people already turning conversations into further action.

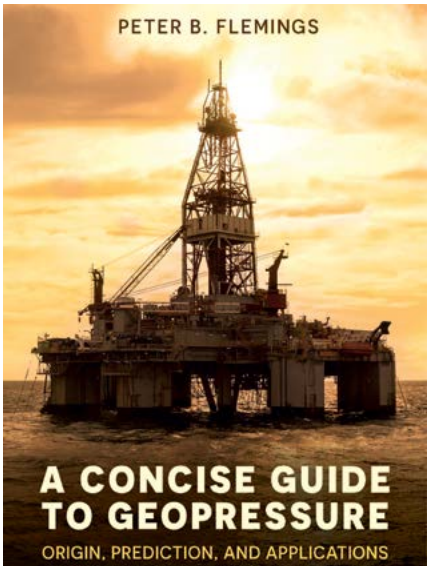
The dialogue is planned to continue into 2022.

The Jackson School's efforts are in partnership with the UT Kay Bailey Hutchison Center for Energy, Law & Business. The dialogue is co-hosted with the University of Alberta and Tecnológico de Monterrey.

Watch the discussions: ***www.ualberta.ca/energy-systems/news-and-events/energy-dialogue-seminars.html***

PHOTO: JACKSON SCHOOL.

Books

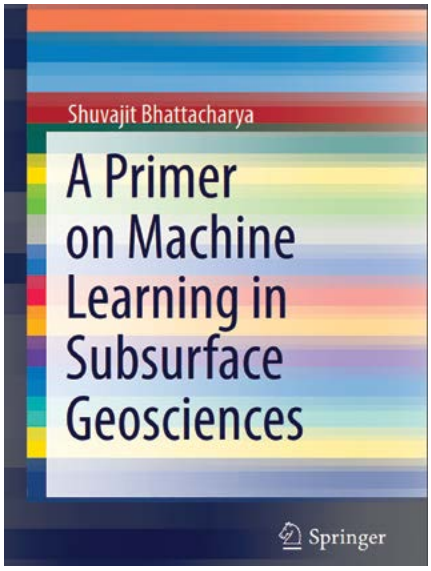


A Concise Guide to Geopressure: Origin, Prediction, and Applications

Peter Flemings, Professor & Research Scientist, Department of Geological Sciences & Institute for Geophysics

A Concise Guide to Geopressure reflects 25 years of pore pressure research at the UT Geofluids Consortium. The book serves as a guide to petroleum reservoirs and how scientists and engineers can safely and economically drill geological systems. The same concepts and lessons are important for storing carbon dioxide underground and drilling geothermal energy wells. The book also explains how geopressure controls geological phenomena, such as submarine landslides and subduction zone earthquakes. By bringing together the disciplines of geotechnical engineering, petroleum engineering and geoscience, the book offers a holistic perspective on an important topic.

The book is available through Cambridge University Press.

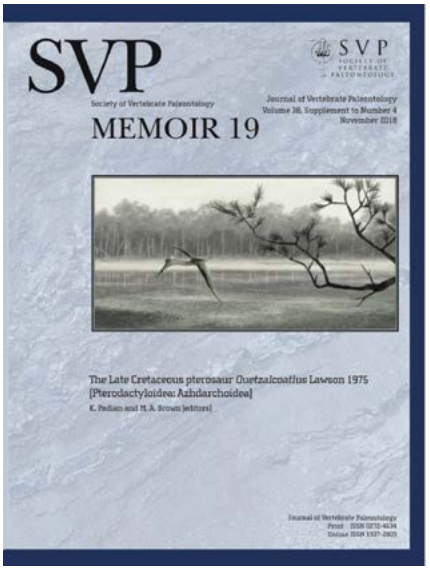


A Primer on Machine Learning in Subsurface Geosciences

Shuvajit Bhattacharya, Research Associate, Bureau of Economic Geology

A Primer on Machine Learning in Subsurface Geosciences is a first-of-its-kind book exploring the benefits, problems and applications of machine learning in a geosciences context. The book reviews algorithms, statistical measures and deep learning models, as well as numerous examples of real-world scenarios applying machine-learning models.

The book is part of the "SpringerBriefs in Petroleum Geoscience & Engineering" book series. It is available through Springer.



The Late Cretaceous Pterosaur Quetzalcoatlus

Edited by Matthew Brown, Director of the Texas Vertebrate Paleontology Collections, and Kevin Padian, Curator of Paleontology at the University of California Museum of Paleontology

This volume provides the first comprehensive look at the fossil remains of the pterosaur Quetzalcoatlus, an airplane-sized flying reptile that was discovered in 1971 in Big Bend National Park by a University of Texas at Austin graduate student. Five of the volume's eight authors are affiliated with UT, including two posthumous contributions by Wann Langston Jr., who spent much of his 75-year career working on Big Bend paleontology. The work examines the excavation and curation, stratigraphy, taphonomy, systematics and functional morphology of the largest animal to ever fly, and it describes two new species of pterosaur from the historic localities.

The volume is available as a memoir of the Society of Vertebrate Paleontology, and digital copies are available free of charge thanks to a generous private donation.

ABOVE: PROFESSOR CHARLES KERANS (SEATED, LEFT) EXPLAINS BASIC CONCEPTS OF STRATIGRAPHY AND SEDIMENTOLOGY TO GEO660B STUDENTS PRIOR TO THEIR FIRST PROJECT IN THE SACRAMENTO MOUNTAINS, NEW MEXICO. CLOCKWISE FROM KERANS: BARBARA FAGUNDEZ, SKYLAR SCHULZ, LEIGH MERCER, LUKE MURRAY, LANDEN WHITE, ABBY CREIGHTON, BRITNEY DAVIS, EVAN SHETINA, SHELBY OLIPHANT, PAUL REDMAN AND BARBARA SULBARAN.

GEO660

Due to the pandemic, field camp was shortened to three weeks from its usual six. But students were still able to put their field skills to the test, taking part in 10 projects in New Mexico and Wyoming. These projects focused on field description and interpretation, along with teamwork, leadership and outdoor living. The camp was divided into two sessions, with students placed in two cohorts, A and B.

TOP: GEO660A STUDENTS STAND ATOP A RIDGE OF CRETACEOUS CLOVERLY FORMATION CONGLOMERATE WHILE MAPPING NEAR ALCOVA RESERVOIR, WYOMING. FROM LEFT TO RIGHT: PRESTON HENLEY, CONNOR BRIGHAM, JAKE GOINS, MATT DEANS, MAYA ORTIZ, HEATHER GUNN, TYLER LOGIE.
MIDDLE: RESEARCH SCIENTIST PETER HENNINGS WITH ASSISTANT INSTRUCTOR ABDULAH ELJALAFI AND TEACHING ASSISTANT MEGAN FLANSBURG WITH GEO660A STUDENTS AT AN OVERLOOK OF THE GREAT UNCONFORMITY IN FREEMONT CANYON NEAR ALCOVA, WYOMING.
BOTTOM: GEO660B STUDENTS, WITH ASSISTANT INSTRUCTOR ABDULAH ELJALAFI (STANDING AT LEFT), SHOW OFF THEIR COMPLETED TEAM CORRELATION PANEL OF MEASURED SECTIONS OF SYNTECTONIC LATE PENNSYLVANIAN-EARLY PERMIAN BURSAM FORMATION FROM THE SACRAMENTO MOUNTAINS OF NEW MEXICO.

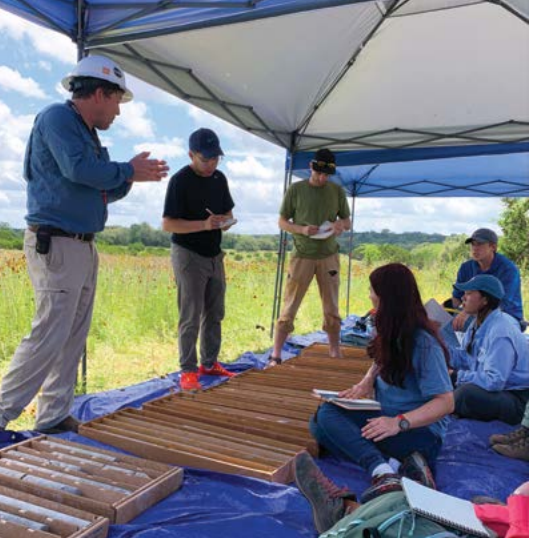
PHOTOS: JACKSON SCHOOL.

MG&G

After a hiatus because of the coronavirus pandemic, the field class was back in Port Aransas in 2021 with several new additions to the program, including a drone for surveying the shore and a vibracorer to sample salt marshes.

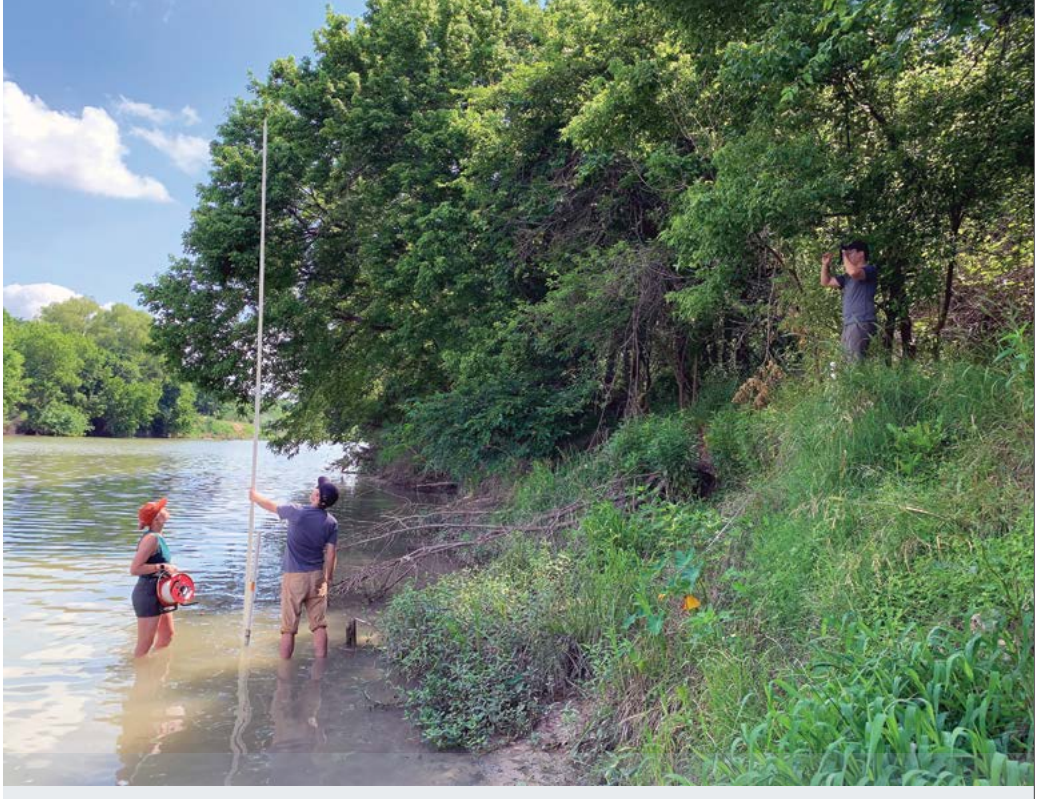
CLOCKWISE FROM TOP: THE CLASS OF 2021 ON THE BEACH IN PORT ARANSAS. (L-R) MARCY DAVIS, DAN DUNCAN, CHRIS LIU, SEAN GULICK, MARLOWE BUELER, DAVIS HAGEMEIER, JOHN GOFF, KAZUMA SAKAMOTO, SOLVEIG SCHILLING, CHRIS LOWERY, CARSON MILLER, LONDON DARCE, AND JAKE BURSTEIN; JAKE BURSTEIN, DAVIS HAGEMEIER AND INSTRUCTOR CHRIS LOWERY DURING SALT MARSH CORING ON HARBOR ISLAND, NEAR PORT ARANSAS; THE TEAM RECOVER THE CHIRP DURING OPERATIONS FROM THE M/V MISS VIVIAN; JAKE BURSTEIN PICKS UP TRASH DURING A CLEAN-UP FOLLOWING A BEACH RESEARCH EXCURSION, ANOTHER NEW ADDITION TO THE PROGRAM; JACKSON SCHOOL UNDERGRADUATE DAVIS HAGEMEIER LOOKS AT FORAMINIFERA IN A SALT MARSH SAMPLE.

PHOTOS: JACKSON SCHOOL.



hydro

Students stayed local, traveling to Hornsby Bend and the White Family Outdoor Learning Center to learn drilling, down-hole geophysics, stream gauging, ecohydrology measurements and groundwater chemistry. Students learned from scientists from the Edwards Aquifer Authority, the Bureau of Economic Geology, Austin Water Center for Environmental Research and local groundwater conservation districts.



ABOVE, LEFT: RESEARCH SCIENTIST BRIAN HUNT HELPS STUDENTS INTERPRET CORE RECOVERED FROM THE UPPER TRINITY AQUIFER VIA DRILLING AT THE WHITE FAMILY OUTDOOR LEARNING CENTER. STUDENTS FROM LEFT TO RIGHT: HARRY KHUC, TYSON MCKINNEY, CAMELIA BALUTA, CAITLIN TRAN, AND SHANE HEATH. DRILLING SPONSORED BY ALUMNUS PAT GOODSON OF GEOPROJECTS INTERNATIONAL. **ABOVE, RIGHT:** STUDENTS DAPHNE SMITH, TYSON MCKINNEY, AND HARRY KHUC USE A STADIA ROD AND HAND-LEVEL TO PERFORM A TOPOGRAPHIC SURVEY OF THE BANK OF THE LOWER COLORADO RIVER AT HORNSBY BEND.

LEFT: ASSISTANT PROFESSOR ASHLEY MATHENY (RIGHT) INSTRUCTS STUDENTS ON HOW TO MEASURE LEAF WATER POTENTIAL AT THE WHITE FAMILY OUTDOOR LEARNING CENTER. STUDENTS CLOCKWISE FROM BOTTOM: BROOKE FRY, LUCAS MARQUES, AND CAMELIA BALUTA. **ABOVE:** STUDENTS RECOVER CORE FOR AQUIFER CHARACTERIZATION DURING ACTIVE DRILLING AT THE WHITE FAMILY OUTDOOR LEARNING CENTER WHILE ASSISTANT PROFESSOR DANIELLA REMPE (RIGHT) AND HAYES COUNTY HYDROGEOLOGIST PHILIP WEBSTER (LEFT) SUPERVISE. STUDENTS FROM LEFT TO RIGHT: SHANE HEATH, LUCAS MARQUES, REGINA PADILLA, AND CAITLIN TRAN

PHOTOS: JACKSON SCHOOL.

LOOKING FORWARD TO THE NEXT **100 YEARS**

We've come a long way since we introduced our foundational field geology camp, GEO660, in 1917. With your help, we'll continue to grow and innovate to produce future leaders in the rapidly changing field of geosciences.

To help the next generation of geoscientists learn in the field, visit **jsg.utexas.edu** and click **Make a Gift**.

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

DIVERSITY UPDATE

PHOTO: GEOFORCE.

Diversity, Equity and Inclusion (DEI) efforts continue to be an important part of the Jackson School of Geosciences.

GeoFORCE

Last summer, when travel was halted and in-person activities were canceled, the GeoFORCE team jumped into action to create a virtual learning curriculum that could engage participants and educate them about geosciences.

This move to virtual learning was borne out of necessity. But it helped lay the groundwork for a new GeoFORCE initiative that is helping expand the reach of the program.

Starting in the summer of 2022, GeoFORCE will offer virtual field academies in addition to the in-person trips. This will allow all interested students in the areas GeoFORCE serves to participate in the field or virtually.

"Every year, GeoFORCE has a waitlist of students," said GeoFORCE program director Leah Turner. "No one should have to miss out because of limited bus space."

Since 2005, GeoFORCE has been partnering with underserved school districts to help drive student interest in careers in STEM, with a focus on the geosciences. During summer academies, students take trips to spectacular geologic sites in Texas and throughout the United States and learn first-hand from geoscientists in the field, the lab and the classroom. The virtual academies will help bring the geosciences to even more students.

GeoFORCE's growth didn't stop there. This summer, they added new student cohorts from school districts in Central Texas including Austin, Del Valle, Manor and Pflugerville. It also launched a new GeoFORCE Family pilot program, which will focus on informing the families of GeoFORCE students about job opportunities in STEM and the geosciences. The program, which is sponsored by Repsol, will start with cohorts from southwest Texas and include visits to Repsol's job sites.

All GeoFORCE experiences are offered at no cost thanks to the generosity of donors. Over the next four years, an anonymous donor is matching every new gift to the program, dollar-for-dollar, up to $750,000.

Undergraduate Research Traineeship Experience (RTX)

Last year, the Jackson School of Geosciences launched GeoVISION, a research traineeship program for GeoFORCE alumni and STEM undergraduates interested in learning computational skills and applying them to geosciences questions.

This year, the program continued under a new name, RTX. It brought together 23 participants, most of them undergraduate students from underrepresented groups, for eight weeks of virtual learning from Jackson School experts. The program provided participants access to all the equipment and supplies needed to take part, including laptops, software and access to the UT library system, as well as a stipend.

Scientists—including faculty, research scientists, postdoctoral researchers and graduate students—from each of the Jackson School's three research units took part in the program. This included one-on-one mentorship as well as teaching training modules, which spanned from remote sensing software, to data analytics, to the coding language Python.

The participants who took part in research projects shared their findings at a virtual poster session at the end of the program. Two participants will be presenting to a larger audience at the upcoming meeting of the American Geophysical Union, according to program coordinator Dana Thomas.

Computational skills are in high-demand in both the workforce and the graduate school environment. Thomas said that RTX provides a skillset students can build on while offering a new, high-tech perspective on geosciences.

In addition to scientific training, RTX participants also took part in personal development and skill-building workshops. Thomas said that RTX is expected to continue into 2022, but that additional funding is required to ensure that students from outside of the GeoFORCE program are able to take part.

Unlearning Racism in Geoscience (URGE)

In addition to outreach, members of the Jackson School community looked at ways to improve inclusivity within the Jackson School by forming a local chapter of URGE.

URGE is a National Science Foundation-supported initiative with 276 chapters, or pods, worldwide. The goal of the program is to encourage geoscientists to come together to develop anti-racist strategies.

Associate Professor Rowan Martindale leads the Jackson School pod. It currently has 93 members and includes faculty, research scientists, postdoctoral researchers, graduate and undergraduate students, and staff.

The pod engaged in eight two-week units during the spring and summer semester that focused on learning about anti-racist strategies and developing resources and action items for the Jackson School.

A key focus going forward is building diversity among Jackson School faculty, staff and graduate students.

To learn more about the Jackson School URGE pod, or to get involved visit: ***urgeoscience.org/pods/ut-austin-jsg-pod***

ABOVE: GEOFORCE STUDENTS LOOKING AT A GEOLOGIC MAP.

PHOTO: CAROLE LAKROUT.

Spelunking for Samples

Field excursions are a bit difficult to plan out in normal times, so you can imagine what it was like in the middle of the pandemic. Luckily, caves aren't usually crowded, but, since the cave we were visiting was in Colorado, we had to travel. My advisor, Nicola, and I had a seed grant accepted in June 2020. At that point, we weren't sure when we would go. This was my first ever field trip that was for my own research, and I was very excited and eager. We almost bought tickets for three dates before we actually made official plans for May 2021.

Caving is a relatively intense field experience, especially with this particular cave. We had to hike up a cliff for a bit over an hour to get to the cave entrance while carrying all of our equipment: safety gear, sampling supplies, food, etc. Once we got to the cave, it was about a four-hour crawl to reach the sampling site near the back of the cave. I'm usually pretty good with tight caves, but there were some spots where I was surprised I got through! It was completely worth the effort when I saw the beautiful formations found in this back room. I had been caving before but had never seen such unique structures up close. We took a food break and began sampling for another few hours. The goal was to collect biological samples and sequence their DNA to figure out what microbes lived in this cave and how they interact with the rocks. Luckily, we had local cavers guide us through the cave and help with the sampling work. After gathering some speleothems, water and mud, we started on the journey back out. After about 11 hours in the cave, we finally emerged into the pitch black and headed for the climb down the cliff with only our headlamps steering us away from certain death. We were exhausted, covered in mud and starving, but it was one of the most rewarding days of my life.

Carole Lakrout
Undergraduate Student

ABOVE: JACKSON SCHOOL UNDERGRADUATE STUDENT CAROLE LAKROUT COLLECTS BIOLOGICAL SAMPLES FROM A COLORADO CAVE.

Mapping the White Outdoor Learning Center by Uncrewed Aerial Vehicle

In July 2021, myself and Ph.D. student Mariel Nelson headed to the field to map the terrain of the Jackson School's White Outdoor Learning Center. This mission marked the first use of our UAV (uncrewed aerial vehicle) system equipped with a LiDAR scanner, which allows us to map surface topography at extremely high precision and in fine detail. We were joined by Dana Chadwick, a research associate at the Jackson School, and Analie Armendariz, an employee of Phoenix LiDAR Systems, the company that built our custom instrument.

As we fly the UAV, the LiDAR unit fires 100,000 laser pulses per second in all directions. When pulses bounce off the ground and return to the UAV, the unit measures how long it takes and multiplies by the speed of light to compute the elevation of the land surface.

Our day in the field was different than a traditional day of field geologic mapping. We started by loading our SUV full with boxes of electronic equipment. When we arrived at the site, we set up the GPS base station, which allows us to accurately locate the UAV. Next, we set up all our gear—the UAV, the LiDAR unit, a computer to monitor data collection, and a local wifi hub so the UAV and computer can communicate. Once set up, we programmed the UAV to run a test flight on the southern portion of the property, where other UT faculty have installed long-term hydrologic monitoring systems. While most of the flight is automated, Mariel piloted the takeoff and landing. After triple-checking our setup, we repeated the flight while collecting data.

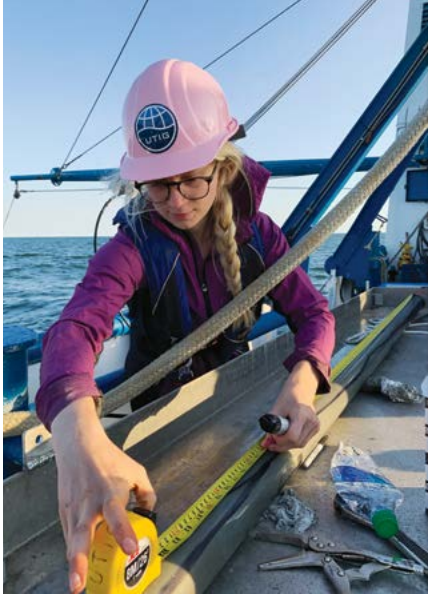
The resulting topography is spectacular. This data will provide a baseline dataset for future mapping missions that we can use to detect changes in the land surface and the tree canopy. We look forward to many, many more LiDAR acquisition flights, from monitoring coastal erosion to rockfalls to river migration across Central Texas!

Timothy Goudge
Assistant Professor

Mariel Nelson
Ph.D. Student

ABOVE: MARIEL NELSON (CENTER) AND TIM GOUDGE (RIGHT) PREPARE THE UAV LIDAR SYSTEM FOR MAPPING.

PHOTO: DANA CHADWICK.



LEFT: JACKSON SCHOOL GRADUATE STUDENTS CARSON MILLER (SECOND FROM RIGHT) AND SOLVEIG SCHILLING (FURTHEST RIGHT) OBSERVE AS UTIG SCIENTISTS AND CREW DEPLOY A SEISMIC IMAGING DEVICE CALLED A SPARKER.
ABOVE: SCHILLING LOGS A SEDIMENT CORE FROM A SANDY RIVER DEPOSIT BURIED BENEATH THE GULF OF MEXICO SEAFLOOR.

GROUP: JOHN GOFF. SCHILLING: CHRIS LOWERY.

Search for Sand

In April 2021, researchers with the University of Texas Institute for Geophysics (UTIG) embarked on a cruise to look for sand deposits off the coast of Galveston, Texas. Among them were graduate students Carson Miller and Solveig Schilling.

My First Research Cruise

We arrived at the dock in Galveston, TX on a gloomy Wednesday afternoon ready to embark on the R/V Tommy Munro. This was my first research cruise and I came into the experience with little to no expectations. While my family envisioned a Carnival cruise experience, I knew it would be cramped quarters, long nights and potential sea sickness.

Around 80% of the Texas coast is considered critically eroded, meaning if sand isn't added to the beach there will be considerable threat from storms, tides, and waves to communities living along the coast. Our goal was to find sand resources for renourishment projects hidden in ancient river valleys —also called paleo-valleys—using seismic imaging and core analysis.

During the last glacial maximum, water was locked up in ice sheets making sea-level much lower than it is today. This allowed rivers to incise large river valleys that became filled with sediments once the glaciers melted and sea-level rose.

Using seismic imaging and core sediments we can see what is deposited in these valleys and analyze their characteristics, which helps coastal managers decide which resources to extract. This is the power of combining two methods: we can image the extent of our sand resources while also ground truthing our imaging with cores.

Bad weather and equipment malfunction meant we were forced back to dock more often than we wanted, but while we were out at sea the seismic imaging would scroll across the screen in real time. We would mark the edges of the paleo-valley, while also noting special features, like channels and terraces, that could be potential coring locations.

Right now, we are only looking at the paleo-Trinity River valley, but extending surveys to other paleo-valleys along the coast will be valuable to understand exactly where Texas sand resources lie.

Carson Miller
Doctoral Student and
UTIG Graduate Research Assistant

Adventure at Sea

A major part of what I got to do aboard the R/V Tommy Munro was help deploy the giant aluminum tubes used to collect sediment cores. Once collected, it's my job to describe the cores and examine the foraminifera (type of fossilized plankton) living within. As a micropaleontologist, I study the foraminifera to understand how the environment has changed over time.

It was thrilling to be on a research team collecting samples and it was a blast to live on a ship. I slept in a tiny bunk (so small I couldn't even sit up!), got to experience 8ft waves and learned how to deal with seasickness. I learned the behind-the-scenes workings of how research vessels operate and got to see the most beautiful sunrises and sunsets. Most importantly, I got to experience a once in a lifetime adventure and the excitement of getting my hands on sediment no one else has ever seen.

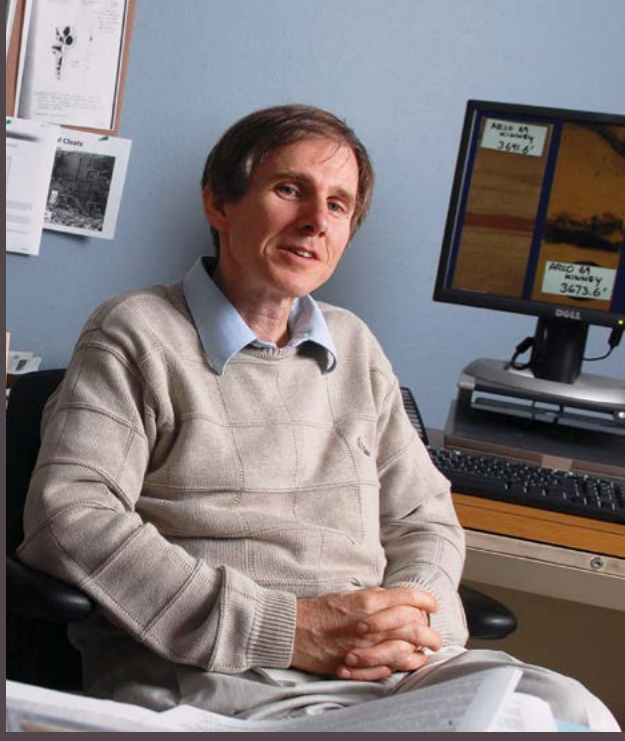
Read more about the search for sand in Texas on to page 10.

Solveig Schilling
Doctoral Student and
UTIG Graduate Research Assistant

William Ambrose

Senior Research Scientist

By Monica Kortsha



WILLIAM AMBROSE

Bill Ambrose built his career at the Bureau of Economic Geology, starting as a graduate research assistant and working his way up to principal investigator of the State of Texas Advanced Resource Recovery group (STARR) before retiring this spring. His work involved collaboration, local and international research projects, and lots and lots of core.

During his long career at the Bureau of Economic Geology, Senior Research Scientist Bill Ambrose started just about every project the same way, with a trip to the bureau's core repository.

The cavernous repository is filled from floor to ceiling with stacks of narrow, cardboard boxes containing rock cores from Texas and around the world. During his 37 years at the bureau, Ambrose has built up a truly impressive core count.

By the time he retired in March, he calculated that he had examined a total core length of 30,737 feet. Stacked into a single column, the core would tower 1,705 feet over Mount Everest.

"In my opinion, it always starts with the rocks," said Ambrose, admitting that this axiom was always easy for him to follow. "That has always been personally my favorite thing to do as a geologist, describe core. I could do it all the livelong day."

> " He knows rocks, stratigraphy, reservoirs, regional plays, and understands science that matters."
>
> — *Scott Tinker*

Ambrose started at the bureau as a part-time graduate research assistant in 1980, working there while earning a master's in geology from The University of Texas at Austin. He left for a private company for two years, from 1984 to 1986. But he was back at the bureau for good by the start of 1987.

Ambrose's research focused on characterizing sedimentary rock formations with energy resources in mind. His early work at the bureau focused on domestic projects. They included finding potential formations for geothermal brine disposal along the Texas coast, determining where pockets of oil may be hiding in old South Texas oil fields, and estimating the extent of coal seams in New Mexico and Wyoming.

Then, in the 1990s, Ambrose went international. He started evaluating the geology of Venezuelan oil reservoirs so companies could make more strategic decisions about where to drill. The work was akin to his South Texas studies, Ambrose said, but with much more oil at stake. Whereas an old Texas well would produce 50 barrels of oil on a good day, a well that produced less than 1,000 barrels per day in Venezuela was considered mediocre.

"Even though the Venezuelan companies were producing oil at prodigious volumes, they were not draining the reservoirs as efficiently as possible," Ambrose said. "And that's because the sand bodies that compose the reservoirs are complex."

Ambrose relied on the core to guide him, and he estimates that about 10,000 feet of his total core count came from Venezuelan rocks.

A decade later, Ambrose was basin hopping along Mexico's Gulf Coast. He collaborated with PEMEX, the country's national oil company, starting with the Macuspana Basin hugging the country's east coast and working his way northward to the Burgos Basin over five years.

But after that, it became all about Texas, with Ambrose joining the STARR group in 2007, under the leadership of Bob Loucks and Ursula Hammes. A year later, Ambrose would be leading the group as its principal investigator.

STARR, or the State of Texas Advanced Resource Recovery group, produces fundamental research about Texas geology that energy companies can leverage in their exploration and production. For Ambrose, his close collaborations with oil and gas companies and experience with careful basin characterization proved to serve STARR well.

Ambrose oversaw a number of regional studies that mapped the geology of multiple counties, and in many cases, contained thousands of oil and gas wells. He said that one of STARR's

continued on page 85

Lorena Moscardelli

Principal Investigator at STARR

By Monica Kortsha

Lorena Moscardelli is applying her experience in both industry and research as the new principal investigator of the State of Texas Advanced Resource Recovery group (STARR) at the Bureau of Economic Geology. Once a research associate in the group, Moscardelli is committed to advancing energy transition research while maintaining close connections between STARR and oil and gas operators.

LORENA MOSCARDELLI

After eight years away, Lorena Moscardelli is back at the Bureau of Economic Geology.

Moscardelli started at the bureau as a research associate at its State of Texas Advanced Resource Recovery group, known as STARR. Now she is leading the group as its principal investigator, filling a space left by William Ambrose, who retired this spring.

"It's great because it's both familiar and new," said Moscardelli, who was previously a principal researcher at Equinor. "There are a wide variety of projects across Texas that cover different basins and geologic formations, a lot of interactions with operators in the state, and we are also kick-starting initiatives linked to the energy transition."

Ambrose, who still takes part in STARR research on a part-time basis, said that STARR benefits from Moscardelli's background in industry and bureau research.

"Lorena has already proven to be an exceptional principal investigator," Ambrose said. "She's uniquely qualified and uniquely situated with insight into what oil and gas companies consider important in developing oil and gas."

> "Lorena has already proven to be an exceptional principal investigator. She's uniquely qualified and uniquely situated..."
>
> — *Bill Ambrose*

STARR's focus is to conduct geoscience and engineering research to increase the production and profitability of earth resources, including oil, natural gas, hydrogen, geothermal and minerals in Texas. Moscardelli started her first stint at STARR as a seismic interpreter in 2007, just after earning a doctoral degree in geological sciences from The University of Texas at Austin.

She grew up in Caracas, Venezuela, and worked in the country's petroleum industry after college. She decided to come to UT when she was among the thousands of oil and gas workers affected by the Venezuelan political turmoil of the early 2000s.

"I knew that I wanted to further my education," said Moscardelli, who had met researchers from the bureau, including then-research scientist Lesli Wood, who would go on to supervise her doctoral work. "The Jackson School of Geosciences gave me the opportunity to further my education during a very critical time in my career, and the experience has been truly transformative."

Moscardelli's doctoral research focused on deep-water deposits, with emphasis on submarine landslides. Two years into her research associate position, and while also serving as a lecturer teaching subsurface mapping and petroleum geology at the Jackson School, she and Wood co-founded the bureau's Quantitative Clastics Laboratory (QCL) to concentrate research on clastic depositional systems, with Moscardelli focusing on the deep-water component of the program. Moscardelli's work at QCL involved collaborating with researchers from Statoil (now Equinor). After she was recruited to the company in 2013, she kept close UT connections, serving as a liaison between Equinor and the Jackson School by following university consortia and overseeing the UT/Equinor fellowship program.

At Equinor, Moscardelli worked in a wide range of regional subsurface characterization projects in the Gulf of Mexico, Nova Scotia and Norway. She conducted most of that work from Equinor's Austin office but spent 2019-2020 living in Bergen, Norway, where she led overburden management activities in the Tampen-Spur region and updated geological models in the Vøring Basin, while spending her free time mountain hiking around the Bergen region. In late 2020, Moscardelli transferred to the Equinor exploration team in

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Fred Taylor

Senior Research Scientist Emeritus

By Constantino Panagopulos

Fred Taylor joined the University of Texas Institute for Geophysics in 1981 with plans to use corals to investigate big questions in geosciences. He made good on that plan, conducting coral research that has unlocked mysteries and earned him a reputation as a pioneering scientist. Now retired and a senior research scientist emeritus, he is continuing to explore and discover.

FRED TAYLOR

When Fred Taylor was in the fifth grade, a friend introduced him to rocks. Not the drab marl of North Carolina, but polished rocks and opals from all over. Taylor was smitten, and before long he was hunting for his own among the old wrecks that dotted the fishing and clamming community where he lived.

"I grew up with boats and fooling around in shallow saltwater. The fact I made that into a career is, I think, a logical progression," Taylor said.

In October 2020, Taylor was appointed Senior Research Scientist Emeritus, the highest honor for a research scientist at The University of Texas at Austin.

Taylor's career is notable for the part he played bringing corals to the mainstream of geosciences. In his research, he has used corals, both living and fossilized, to measure tectonic deformation, geologic time, the rise and fall of sea level, and climate change. Along the way, he has invented tools and equipment for field research that remain in use today.

Demian Saffer, director of the University of Texas Institute for Geophysics (UTIG) where Taylor has worked for more than 40 years, said his impact on the field is rooted in innovation and good science.

"Fred's contributions span fundamental science that has impacted a wide swath of the earth sciences," said Saffer. "He truly embodies the institute's spirit and mission. We are fortunate to have his continued engagement as an emeritus scientist."

> "He truly embodies the institute's spirit and mission. We are fortunate to have his continued engagement as an emeritus scientist."
>
> — *Demian Saffer*

Taylor's career with corals began as a grad student at Brown University measuring sea level change in Barbados. He earned a doctoral degree at Cornell University and joined UTIG in 1979 after a college friend and UTIG researcher, Cliff Frohlich, invited him to visit the institute's then-headquarters in Galveston. UTIG liked Taylor's proposal to use corals as a tide gauge for measuring tectonic motion, and Taylor liked the freedom the institute offered.

His first assignment took him to the South Pacific archipelago of Vanuatu, where he was the first to use corals to show earthquake deformation and plate motion. Decades later, scientists began using GPS to do the same.

The next breakthrough came by way of corals' natural atomic clock. When corals absorb naturally occurring uranium, it steadily decays into the element thorium. By comparing thorium isotopes with the remaining uranium, scientists can determine how much time has passed since the coral was alive.

In the mid-1980s, Taylor and Caltech grad student Larry Edwards decided to see how far they could push the technique using a thermal ionization mass spectrometer on 14,000-year-old coral from Barbados. Their findings were so accurate the community used them to calibrate the (then unreliable) technique of radiocarbon dating.

Taylor then turned his attention to finding historical changes in the frequency and intensity of the El Niño Southern Oscillation (ENSO), a tropical climate phenomenon with far-reaching effects.

"An ENSO event imposes more climate change on certain parts of the Earth than 2-or-3-degree climate change," Taylor said. "If it becomes more frequent or significantly stronger in the future, that's going to be tough for a lot of people."

Taylor wanted to drill difficult to find corals that grew during

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Tucker Hentz
Research Scientist Associate

There was a time when Tucker Hentz thought he would become a medical doctor. But there was always something lurking underneath, right under his feet, that kept drawing him in.

Hentz switched his college major to geology and went on to spend four decades studying sedimentary rock, basinal deposits, and siliciclastic stratigraphy. As a research scientist associate at the Bureau of Economic Geology, he has researched the stratigraphic setting of just about every corner of the Lone Star State.

His work has been critical for researchers, government agencies, and oil and gas companies searching for hydrocarbons. Now, after 38 years at the bureau, Hentz is retiring to spend more time on his other interests.

"It was time," said the 66-year-old.

When he first landed in Austin, Hentz was given the job of mapping the surface geology of 8,000 square miles in north-central Texas, near Wichita Falls, for the state's geologic atlas. That three-year task fascinated and challenged Hentz because it included both marine and continental deposits. Figuring out regionally where one deposit ended and the other began was a challenging concept, but he devised a stratigraphic scheme that worked and has been used by researchers ever since.

"I am very proud of that," he said.

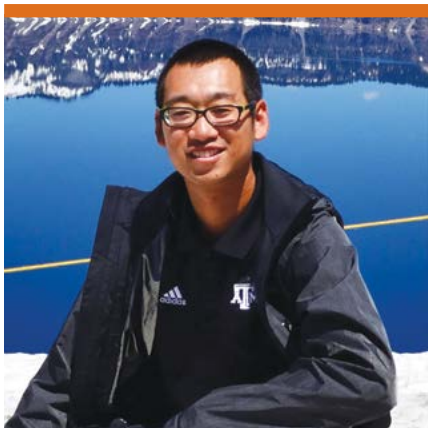
His work over the years expanded to other regions and sedimentary basins of Texas to help guide the state's energy companies. Working with the bureau's State of Texas Advanced Resource Recovery (STARR) program, he would detail the geology and provide companies with a road map for their exploration efforts. And in some cases, he would use 3D seismic data to help detail the subsurface stratigraphy of the Gulf of Mexico, helping companies fine-tune their underwater operations.

As the years went on, Hentz watched his field transition to an increasing emphasis on environmental concerns. His final project, which he's currently finishing on a part-time basis, is helping energy companies locate sandstone reservoirs into which liquified CO_2 can be pumped to prevent it from entering the atmosphere.

Hentz sees that project as a worthy end to his long career.

"I get tremendous satisfaction out of it because I feel like it's my small contribution to improving the conditions of the planet," he said.

By Alan Gomez



Dunyu Liu
Computational Geoscientist

In 2008, when Dunyu Liu was an undergraduate at Peking University, a magnitude 8 earthquake struck southeast China. The tragic event, which killed 87,000 people, had a profound effect on the young sophomore. Liu decided he wanted to do something that would help make earthquakes less dangerous.

"I realized that if we can better understand earthquakes, maybe we can better predict them," he said.

Today, Liu is a computational geoscientist at the University of Texas Institute for Geophysics (UTIG), where he helps researchers investigate earthquakes and other Earth processes using supercomputers such as those found next door at UT's Texas Advanced Computing Center (TACC). He is the first to hold this role at the institute.

Liu's introduction to supercomputers began as a seismology major studying earthquakes. To make sense of the complex chain of events that lead up to an earthquake, scientists rely on high-performance computing and numerical methods—techniques that turn complex mathematical equations into realistic physics simulations.

In grad school Liu learned to use a technique called finite element method that works by breaking down complex problems into manageable—or finite—pieces. The physics are chaotic in earthquakes, but, given enough processing power, they can be simulated.

For his master's thesis at Peking University, Liu used the technique to create a supercomputer-driven model of the 2011 Tohoku earthquake. Later, he refined his techniques while earning a doctoral degree from Texas A&M University.

Now at UTIG, Liu is putting his knowledge to use by getting scientists up to speed on using supercomputers. Since joining in January 2021, he has already helped bring one of the world's most sophisticated climate simulations to TACC, making it available for climate researchers throughout the Jackson School. He has also helped researchers model Earth tectonics and create simulations of planetary interiors and their magnetic fields, and he is developing supercomputer "quick start, one-page guides."

"His presence brings new capabilities to our research programs by advancing the institute's growing efforts in computational geophysics across a wide range of disciplines," said UTIG Director Demian Saffer.

By Constantino Panagopulos

Matthew Malkowski
Assistant Professor

Matt Malkowski joined the Jackson School of Geosciences as an assistant professor this fall. But when he was growing up in a rural corner of Michigan surrounded by factories and farms, the idea of a life in academia was completely foreign to him.

His father worked construction and his mother worked in a furniture factory. He worked as a bank teller and paid his own tuition at a local community college where he focused on business classes, thinking he should try to maximize his earning potential.

"Growing up in that area and not having a lot of educated people around you, you're not thinking, 'I'm going to grow up to be a scientist'," he said. "You're just trying to make your car payment."

His outlook changed after he took an "Intro to Geology" class as his science elective. He transferred to Michigan State University, where he earned bachelor's and master's degrees and then to Stanford University for a Ph.D. in geological sciences.

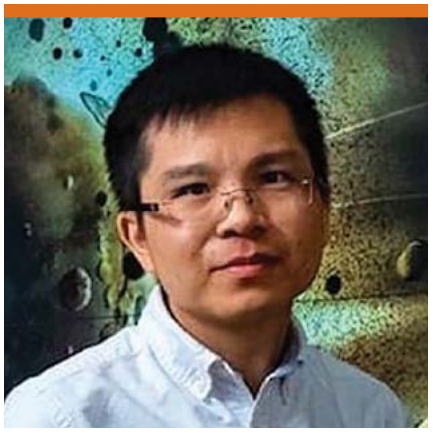
Now at the Jackson School, Malkowski is continuing his research on the Earth's sedimentary record, studying mountain belts and ocean basins to understand how each was formed by the climate, tectonic movement and sea level change.

Through his work, Malkowski is trying to bridge the historical records he finds to help solve modern-day issues. For example, he is working on a project examining the sustainability of sand mining in San Francisco Bay and another project intended to redraw the maritime-economic border between Alaska and Russia based on the geology of the seafloor in the Bering Sea.

The kid from Scottville, Michigan, (population 1,194) has now crisscrossed the globe, from the southernmost corner of South America to the mountaintops of Tibet. And now he's ready to continue that work in Austin.

"Sedimentology and stratigraphy can sound boring," Malkowski said. But, "What I love about it is how humbling it all is. Geology does respond to what humans do, but at the end of the day, we're just blips on the surface and the things that are going on are so impressive, they're so massive."

By Alan Gomez



Chenguang Sun
Assistant Professor

The farming village where Chenguang Sun grew up in central China was so small that he had to go to a larger town for middle school, a larger city for high school, and he had to travel 500 miles away to study at a university in Beijing.

The first in his family to go to college, Sun would go on to graduate from the China University of Geosciences, earn a Ph.D. at Brown University, improve the way that scientists decode rocks and magmas, and he is now setting up his new lab at The University of Texas at Austin's Jackson School of Geosciences.

"When I look back, it's very difficult for me to imagine how far I've been," he said.

Sun's work has focused primarily on developing new tools to measure the conditions that were present when rocks were formed. Specifically, he has developed a series of mathematical formulas, which he calls thermometers and speedometers, that can estimate the temperature at which rocks were formed and the speed at which they cooled.

Sun said geologists had been working with decades-old tools that had been tweaked and recalibrated, but he realized it was time for a complete overhaul.

"I wanted to learn something new, something the previous tool could not tell us," he said.

Sun's new tools have helped scientists understand how the Earth's crust is formed—both on land and on the seafloor—and provided new insights into the evolution of magma chambers buried deep beneath the Earth's volcanoes. That work earned him the 2021 Mineralogical Society of America Award.

Now settled in Austin with his wife and two young boys, Sun doesn't want to dwell on his past research. He'll be teaching thermodynamics classes in the fall and is setting up a research lab to simulate high-temperature, high-pressure environments (his equipment can reach 1,800 degrees Celsius and 3.5 gigapascals, the equivalent of being 120 kilometers inside the Earth).

And, of course, he's diving into new research projects. This time, he'll explore the long-term cycle of carbon as it churns through the crust, down into the mantle and back out to the surface.

"I'm always looking for something new," he said.

By Alan Gomez

PROFILES

Xiaohua "Eric" Xu
Research Associate

When Xiaohua Xu analyzed high-resolution satellite images of the 2019 Ridgecrest earthquakes, he found that they had lit up clusters of previously unknown faults in the surrounding crust that seemed to move backward immediately after the earthquakes.

The analysis, which was published in *Science* when he was a postdoctoral researcher at the Scripps Institution of Oceanography, solved a long unexplained problem about why Earth's surface appears to slip less in deeper parts of the fault.

Now a research associate at the University of Texas Institute for Geophysics (UTIG), Xu wants to use the same technique to find faults in remote, inaccessible parts of the world. The aim is to learn more about the earthquake cycle and apply what he learns to refine hazard maps for earthquake hot spots.

"When I was studying for my college entrance exams in 2008, there was a big earthquake that killed a lot of people in China—the Wenchuan earthquake," Xu said. "I decided that by studying geophysics, I could help reduce the hazard of such events."

Xu grew up in Dongying, near the mouth of the Yellow River, a region once famous for its petroleum resources. He earned a degree in geophysics at the University of Science and Technology of China before coming to the U.S. to join the doctoral program at Scripps. There, he was introduced to the idea of using geodesy—the study of the Earth's surface—to look at earthquakes.

In 2014, Xu helped develop GMTSAR, a widely used opensource program for turning satellite data into millimeter-scale deformation maps of Earth's surface. It's the same software he used to reveal Ridgecrest's backward-moving faults.

"Discovery is the really fun part of my work," Xu said. "When new data tells you something you didn't know, that's a really good feeling."

UTIG Director Demian Saffer said that Xu's experience with satellite data and geodesy adds a new capability to the institute's geodynamic, earthquake and ice sheet research.

"He brings a formidable skillset in satellite geodesy and remote sensing approaches that will provide a foundation for exciting and impactful science, as well as for a wide range of new collaborations across the Jackson School," he said.

Shuvajit Bhattacharya
Research Associate

Shuvajit Bhattacharya joined the Bureau of Economic Geology as a research associate in August 2020. He was previously an assistant professor of geophysics at the University of Alaska Anchorage. At the bureau, he integrates petrophysical, geophysical, and machine learning tools to solve geologic problems of critical importance to energy resources exploration, development, and carbon sequestration. He is also interested in geothermal energy and hydrogen storage. He has taught and mentored many students and is the author of *A Primer on Machine Learning in Subsurface Geosciences*, a Springer brief in petroleum geoscience and engineering.

Alex Bump
Research Scientist Associate

Alex Bump joined the Bureau of Economic Geology's Gulf Coast Carbon Center (GCCC) as a research scientist associate in October 2019. He comes to the bureau after 16 years in global exploration with BP, where he worked on over 50 basins on five continents, taught hundreds of students and held roles including adviser and head of discipline for structural geology and tectonics. His current work at the GCCC focuses on adapting petroleum exploration workflows to de-risking and developing geologic storage sites for CO_2.

Tristan Childress
Research Associate

Tristan Childress joined the Bureau of Economic Geology as a research associate and economic geologist in November 2020. He earned a doctoral degree in economic geology at the University of Michigan in 2019 and has experience conducting exploration geochemistry research in Alaska and Alabama. At the bureau, he researches the occurrence and distribution of economic deposits within the state of Texas, with a focus on conventional and unconventional critical mineral resources.

PROFILES

Kelly Hattori
Research Scientist Associate

Kelly Hattori is a research scientist associate at the State of Texas Advanced Oil and Gas Resource Recovery program at the Bureau of Economic Geology. Hattori is a carbonate stratigrapher and broadly works on Gulf Coast Cretaceous carbonates, particularly those deposited in shallow-water systems. She has also built a specialty in salt-sediment interactions within the East Texas Basin that examines the sometimes-conflicting relationship between the flow of salt and traditional sequence stratigraphy as well as the impact of salt body topography on carbonate depositional systems.

Brian Hunt
Research Scientist Associate

Brian Hunt joined the Bureau of Economic Geology as a research scientist associate in October 2020 and is focusing on making geologic maps and conducting hydrogeologic studies. Current projects include geologic quadrangles in Mason and Blanco counties and hydrogeologic studies characterizing the Trinity Aquifer (Hamilton Pool, Travis County) and the Edwards-Trinity Plateau Aquifer (Devil's River, Val Verde County). Before joining the bureau, he worked as a hydrogeologist for the Barton Springs/Edwards Aquifer Conservation District. Hunt has more than 20 years of experience working on groundwater and aquifer sustainability issues in Central Texas and has over 100 published articles, reports and abstracts. He is a professional geoscientist in Texas and is a past president and active member of the Austin Geological Society.

Tingwei "Lucy" Ko
Research Associate

Lucy Ko is a research associate at the Bureau of Economic Geology studying the geochemical properties of mudrocks and subsurface effects of burial and thermal maturation. Ko started at the bureau in March 2020. Ko's geosciences career began as an organic geochemist applying biological and geochemical tools to understand tight gas basins in the Rocky Mountains. She switched to sedimentology and stratigraphy when she enrolled in the Jackson School as a doctoral student, followed by a postdoctoral fellowship with the bureau, after she earned a doctoral degree. Ko has also earned master's degrees from the Colorado School of Mines and National Taiwan University.

Shukuru Makanyaga
Research Scientist Associate

Shukuru Makanyaga joined the Bureau of Economic Geology in December 2019. He is a research scientist associate focusing on analyzing well logs as part of a project funded by the Texas Railroad Commission. Makanyaga was previously a wellsite geologist with Impac Exploration Services, where he spent two years at drilling sites in West Texas and southeast New Mexico. Makanyaga credits his path to the geosciences to GeoFORCE, an outreach program of the Jackson School of Geosciences. Makanyaga was part of the program from 2009 to 2012. He earned a bachelor's degree in geology from Texas A&M University in 2017.

Vincent O'Sullivan
Research Scientist Associate

Vincent O'Sullivan joined the Bureau of Economic Geology in August 2020 as a research scientist associate. O'Sullivan has a background in software and hardware engineering and is applying his expertise toward instrumentation, networking and seismology at the bureau. He previously worked as an engineer at The University of Texas at Austin, Engineer Your World program, and as a product/reliability engineer at Freescale Semiconductor and Motorola.

Alexey Portnov
Research Associate

Alexey Portnov joined the University of Texas Institute for Geophysics (UTIG) as research associate in January 2021. He has participated in 16 scientific cruises in the Gulf of Mexico, the European and Russian Arctic shelf, and offshore Vietnam. His research focuses on gas hydrate systems in two regions: the Arctic, where he is involved in projects that study methane escaping from hydrates and warming permafrost, and the northern Gulf of Mexico, where he studies the potential of gas hydrates as a future energy resource. Before joining UTIG, Portnov was a postdoctoral researcher at Ohio State University and Norway's Center for Arctic Gas Hydrate, Environment and Climate, where he earlier received a doctoral degree in geophysics. He has a master's degree in marine geology from St. Petersburg State University.

Jinyu Zhang
Research Associate

Jinyu Zhang became a research associate at the Bureau of Economic Geology in June 2020 following a postdoctoral fellowship. At the bureau, he integrates subsurface characterization methods and numerical modelling to unravel sedimentary processes, with applications ranging from characterizing hydrocarbon reservoirs to finding climate signals in buried sediments. He has a Ph.D. in geology from the Jackson School of Geosciences.

FROM PAGE 78 | William Ambrose

biggest success stories was in East Texas, where the group identified areas where existing wells just needed to be drilled a bit deeper—100 or 200 feet—to access pockets of oil that had never been produced.

But it's not just the companies that benefit from STARR's expertise. For every barrel of oil, the state of Texas takes its share in taxes. STARR has proved to be a great return on the state's investment, with its research helping bring in anywhere from seven to 15 times the amount of money the group received in state funding.

Bureau director Scott Tinker said that Ambrose's expertise helped define an era of research at STARR and at the bureau as a whole.

"When I think of the STARR program, and the bureau more broadly as the State Geological Survey of Texas, I think of Bill Ambrose," Tinker said. "He is the 'type section' of a state geological survey scientist. He knows rocks, stratigraphy, reservoirs, regional plays, and understands science that matters."

Ambrose said that STARR is in good hands under the leadership of its new director, Lorena Moscardelli, who, like Ambrose, started her bureau career as a graduate student. But expect to see Ambrose around. He is continuing to contribute to STARR research on a part-time basis and no doubt adding to his core count.

FROM PAGE 79 | Lorena Moscardelli

Canada and shortly after decided to return to the bureau as leader of STARR.

"It was too hard to resist," Moscardelli said.

At the same time as working in industry, Moscardelli remained involved with the submarine landslide research community, serving as the chair of the "Significance of Modern and Ancient Subaqueous Landslides" project also known as S4SLIDE from 2015 to 2020.

Collaboration has always been a fundamental component of Moscardelli's career and ethos. At STARR, Moscardelli is continuing this by facilitating connections between operators and researchers at the bureau. Moscardelli said working with operators helps inform STARR's research and define priorities when initiating oil and gas research projects. This close connection also keeps oil and gas operators in the know about energy transition research at STARR and the bureau. Among the many initiatives, STARR is assessing hydrogen storage within salt formations in the Gulf Coast and the Permian Basin and studying the feasibility of in-situ hydrogen generation in depleted reservoirs.

In addition to advancing energy research, Moscardelli said she is also working to foster an inclusive environment at STARR. She said that with an active community of research scientists and industry partners, STARR is a great place for geoscientists from all backgrounds to connect and grow.

"STARR's biggest asset is its people, and I am committed to create a work environment where they can thrive while making meaningful contributions to both the state of Texas and to science," she said.

FROM PAGE 80 | Fred Taylor

the most recent glacial maximum. Undeterred, Taylor used tectonic and sea level modelling to pinpoint where they might be buried. The results took him back to Vanuatu. But the locations were deep and inaccessible by road, so he engineered a drilling rig that could be broken down and carried by hand. On its first outing, the drill recovered lengths of coral that were 16,000 years old and suitable for climate reconstructions, already two millennia older than any useful ones previously found.

"With information like that, you can reconstruct ENSO back to when the global climate regime was totally different and match it with climate models that predict what it does in the future," he said.

The portable drill was just the latest of Taylor's innovations. In the early 2000s he designed an underwater coral coring drill that was safe to use in marine parks because it operated with pressurized seawater instead of hydraulic oil. In the 1990s he helped design a single-point GPS mast that has since been adopted by UNAVCO, a geodesy nonprofit that supports geosciences research around the world.

As emeritus scientist, Taylor isn't ready to hang up his hat quite yet. He's made improvements to the portable coral coring drill's design and currently is helping colleague Jud Partin get it ready for an NSF-funded mission to reach 20,000-year-old cores.

PHOTO: IAN DALZIEL.

Top Geology Award Goes to Ian Dalziel

Ian Dalziel, a research professor at the University of Texas Institute for Geophysics (UTIG), has been awarded the Geological Society of America's Penrose Medal for pioneering discoveries about Earth's ancient geography and its past supercontinents. Established in 1927, the Penrose Medal is widely considered to be geology's most prestigious career award.

In a letter, GSA Past-President Doug Walker said that Dalziel's scientific contributions marked a major advance in the science of geology and shed new light on key periods in our planet's distant past, such as the "Snowball Earth" and the "Cambrian Explosion" of multicellular life.

Dalziel's work has been important in reconstructing the position of our planet's past continents. His discoveries include evidence that half a billion years ago, during the Cambrian Explosion, Texas lay alongside Antarctica. He also uncovered geology showing that 50 million years later it was part of a large plateau joining ancestral North America to the Andes of Argentina. These and other discoveries spurred a new interest in the geography of our planet from before Pangea, the last time Earth's landmasses assembled as one, and inspired the idea that other supercontinents had previously existed.

"Ian has certainly earned his place among geology's scientific giants," said Demian Saffer, director of UTIG where Dalziel has worked since 1985. "He is a prolific field scientist whose vision exemplifies the spirit of discovery that is at the heart of UTIG's mission."

This year's award is the fifth time that a Penrose Medal has gone to a faculty member or an alumnus of The University of Texas at Austin's Jackson School of Geosciences. Past recipients include the legendary oceanographer Maurice "Doc" Ewing (UTIG's founder) and former Jackson School faculty member Robert Folk.

The award was announced in the July issue of *GSA Today*.

Dalziel became fascinated with geology at an early age when, as a child, his parents took him on weeks-long treks across the islands and Highlands of Scotland—where he is from. After graduating from the University of Edinburgh with a Ph.D. in geology, Dalziel joined the University of Wisconsin-Madison in 1963, and the Department of Geology and Lamont Doherty Geological (now Earth) Observatory of Columbia University in 1968. His first breakthrough came in 1973 when he visited South Georgia, an inhospitable island about 1,000 miles to the east of Cape Horn. There, he found identical geology to that he had encountered in the southernmost Andes of Chile and Argentina: proof that until at least 100 million years ago, the now distant places were joined, an important idea at the time considering many geologists were still adjusting to the new paradigm of plate tectonics.

The discovery earned Dalziel an honorary membership with the Argentine Geological Association.

"Ian had energy, expertise and willingness to work in places no one had worked before," said Victor Ramos, who was the association's president at the time and is now professor emeritus at the University of Buenos Aires. "Most importantly, he worked closely with the scientific community in Chile and Argentina. That way of working was very welcome in South America at the time."

Dalziel continued searching for signs of Earth's tectonic history in Antarctica, where he and his colleagues found that the West Antarctic Ice Sheet—the least stable

PHOTO: IAN DALZIEL.

on the planet—lies on an archipelago made up of distinct blocks of crust, all of which had moved, and might still be moving separately. After joining UT in 1985, Dalziel led a team that placed a network of GPS receivers across West Antarctica. For the first time, scientists watched the bedrock rise as the weight of the ice melted away. The findings helped raise the alarm that Antarctica's melting ice was a more urgent threat to global sea level rise than anyone had expected.

Perhaps Dalziel's most noteworthy contribution, however, is research that led to the theory of supercontinent cycles—the idea that every several hundred million years, Earth's continents merge into a single landmass. In 1989, he persuaded 25 of the world's top geologists to accompany him on a field trip to Antarctica where he had a hunch he might find physical clues to Earth's geography prior to the assembly of Pangea, the only known supercontinent at the time.

"The idea was to bring Antarctic geology into the global mainstream," Dalziel said

It did. Ideas sparked by the expedition kicked off a wave of research that opened the way to testable hypotheses about pre-Pangea geography, past supercontinents and their sway over global environments.

Now in his 80s, Dalziel intends to continue seeking answers (and adventure) in far flung places.

"There's always connections to be made over the horizon," Dalziel said, who is currently planning a return to South Georgia. "There's so much geology out there in some ways choosing where to look for the right clues becomes almost a measure of scientific taste."

Ian Dalziel received the Penrose Medal on October 10 during a ceremony at GSA Connects 2021 in Portland, Oregon.

The previous UT recipients of the Penrose Medal are Department of Geological Sciences faculty members Bob Folk (2000) and "Doc" Ewing (1974), Bureau of Economic Geology research scientist Preston Cloud (1976), and Department of Geological Sciences alumnus John Crowell (1995).

ABOVE: A VERY YOUNG IAN DALZIEL ON THE SHORES OF LOCH NAN UAMH ON THE WEST COAST OF SCOTLAND. CHILDHOOD TRIPS TO THE SCOTTISH ISLANDS AND HIGHLANDS INFLUENCED DALZIEL'S INTEREST IN GEOLOGY AND EXPLORATION.

OPPOSITE PAGE: IAN DALZIEL AT SOUTH GEORGIA ISLAND IN THE FAR SOUTH ATLANTIC OCEAN.

Becker Earns Jackson School a Second Evgueni Burov Medal

Thorsten Becker, a professor and research scientist in the Department of Geological Sciences and University of Texas Institute for Geophysics, was the 2021 recipient of the Evgueni Burov Medal, a mid-career award presented by the International Lithosphere Program for "unselfish service to the scientific community."

The award recognized Becker's contributions to research and leadership that have helped advance the study of the Earth's solid interior.

Becker's research has revealed how the Earth's deep interior influences earthquakes and shapes the landscape around us. His work combines geophysics with computational science to answer large-scale questions about plate tectonics and the planet's evolution. He is also notable for his active presence within the scientific community. He took on his first editorship at *Geophysical Journal International* just two years after graduating, and has held similar roles at scientific journals ever since. He has helped establish numerous research networks, including a 2018 international collaboration to better understand subduction zones, and a 2021 effort funded by the National Science Foundation to coordinate with national labs at the world's earthquake hotspots.

The Evgueni Burov Medal was established in 2018 in honor of Evgueni Burov, an enthusiastic and collaborative geophysicist who died in 2015. This year's medal is the second to go to a Jackson School professor and research scientist after Luc Lavier was awarded the prize in 2019.

Goudge Named CIFAR Azrieli Global Scholar

Jackson School of Geosciences Assistant Professor Tim Goudge has been chosen as a CIFAR Azrieli Global Scholar, joining an international program that supports outstanding early-career researchers through mentorship, a global network, professional skills development and approximately $80,000 in unrestricted research support for two years.

"The CIFAR Azrieli Global Scholars program is one of the most selective and prestigious early-career opportunities for young researchers anywhere in the world," said Alan Bernstein, president and CEO of CIFAR. "These young people are selected for their excellence in research as well as their potential to become the leaders of tomorrow. They are mentored by some of the world's top natural or social scientists and are given the unique opportunity to join a close-knit community of CIFAR fellows, challenging each other with new ideas and addressing some of the most exciting and important questions facing science and humanity."

Goudge, who joined the faculty in the Department of Geological Sciences in 2019, is one of 19 scholars in the program's 2021-23 cohort. He joins a cohort with researchers from eight countries: Canada, the United States, the United Kingdom, South Africa, Australia, China, France and Chile. The diverse group of researchers includes specialists in economics, health, sociology, fungal infections and other areas. They will support several of the CIFAR research programs, but the researchers will come together as a cohort at times to learn from one another.

"CIFAR is all about growing collaborations," said Goudge. "The Global Scholars program brings together all sorts of really smart people – people who do research that is completely different from what I do. I am really looking forward to interacting with this group and seeing what similarities really do exist in terms of research methods (and) how we go about discovering things."

Goudge grew up in Canada and earned a bachelor's degree in geological engineering from Queen's University and a master's and

doctorate in geological science at Brown University. He came to the Jackson School as a distinguished postdoctoral fellow in 2015 before joining the faculty. Today, he studies how planetary landscapes evolve and uses remote sensing data to look at signatures of surface processes recorded in the topography, mineralogy and sedimentary rock record of Mars, Earth and other planetary bodies.

As part of the Global Scholars program, Goudge will join CIFAR's "Earth 4D: Subsurface Science & Exploration" program. He will bring his expertise in planetary sciences to collaborate with the experts in this program who are focused on research around the exploration for life in the subsurface of Earth and other planets in our Solar System.

CIFAR is a Canadian-based global research organization. The CIFAR Azrieli Global Scholar program is supported by the Azrieli Foundation, which funds institutions and operates programs in Canada and Israel focusing on scientific and medical research, higher education, youth empowerment and school perseverance, Holocaust education, music and the arts, architecture, and quality of life initiatives for people with developmental disabilities

Tinker Receives Energy Leadership Award from E&P Magazine

Scott Tinker, the director of the Bureau of Economic Geology, is the 2021 recipient of *Exploration & Production* magazine's Energy Leadership Award.

The award recognizes Tinker's tireless energy outreach. His recent efforts have focused on creating media — which includes two documentaries — that informs the general public about the role energy plays in their lives and those of others around the world.

"It's always an honor and flattering to be recognized for things, but the reality is, I have a great team of people," Tinker said. "So, the award is for a cast of thousands."

Tinker has had a long career in the energy industry. He joined the bureau as its director in 2000 after 17 years as a geologist in the oil and gas industry. Most of that time was spent at Marathon Oil's research and technology center where Tinker worked as an advanced senior geologist.

During his time at the bureau, Tinker has also served as president of a number of professional geological societies, including the Association of American State Geologists, American Association of Petroleum Geologists, American Geosciences Institute, and Gulf Coast Association of Geological Societies.

Tinker's first documentary, "Switch," focuses on the pros and cons of different types of energy around the world. Since its debut in 2012, it has been screened in 50 countries to more than 15 million viewers.

His second documentary, "Switch On," was released in 2020 and explores how the lack of access to dependable and affordable sources of energy — a phenomenon known as energy poverty — affects communities around the world, and strategies to overcome it.

The films are available for free online to all thanks to the Switch Energy Alliance, a non-profit founded by Tinker in 2016 to promote science-based energy education.

The alliance has also helped produce a number of short videos for classroom use that explain basic energy concepts and a five-minute movie, "Energy Makes Our World," for museums. The movie is currently being played between large screen features at the Houston Museum of Natural Science and in its Wiess Energy Hall.

Tinker is also the voice of "EarthDate," a weekly public radio segment that shares stories and facts about the planet. It is produced by the bureau, sponsored by EarthX and featured on more than 410 public radio stations in all 50 states. A PBS series, in which he will moderate discussions between recognized energy experts, is currently in the planning stages.

In addition to his own projects, Tinker frequently serves as an expert source for reporters and as

an event speaker. His more than 900 global talks include keynotes at professional events, presentations to groups ranging from primary school students, to board directors at major corporations, and testimony for the U.S. Senate.

Matheny Awarded NSF CAREER Grant to Research Water Storage in Trees

Ashley Matheny, an assistant professor in the Department of Geological Sciences, secured a prestigious grant from the National Science Foundation's Faculty Early Career Development Program. This award, known as a CAREER grant, provides five years of funding to help early-career faculty members establish a strong research and educational program that leads to a lifetime of leadership in their field.

Matheny's research will create novel sensors to directly measure water content at different depths when inserted in trees. She is collaborating with Pete Marchetto of Conservify, who is already constructing a prototype that measures the lateral transport of water in a tree. This type of transport is poorly understood since water movement is typically observed vertically from roots to stems.

"I am excited about this project and to help discover a more complete picture of how plants use water," said Matheny. "Our hypothesis is that defunct vessels in trees retain water, even if they are not actively transporting it, and can act as a backup or storage unit for the tree when it is water limited."

Matheny plans to measure water content in two contrasting North American forest types: a temperate, deciduous forest of red oak, white pine and red maple common in Michigan's deep sandy soils, and a semi-arid evergreen forest of Ashe juniper and live oak rooted in the rocky limestone landscape of central Texas. The research location for the semi-arid evergreen forest is the White Family Outdoor Learning Center, a 266-acre, outdoor classroom in the Texas Hill Country that was recently donated to the Jackson School by Leslie P. and Dianne White. This field station is fast becoming a local go-to area for research in hydrology.

The CAREER grant also has a strong educational component and provides resources to work with collaborators at Arizona State University to create immersive videos that provide remote "field experiences" for college and AP high school students throughout Texas. These videos, which will have Spanish and English versions, will take students to the White Center, the field site in Michigan, and an additional research site: a mangrove forest at The University of Texas at Austin's Marine Science Institute in Port Aransas, Texas.

"These virtual field trips should increase inclusivity through student access to the geosciences," said Matheny. "This grant will give us a great start after COVID-19 and the new world we are adapting to with online education. I want the kids to see the exciting world they can discover studying the earth sciences!"

Ketcham Receives Top Thermochronology Prize

Professor Richard Ketcham was selected as the 2020 recipient of the Martin Dodson Prize, the highest honor bestowed by the International Standing Committee on Thermochronology.

Due to the COVID-19 pandemic, the prize was not publicly announced until 2021. Ketcham received the award at the committee's biannual meeting in Santa Fe in September 2021.

"This is a community where everybody knows everybody, knows what they do, and what they contributed, so it's personal," Ketcham said. "It's very nice to get this affirmation from the committee and the community."

Ketcham is a joint recipient of the award. He shares it with Kerry

Gallagher, a professor at the University of Rennes.

Thermochronology is the study of getting information on rocks' thermal histories, the temperatures they have experienced through geologic time. According to the committee, Ketcham and Gallagher were selected for the prize "in recognition of their longterm, extraordinary contributions to make mathematically robust, yet user-friendly thermal history modeling tools available to the thermochronology community."

Ketcham has done extensive research on the theory of how thermochronometric systems work and is best known for developing a thermal history modeling program called HeFTy.

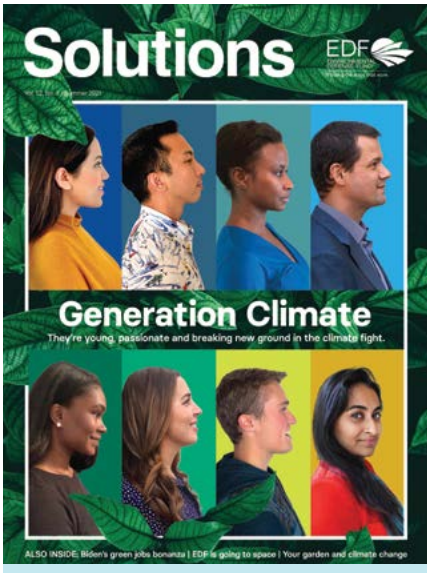
The program name refers to the Helium and Fission-Track thermochronometric methods while also serving as a reminder of the first rule of computer modeling: garbage in, garbage out.

"Naming the software after a trash bag really drives home a message that I want all of HeFTy's users to keep in mind," Ketcham said.

Jackson School of Geosciences Professor and Department of Geological Sciences Chair Daniel Stockli, who is also a thermochronologist, said that Ketcham's contributions to thermochronology science have helped significantly advance the field.

"This is a well-deserved award and recognition by the international thermochronology community for both his groundbreaking work in fission track annealing studies as well as thermal inverse modeling," Stockli said. "His modeling software packages are widely used and recognizable, have revolutionized thermal modeling, and represent the state of the art."

The award is named in honor of the late Martin Dodson, who pioneered the method of quantitative thermochronology.



Persad Named Climate Leader

Assistant Professor Geeta Persad was selected by the Environmental Defense Fund (EDF) as one of eight "Generation Climate" leaders. The honor recognizes a "rising generation of powerful and passionate young people, whose creativity, resilience and impatience are already making an impact on every aspect of this fight," wrote EDF President Fred Krupp in the summer edition of *Solutions* magazine.

The honorees appeared on the magazine's cover, which includes a short article on each leader.

"I am tremendously honored to have received this recognition, especially given the caliber of other Climate Leaders featured," Persad said. "The honor has been an emphatic validation to continue the impact-motivated and policy-interactive scientific work my group has been investing in. It is particularly gratifying to be recognized in this way by an organization like EDF, which itself is doing such important climate change research and advocacy."

The article on Persad highlights her 2020 research conducted in partnership with the Union of Concerned Scientists on how climate change is expected to influence California's water supply (more on this research on page 11). The article also mentioned Persad's work on how aerosol particles such as soot generated in the United States can suppress rainfall in far-off places like Indonesia.

"Geeta is a very sharp scientist who's not satisfied to let others make the world a better place," said Michael Oppenheimer, the former chief scientist at EDF and a mentor of Persad's, in the article. "She's eager to do some of that heavy lifting herself."

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

SPE ..... Society of Petroleum Engineers

SSA.....Seismological Society of America

UTIG ..... Institute for Geophysics

FACULTY AND RESEARCHERS

MOHSEN AHMADIAN
Best Paper Award, Journal of Environmental & Engineering Geophysics

ADRIEN ARNULF
Honorable Mention, Best Paper at the Annual Meeting, SEG

SAHAR BAKHSHIAN
Runner-up, Tinker Family Publication Award, BEG

THORSTEN BECKER
Evgueni Burov Medal, International Lithosphere Program
Elected Member, Academia Europaea

DON BLANKENSHIP
Director's Circle of Excellence, UTIG

GINNY CATANIA
Community Partnership, Diversity, Equity, and Inclusion Award, JSG

DAVID CHAPMAN
Best Paper Award, Journal of Environmental & Engineering Geophysics

KERRY COOK
Outstanding Research Award, JSG

JACOB COVAULT
Tinker Family Publication Award, BEG
Jules Braunstein Memorial Award, Best Poster Session Paper, AAPG
Robert Mitchum Award for Best Paper in Basin Research, European Association of Geoscientists & Engineers

MARCY DAVIS
Eleanor Picard Excellence Award, UTIG

IAN DALZIEL
Penrose Medal, GSA

DALLAS DUNLAP
Jules Braunstein Memorial Award, Best Poster Session Paper, AAPG

TIM DOOLEY
Runner-up, Tinker Family Publication Award, BEG

SERGEY FOMEL
Distinguished Lecturer, SEG
Honorary Member, Geophysical Society of Houston

JOHN GOFF
Joseph C. Walter Jr. Excellence Award, JSG

TIMOTHY GOUDGE
Azrieli Global Scholar, Canadian Institute for Advanced Research
Knebel Teaching Award, DGS
Ronald Greeley Early Career Award in Planetary Sciences, AGU

CYRIL GRIMA
Director's Circle of Excellence, UTIG

SEAN GULICK
Director's Circle of Excellence, UTIG
Outstanding Educator Award, JSG

MARK HELPER
Knebel Teaching Award, DGS

BRIAN HORTON
Knebel Teaching Award, DGS

SEYYED HOSSEINI
Runner-up, Tinker Family Publication Award, BEG

MICHAEL HUDEC
Jules Braunstein Memorial Award, Best Poster Session Paper, AAPG
Runner-up, Tinker Family Publication Award, BEG

RICHARD KETCHAM
Martin Dodson Prize, International Standing Committee on Thermochronology

JOHN LASSITER
Knebel Teaching Award

CHRISTOPHER LOWERY
Outstanding Research, UTIG

ASHLEY MATHENY
CAREER grant, NSF

KITTY MILLIKEN
Honorary Membership Award, SEPM

PANKAJ MISHRA
Honorable Mention, Best Paper at the Annual Meeting, SEG

DAVID MOHRIG
G. K. Gilbert Award in Surface Processes, AGU

GEETA PERSAD
Generation Climate leader, Environmental Defense Fund

CORNELIA RASMUSSEN
Outstanding Young Researcher, UTIG

BO REN
Career Development Publication Award, BEG
Southwestern America Regional Young Professional Member Outstanding Service Award, SPE

MRINAL SEN
Honorable Mention, Best Paper at the Annual Meeting, SEG

CAROLINE SEYLER
Outstanding Student Presentation Award, AGU

ZACHARY SICKMANN
Outstanding Postdoc, UTIG

JOHN SNEDDEN
Career Award, UTIG

CHENGUANG SUN
Mineralogical Society of America Award, MSA

ZOLTAN SYLVESTER
Tinker Family Publication Award, BEG
Jules Braunstein Memorial Award, Best Poster Session Paper, AAPG

SCOTT TINKER
Energy Leadership Award, Hart Energy

DANIEL TRUGMAN
Knebel Teaching Award, DGS
Top Five Downloaded Paper in 2020, Bulletin of the Seismological Society of America

LAURA WALLACE
Director's Circle of Excellence, UTIG

JINYU ZHANG
Tinker Family Publication Award, BEG

ZEYU ZHAO
Honorable Mention, Best Paper at the Annual Meeting, SEG

PROMOTIONS

JAIME BARNES
Professor

DANIEL BREECKER
Professor

BEN HESTER
Manager for Research Administration and Finance

SEYYED HOSSEINI
Senior Research Scientist

XAVIER JANSON
Senior Research Scientist

FARZAM JAVADPOUR
Senior Research Scientist

SHENG PENG
Research Scientist

SARA SIEBERATH
Assistant Director for Research Administration and Finance

MICHAEL SWEET
Program Director

LAURA WALLACE
Senior Research Scientist

STUDENTS

RAWAN ALASAD
Grants-in-Aid Fund, AAPG Foundation

SAIF ALHAJRI
Mineralogical Society of America's Undergraduate Prize, MSA

EMILY BAMBER
Outstanding Student Presentation Award, AGU
Future Investigators in NASA Earth and Space Science and Technology Fellowship, NASA

CLAUDIA BANKS
Graduate Student Research Grant, GSA
Graduate Research Fellowship Program Honorable Mention, NSF

LAKIN BEAL
Runner-up, Graduate Student Best Paper, JSG

JAMES BIEMILLER
Ewing-Worzel Graduate Fellowship, UTIG

REETAM BISWAS
Honorable Mention, Best Paper at the Annual Meeting, SEG

JAKE BURSTEIN
Ewing-Worzel Graduate Fellowship, UTIG

COLE CARRABBA
L. Austin Weeks Undergraduate Grant, AAPG Foundation

EDWARD CLENNETT
Graduate Fellowship, JSG

ETHAN CONRAD
Outstanding Student Presentation Award, AGU

SARAH DAVIS
Outstanding Teaching Assistant Award – Spring, DGS
Charlotte Mangum Award, Society for Integrative and Comparative Biology

SCOTT ECKLEY
Best Lightning Talk, Tomography for Scientific Advancement Symposium

ABDULAH ELJALAFI
Meckel Family Grant, AAPG Foundation
Outstanding Teaching Assistant Award – Fall, DGS
Outstanding Teaching Assistant Award – Spring, DGS

MEGAN FLANSBURG
Outstanding Teaching Assistant Award – Fall, DGS

ANDREW GASE
Outstanding Graduate Student, UTIG

NICOLE GONZALEZ
Future Leaders Fellowship, BP

BROOKLYN GOSE
Master's Saturday Best Speaker, DGS

HIMA HASSENRUCK-GUDIPATI
GSEC Student Service Award, DGS

EVELIN GUTIERREZ
William Dow Hamm Memorial Grant, AAPG Foundation

JAIME HIRTZ
Master's Saturday Best Speaker, DGS

ESTEFANIA SALGADO-JAUREGUI
Jackson Fellowship in Geohydrology and Wiley Fund for Excellence in Hydrogeology, JSG

SARP KARAKAYA
R. Randy Ray Memorial Grant, AAPG Foundation

DOMINIK KARDELL
Best Ph.D. Talk, DGS

JASMEEN KAUR
Austin Geological Society Award

MARK LAWRENCE
Estwing Hammer Award, DGS

KYLE MA
Mineralogical Society of America's Undergraduate Prize, MSA

NAOMA MCCALL
Outstanding Graduate Student, UTIG

NICK MESZAROS
AGeS2 Geochronology Student Research Grant, GSA/NSF
Off Campus Research Grant, JSG

JOHN MORETTI
Whitney Endowed Presidential Scholarship, JSG

ZACHARY MURPHY
Runner-up, Graduate Student Best Paper, JSG
Ewing-Worzel Graduate Fellowship, UTIG

KELLY OLSEN
Runner-up, Graduate Student Best Paper, JSG

PATRICIA ASCANIO-PELLON
Grants-in-Aid Fund, AAPG Foundation

EIRINI POULAKI
Outstanding Teaching Assistant Award – Spring, DGS

SEBASTIAN RAMIRO RAMIREZ
Equinor Fellow

WILLIAM REYES
Graduate Research Fellowship Program, NSF

CATHERINE ROSS
Ewing-Worzel Graduate Fellowship, UTIG
Graduate Student Fellowship, UT Center for Planetary Systems Habitability
Barrow Graduate Fellowship and Salvador Stratigraphy Scholarship Endowment, JSG

IRINEO SANCHEZ
Austin Geological Society Award

SIMON SCARPETTA
Graduate Student Best Paper, JSG

KEVIN SHIONALYN
Robert D. Bentley Award for Superior Academic Performance, Central Washington University

BRANDON SHUCK
Ewing-Worzel Graduate Fellowship, UTIG
Outstanding Graduate Student Award, UTIG
Outstanding Student Presentation Award, AGU
Student Presentation Award, SSA

SINJINI SINHA
Student Grant Program, Evolving Earth Foundation

Lewis and Clark Fund, American Philosophical Society

COLE SPEED
Grants-in-Aid Fund, AAPG Foundation

PATTY STANDRING
Arthur James Boucot Award, Paleontological Society
Tilly Edinger Travel Grant, Time Scavengers
Graduate Research Fellowship Program, NSF

THARIT TANGKIJWANICHAKUL
L. Austin Weeks Undergraduate Grant, AAPG Foundation

JUSTIN THOMPSON
Best Ph.D. Talk, DGS

WEI WEI
Ewing-Worzel Graduate Fellowship, UTIG

ERIC WIESER
EER Fellowship, JSG

NATALIE WOLFENBARGER
Ewing-Worzel Graduate Fellowship, UTIG

GEORGE SEGEE-WRIGHT
Graduate Student Research Grant, GSA
Harold T. Stearns Fellowship Award, GSA
Graduate School Summer Fellowship, UT

YU-CHEN ZHENG
David Worthington Family Grant, AAPG Foundation

STAFF

JESSICA BRADFORD
Texas Exes James W. Vick Advising Award, UT

PHILIP GUERRERO
Outstanding Service Award, JSG

BENJAMIN HESTER
Staff Excellence Award, JSG

MONICA KORTSHA
University Excellence in Communications Writing Award, UT
University Excellence in Communications Media Relations Award Finalist, UT

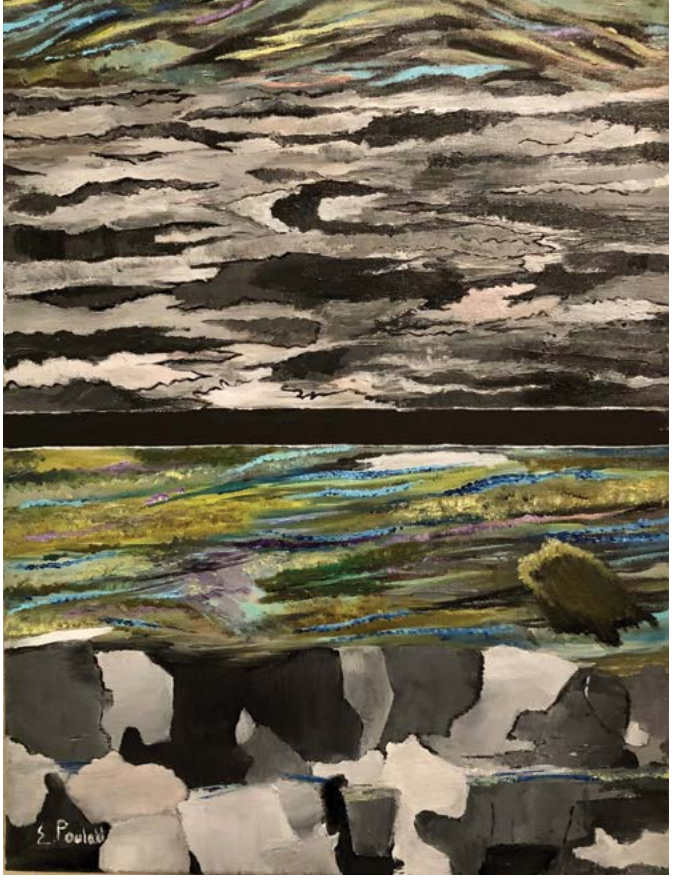
KIM LAVALLEY
Staff Service Award, BEG

AMANDA MASTERSON
Special Recognition Award, BEG

SARA SIEBERATH
Outstanding Support Staff, UTIG

CARLA THOMAS
Outstanding Support Staff, UTIG

JOSEPH YEH
The University of Texas at Austin President's 2021 Outstanding Staff Award
Staff Excellence Award, BEG



PAINTING: EIRINI POULAKI.

STUDENT RESEARCH SYMPOSIUM AWARDS

In February 2021, the Jackson School's Graduate Student Executive Committee hosted its 10th Annual Research Symposium. Winners and honorable mentions are as follows:

LATE-CAREER PH.D. STUDENT

1st Place: Paul Morris: Sinuous Deep-Water Channel Systems: Curvature Driven Evolution Drives Autogenic Aggradation Processes – Example from Eastern Gulf of Mexico

2nd Place: Kwun Yip Fung: Testing different dataset and machine learning methods accuracy in producing the Austin Local Climate Zone map

Honorable Mention: Grace Beaudoin: The evolution of the halogen budget in ophiolites from the Western Alps

LATE-CAREER MASTER'S STUDENT

1st Place: Leland Spangler: Timing and Controls on late Paleozoic Tectonism and Synorogenic Sedimentation, Bursum Formation, Sacramento Mountains, New Mexico

2nd Place: Joseph Syzdek: Mechanical Stratigraphic Control on Deformation in a Fault-Propagation Fold, Gobbler Anticline, Sacramento Mountains, New Mexico

Honorable Mention: Bethany Rysak: Analysis of Hydraulic Fracture Growth and Segmentation: Implications of Observations From the HFTS1 Slant Core, Wolfcamp Fm., Midland Basin, West Texas

EARLY-CAREER GRADUATE STUDENT

1st Place: Michelle Tebolt: Investigating the depositional environment of sedimentary fan features on Mars using orbital stratigraphy

2nd Place: Emily Bamber: How did Mars' crater paleolakes form? Insights from Geomorphology

Honorable Mention: Ethan Conrad: Cenozoic Evolution of the Northern Caribbean Plate Boundary: Insights from Thermochronometric, Kinematic and Geomorphic Data

UNDERGRADUATE STUDENT

1st Place: Carole Lakrout: Life Mediated Mineral Deposits in Caves

2nd Place: Reem Alomar: Estimating the triangular smoothing radius using the Gauss-Newton method

Honorable Mention: Katherine Faulkner: Categorizing Variations of Phanerozoic Foraminifera Mineralogy

BEST REPRESENTED RESEARCH GROUP

1st Place: Timothy Goudge Research Group

2nd Place: Daniel Stockli Research Group

HIGH SCHOOL BEST POSTER AWARD

First Place: Miguel Liu-Schiaffini: Automated Identification of Ice Sheet Surface and Bed Interfaces Using Deep Learning

Second Place (Tie): Lochana Kalyanaraman: Analyzing Earth's Processes for Space Exploration: Carrying our Knowledge of Life Beyond Earth; **Second Place (Tie):** Enrique Morales: Planet Terra

FIGURE COMPETITION

First Place: Eirini Poulaki: Thin sections from S. Spain-Oil painting on Canvas

Second Place: Rawan Alasad: Flow transformations in subaerial and subaqueous debris flows

Third Place (Tie): Brandon Shuck: Subduction initiation is a four dimensional process; **Third Place (Tie):** Cole Speed: A river through time; **Third Place (Tie):** Emily Bamber: Mechanisms of forming fluvial valleys into craters on Mars; **Third Place (Tie):** Ethan Conrad: Hypothesis for the Cenozoic evolution of the Northern Caribbean plate boundary; **Third Place (Tie):** Grace Beaudoin: Halogen geochemical cycling; **Third Place (Tie):** Samuel Robbins: Red Sea rift model

ABOVE: AN OIL PAINTING BY EIRINI POULAKI OF A THIN SECTION FROM SOUTHERN SPAIN THAT WON FIRST PLACE IN THE FIGURE COMPETITION.

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
David Boyles
Barbara & Philip Braithwaite
Ina* and Jesse* Brundrett
Susan Cage
Louise * & Decker* Dawson
Joyce & James Doyle
Karen & Ed Duncan
Connie & Byron* Dyer
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Fred Gibson
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Kathleen Howard
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Rita & Jimmie Russell
Julia Trimble & Tim Diggs
Kevin Tuerff
Mark Ver Hoeve
Kathy & Steve Weiner
Wendy Weiss & Robert Mace
Pam & Rom Welborn
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
Chuck Caughey
Louise* & Decker* Dawson
Karen & Ed Duncan
Jacque* & Scotty* Holland
Katie* & Jack* Jackson
Angela & Munib Masri
Edith* & Peter O'Donnell
Eleanor & Scott Petty
Rita & Jimmie Russell
Dick Stoneburner
Elizabeth & Joe* Walter
Dianne & Les 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
Ann & Henry Hamman
Kathleen Howard
Kenneth Neavel
Mark Ver Hoeve
Kathy & Steve Weiner
Edith & Bob Zinn

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.

James Austin, Jr.
Annell Bay & Robert Suchecki
Patricia Boyd
David Boyles
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
Sally & Ralph* Duchin
Connie & Byron* Dyer
Heather & John Echols
Carol & Jim Farnsworth
Judy & Jim Gibbs
Bill Gipson
Cala Ferrand & Al Haertlein
Lisa & Erik Hanson
Grace & Hugh Hay-Roe
Charlene & Dean Henney
Melinda & Jeff Hildebrand
Caroline Rose Hunt*
Rosa & Tom Layman
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Patsy & David Lehman
Sandra Lindquist
Susi & Mike Looney
Judy & Ernie Lundelius
Sara & David Martineau
Alicia & David Martineau
Delle Maxwell
Marian Maxwell*

*Deceased

Susan & Jack Mayfield
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Madrienne Petitjean
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Marsha & Gregg Robertson
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Sandra & David* Sigman
Russ Slayback
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Dorothy Sumner*
Sherry & Gary Thompson
Julia Trimble & Tim Diggs
Allison & Bryan Wagner
Anita & Charles* Weiner
Pamela & Rom Welborn
Wendy Weiss & Robert Mace
Mike Wiley*
Mary Wilkinson
Pinar Yilmaz

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
Ellen & Gene Ames
Debbie & Jim Anderson
Patricia & Malcolm Bailey
Carol & Rod Baker
Dan Barker*
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1950's

Eugene L. Ames, Jr. (B.S. '55) can be contacted at gamesjr33@gmail.com.

Richard T. Buffler (B.S. '59) Dick says "I am still living in Santa Fe, New Mexico. I recently sold my home in the hills after my wife Patricia passed in 2013. I have now moved into a wonderful retirement facility, El Castillo, located on the Santa Fe river close to downtown. Here I have a small but great apartment, many new friends, nice activities, and good food. My good friend and partner of 5 years, Christine Boss, who lives across town, and I share a wonderful life together. This past year we have been able to travel quite a bit, mainly short trips exploring New Mexico. It turns out to be a wonderful state with great history, culture and geology. Please come see us when you can."

Jack Cleveland Cartwright (B.S. '51) shares, "Barbara and I are fully qualified retired senior citizens. We are blessed to be living in a wonderful retirement facility in Midland. We met in 1953 when I returned to graduate school. Barbara was working in the Geology Library. We married in 1955. Our marriage has been blessed with a large family of children, grandchildren, great-grandchildren and even some great-great-grandchildren."

Connie Mayes Dyer (B.A. '58) says, "There have been many changes in my life in the past few years, but I'm eagerly looking forward to attending this Fall's Advisory Council meeting. It'll be my first in several years. Thanks to JSG for keeping me up to date. For those who knew him....Byron, my husband of 60 years, passed away in April, 2020. He was a geology alum of Lamar University, but a good friend of the Jackson School! Three weeks after his death, I had a hard fall on my driveway and I am still working on recovery from that. I'm a little gimpy with a good bit of metal in my left leg and hip, but very very lucky. Probably the end of my tap-dancing days, however. The best family news is that I will be a great grandmother of a baby boy in January, thanks to the first of my 8 grandchildren, Blaine Gabrisch Mooring and her husband Gage! As if my loyalties were not already spread all over Texas through my children (UT, SMU, TT, UH), my grands have spread out to TCU (3 grads), A&M (1), NYU (1) and finally this summer, a UT grad. No geologists among them! All my best to you late 50's grads."

Jimmie Russell (B.A. '52, M.A. '54) writes, "SAD!! This Time-Period personally has been a very sad one! Several close friends and colleagues passed away. There were several reasons why that happened. All were sad. One had been told, by his doctor, only the month before, that he was "in the bloom of health." Although I was unable to attend their memorial services, their widows and families are "chatted" with by telephone. I almost became despondent, because of dwelling excessively on all of the foregoing difficulties. However, knowing that "when you have caused yourself to be at the bottom of a hole, QUIT DIGGING!" Therefore, I said to myself, "SELF, Cut out the ****, and GET WITH IT!!" Heeding the advice to "SELF," and persevering, I conjured-up a positive attitude, and low-and-behold!!, the world looked more like a pleasant place, AND, I could SMILE!! I became 90 years-old, WOW! During that time, I have marveled at the things I have observed, primarily changes. Not all are good. There are many more people. Fortunately, it would appear that society has "mellowed", but maybe not! Hope for the best. Best regards; I will enjoy your contacting me, and HOOK 'EM!" Jimmie can be contacted at 512-454-7498, jimmierussell@gmail.com.

Theodore Stanzel (B.S. '56) shares, "Paying attention to the important, significant issues confronting our lives in retirement. As travel opportunities return our plans are focused on a short trip to Black Hills Badlands of South Dakota. Expectations for the future seem even better."

1960's

Charles A. Caughey (B.A. '60, M.A. '73) says, "Amid the pandemic crisis I was able to escape to visit friends in the mountains of Utah (August) and then with a friend to Key West and Fort Jefferson in the Dry Tortugas (November). Work with the AAPG Publications Pipeline, which collected donated geoscience and related books and journals for shipment to universities in need of library materials, finally ended after 19 years and 239 tons of publications delivered around the world. With international campuses closed, we cleared the warehouse by sending books to smaller colleges across the US and then staged book giveaways to professors and students. But good news in 2021: funds awarded from my GeoFORCE scholarship, and the first recipient of the Pak Chuck fellowship arrived from Indonesia for MS study at the Jackson School in August."

Joe Norman Meadows (B.A. '62) says, "Got a new aortic valve replacement. Does this mean I have to take calculus again?" Joe can be contacted at joemeadows@sbcglobal.net.

Jereld E. Queen (B.S. '61, M.A. '63) writes, "Glad that JSG is thriving during this latest downturn in the petroleum industry."

Rubin A. Schultz, Jr. (B.S. '61) shares, "Not much new. COVID virus kept Nancy and me around home last winter although we did take a short trip to Branson during veterans week in November. Had another great granddaughter added to the family in June and another one due in November."

William C. Young (B.A. '61) writes, "Still have the same agenda: Travels, museums, family and friends. My health is about the same and I'm still trying to empty my bucket list. I wish all of you the best life has to offer."

1970's

C. Elmo Brown (B.A. '76) says, "As with most folks, we have been weathering the COVID storm by hunkering down at home here in Kerrville; although, we did take a couple of trips out to Big Bend to enjoy the desert beauty in the past several months (it is really easy to isolate there since our most frequent visitors are javelinas). We have also had some Texas-ex geologists pass through this year. First, it was Denverites Bill and Jackie Bath (Jackie is a past recipient of the AAPG Teacher of the Year Award) who visited while on their way to the Gulf Coast for a family outing. Then Scott and Suzy Gorham dropped in for a quick visit later in the year. I also visited Ted Flanigan and Paul Garrison while Paul was passing through on his way to Florida from Wyoming. So, we are not totally isolated from the world! And, we look forward to seeing a lot more geological compatriots while at the AAPG meeting in Denver in a few weeks and hope to get more involved in the South Texas Geological Society as the virus winds down."

Roger Q. Callaway (B.S. '77) shares, "Now, let me see," said the blind man.. it must be 2021 and I'm here at the wire again, writing for my audience of 1, or 2. Once again, perhaps my major accomplishment for 2020/2021 was.. not dying! This past December, it looked like my best bet for surviving the COVID 19 plague was vaccination. The MD conglomerate that serves my medical needs was also hosting a branch of the J&J phase 3 trial and at the last minute, I slipped under the wire and was accepted into the cohort. It was a blind study with a 50/50 chance of getting stuck with the vaccine, but, better than nothing, right? Very slight reaction, but some. About 6 weeks later, my wife got sick, fever, aches, etc. She got tested and turned up positive so the family got tested, and I turned up positive, but with almost NO Symptoms; just a runny nose. So did I get the Real Vaccine? March 15th the trial was unblinded, and I had gotten the vaccine. So What Happened? Beats me. In June, it seemed like the plague was loosening up its siege, and with vaccination papers in hand, my daughter and I made the delayed annual pilgrimage to see my brother in New York. Successfully navigated the perilous roads, a brilliant trip where I demonstrated my brisket skills, and also introduced the New York branch to Oaxacan refried black beans. Somehow, I have parlayed my 35 year old memories as mine geologist into a tourist visa at the old mine, which is in the process of reevaluation. It is just as confusing as it was, lo those many years ago. I still feel fortunate to have graduated from the U of T College of Natural Sciences with my B.S. in Geology clutched in my hand. It has served me well. Somehow, a review of last year's notes had me as graduating in 1970. No. It was 7/7/77." Roger can be contacted at rqcallaway@gmail.com.

Frank G. Cornish (M.A. '75) writes, "When I was a young teenager my Dad took me on a trip that I made the call on, based upon my rock collecting guides. From De Ridder, LA, we swung through Arkansas, Oklahoma and Texas. I collected moss agate, quartz and boxes of Cretaceous fossils from central Texas and still have those rocks. When my Dad came back from deployment in Libya, he brought me dark brown desert polished petrified wood from the Sahara. My mother was the driving force in pushing me academically, but Dad reinforced my geological leanings. He passed away this summer, his petrified wood sits on my office desk. Thanks Dad for supporting a rock collector that turned a hobby into a profession that I still love."

Robert A. Levich (M.A. '73) can be contacted at cpgeologist@gmail.com.

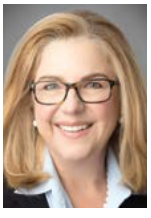
1980's

Carol Swenumson Baker (B.S. '84) says, "After 36 years working at ExxonMobil I have retired. I'm loving having more time to travel and reconnect with friends." Carol can be contacted at Rod_carol@att.net.

Jim Clarke (B.S. '84) writes, "Hello to the Class of '84! While my career path took me into air quality science, I've at least been a tourist level geologist all along; never forget your roots. A few years ago I re-visited the lepidolite mine near Dixon NM where we did a plane table mapping exercise in summer field camp, and have recently been back to Lake Brownwood State Park where Jim Sprinkle had us all scouring the ground for crinoids - good times! I'm getting close to logging 40 years with AECOM, managing air quality measurements work around the US, and recently moved out of Austin to an old farm in eastern Burnet County, seeing retirement just off in the distance. The photo is of me and my grandson checking out our recently rebuilt pond last year (it's full of water and catfish now - yay!) I hope all are doing well, and as always Hook 'Em!"

Donald Wayne Downey (B.A. '82) shares, "Enjoying retirement from Chevron! Family oil company Roxanna is drilling wells in the Saratoga Chalk in Louisiana. I keep busy working with WWII Veterans, mainly Pearl Harbor Survivors. We record their entire life story and give them and their families video recordings and published books for free. Chevron pays for half of the costs. We have distributed hundreds of DVDs and books at no charge. We also make extremely detailed maps of their personal WWII experience. The veterans use our posters of their photos and maps when they speak at schools and other meetings. We also get the veterans entered into parades including making magnetic signs with their names and WWII stations for the doors of the military jeeps they ride in. It really is a pleasure to work

with the WWII (and Korean War and Vietnam War) vets who had not yet told their story. This is quite a change in careers from working at Chevron international E&P research, but I use the book-writing and computer skills learned writing MS thesis and Chevron reports, plus I did attend two years of RTF at UT before switching to a science major. Thanks to everyone who helped me get an undergraduate degree, and especially everyone who worked at the BEG back then. JSG is the best soft-rock school in the world. I graduated with 91% on the Geology subject GRE in 1982."



Tatiana Frierson (B.S. '85) writes, "In July 2019, I joined Inspirus (a Sodexo company) as their CEO. Inspirus is a software and services firm in the employee recognition space. It has been a real transformation challenge with the pandemic. However in less than two years I am happy to say we have a bonafide turnaround improving underlying Profit (UOP) by 85%! Hope everyone is staying safe and healthy! Looking forward to an even better 2022. Cheers." Tatiana can be contacted at tatianafrierson@gmail.com.

Karen Havholm (M.A. '86, Ph.D. '91) shares, "Retired from the University of Wisconsin-Eau Claire at the same time as the pandemic started. Had a good experience judging at the Jackson School virtual student research presentation event. Hoping to be able to begin retirement travel soon. First stop, once borders open: Yellowknife, NWT, Canada, where our daughter works at the Geological Survey."

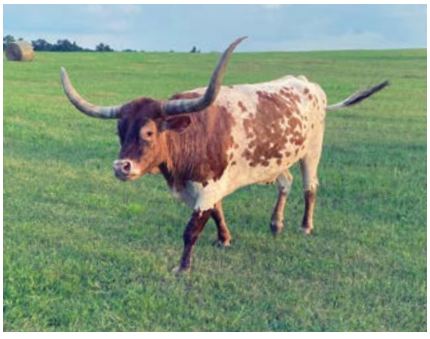
Charles Graham Johnson (B.S. '83) says, "Still working old legacy fields for mostly stripper-type production. Been with the same outfit now for over a quarter century. Ellen and I had our first grandchild (Sam) in 2019, and our second is due in January 2021. Life is good, but it will be better when oil gets back over $100 per barrel."

Richard (Rick) Alan Kolb (M.A. '81) shares, "I retired from SynTerra Corporation on August 10, 2021 after 31 years of working as a consulting geologist, preceded by 8 years with Mobil Oil in New Orleans. I had planned a cross country motorcycle trip to celebrate and start my next chapter, and until July 1st everything looked fine, but then we slid back into Covid times, so I will defer the trip. I will remain in Cary, North Carolina but hope to eventually live in the Rockies, where I have many friends and can see rocks that aren't covered by trees. Both of my kids live in Austin, which has always been too hot of a place for me to thrive."

Anne Smith Miller (B.A. '83) writes, "After 30+ years of service, I retired from the Texas Commission on Environmental Quality. Both of our sons graduated from UT Austin. It would be great to hear from old friends!"

David Noe (M.A. '84) says, "Hello to the "Dirty Dozen" and other early 1980's grad school alums! I am doing well, living in the North Fork Valley (the organic-farming cornucopia of Western Colorado) where I co-own and operate a guided tour business. If you're ever in the mood to escape the resort-area crowds and take a wine-tasting tour, a geology tour, or a nature tour, please contact me at Colorado Detours or Western Colorado Wine Tour!" David can be contacted at info@colorado-detours.com.

Robert Mark Reed (B.S. '85, Ph.D. '99) shares, "I am still working at the Bureau of Economic Geology and will probably stay until I am strong-armed into retirement. Very happy to have a job that consists mostly of telling interesting stories using microscope images. The pandemic has been a struggle, but with help from higher ups (thanks Deans!) we have managed to keep the SEM lab open most of the time. One of my current projects is a fascinating study of central Texas Cretaceous volcanic reservoirs. I recently had an outdoor mini-reunion at the Posse East with alumni Marc Wink and Ted Stout. I hope to catch up with more former classmates at AAPG/SEG in Denver and GSA in Portland this fall."



Jerry Schwarzbach (B.A. '83) writes, "Still enjoying ranching, flying & doctoring. Attached is picture of my Longhorn. Proud to be President of Tyler-Smith County Texas Exes. Class of '83."

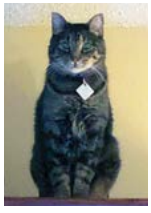
Stephen W. Speer (M.A. '83) says, "Life is good.....doing a bit of traveling this year with Therese looking for a nice spot to hang out for extended stays. Costa Rica and SW Colorado this year...saw fellow alum Dave Noe at his hangout in Paonia, CO. He looks great and is doing quite well being "retired" doing local geological and wine country tours for the lucky people who search him out. Mount Pleasant is still a great place to live but is growing rapidly and becoming much more hectic. Guess that's the price ya pay for living in such a nice place. Opening a new bar/gastropub here this August...was supposed to open in May, 2020 but COVID had other plans, hopefully it does fine. That's about all for now. Come

see us and I'll buy you a beer eh? Cheers to all of the "Dirty Dozen," pray you all are doing well!"

Burgess Hagan Stengl (B.S. '85) writes, "It's been a couple of years since I submitted anything to the Newsletter, so it's good to be back. I am still in the solid waste industry, however, after a 20-year hiatus, I am back working for the State. I accepted a position with the Texas Commission on Environmental Quality in late July, and am looking forward to working in the Municipal Solid Waste Permits Section. We still live in Spring, so since my new job is in Austin, working remotely is something good that has come from the pandemic. My wife and I were scheduled to take a trip to Germany in 2020 to celebrate our 40th anniversary, however, we were forced to delay the trip until our 41st anniversary. We will be visiting our former exchange student and his family, and I will let you know how the trip turned out in the next Newsletter! Our daughters and their families are living in Hutto and Spring, and my son recently graduated from UT San Antonio with a degree in Geographic Environmental Sustainability. By the time the Newsletter is published, I am hopeful he has a full-time job! In closing I would like to say hello to my fellow graduates from 1985. It's hard to believe it was so long ago. Everyone stay safe!" Burgess can be contacted at texbirds@sbcglobal.net.

William "Barry" Wethington (B.S. '85) shares, "After spending 30+ years in this fantastic industry (Oil and Gas), of which 27 were overseas, I retired in Dec. 2020. I then started an advisory firm and I am an active board member for an energy funding platform. I do this part-time to stay engaged in the industry. More importantly, I just celebrated a 36 year anniversary, my three children are doing well (one followed in my foot steps and works for EOG) and so far they have blessed us with three beautiful grandchildren. We split our time between Smith Mountain Lake home in Virginia and a home in the DFW area. One thing about the industry, it continually changes and at present the energy transition is exciting. The rise of clean energy is needed as is the ability of the traditional business models to operate in a more environmentally-friendly manner. The oil and gas industry will figure out how to do this (it has met every challenge in the past) and the industry will play a key role in the energy mix for decades going forward. I would enjoy a conversation with anyone from the class of '85 (Roger, Brian, Monica, Tracy, etc...)." Barry can be contacted at wbwethington@gmail.com.

1990's



Donald Andrew Bowen (B.S. '91) says, "My time in the geology program and my career in hydrogeology were some wonderful times. In 2022 I will return to graduate school to pursue a degree in Social Work to become a counselor using faith as the modality. In my very little free time I garden and use the herbs in my cooking and baking. Until I am married I take care of town "furry kids" named Marble & Miracle." Andrew can be contacted at bowen.andrew@gmail.com.

Christi Gell (B.S. '96) writes, "Hi everyone! Charlie and I are still in Houston and enjoying working from home. We both had job changes in October - Charlie joined AWS and I joined Eliis. It was a fun job move for me because I have reconnected with some old classmates like Dallas at the BEG who uses our PaleoScan software! Really great catching up. Whenever I get to Austin I stop by Westminster to check on Dr. McBride and Dr. Lundelius. We even got EFM to Zoom call with us, which has been a hoot. The kids are growing like weeds of course. We took a summer vacation to California to escape the Houston heat a bit, and of course enjoy some geology not seen around these parts. Hook 'Em!"

Brian B. Hunt (B.S. '96, M.S. '00) says, "After 19 years as a hydrogeologist for a central Texas groundwater district, I am so very excited to have accepted a job at UT's Bureau of Economic Geology in the Environmental Research division. Working with such brilliant scientists at the BEG and UT was a real draw to change jobs. One of my primary tasks will be making geologic maps for the Bureau. I finished two maps this year, the Grit Quadrangle in Mason County, and a compilation of four quadrangles along the Pedernales in Blanco County. It was an honor to co-author the Grit map with my field geology field instructor and mentor Mark Helper! My other job tasks presently include two hydrogeology characterization projects, one along the Devil's River in Val Verde County and another centered on Hamilton Pool in western Travis County. Getting back to basic geologic mapping has been so fun, and I think is the key to hydrogeologic understanding." Brian can be contacted at brian.hunt@beg.utexas.edu.

Cristopher Marshall (B.S. '97) says, "My last semester at UT Austin (1997) I

was able to take Dr. Barker's coveted "Volcanology" class. It was only offered every other spring at that point. Since that time I have dreamed of summitting Kilimanjaro--Africa's highest point at 19,341 feet. This summer that became a reality! After dreaming, and then planning, and finally preparing, on June 23rd, 2021 I climbed and successfully summitted the monstrous dormant volcano. It was all I had hoped it would be and was even more epic than I had ever imagined! On a professional note, I will start my 24th year of teaching high school Earth/Space Science. I have been blessed to be able to teach the subjects that I hold near and dear to my heart for the entirety of my career. I continue to try and make students very aware of the need for future geoscientists. As I tell all of them, "If you want your WiFi and your iPhones, you better have plenty of clean water and reliable energy. Geoscientists are the most important people in helping keep our digital way of life sustained!" Thanks to all the people at UT JSG that have helped me to get and be where I am today. Much Love and God Bless!"

2000's

James McGuire (M.S. '03) was unanimously elected by his peers to serve a three-year term on the Executive Committee of the State Bar of Texas' Environmental & Natural Resources Law Section (ENRLS) on August 6, 2021. In that capacity, he will help ENRLS educate and collaborate with environmental lawyers across the State of Texas, coordinate scholarships and paid internships, and promote an upcoming 2022 symposium on climate change and the law. James is currently the Regional Counsel for EPA Region 6, where he leads a 60-lawyer office covering Arkansas, Louisiana, New Mexico, Oklahoma, Texas, and 66 federally recognized tribes.

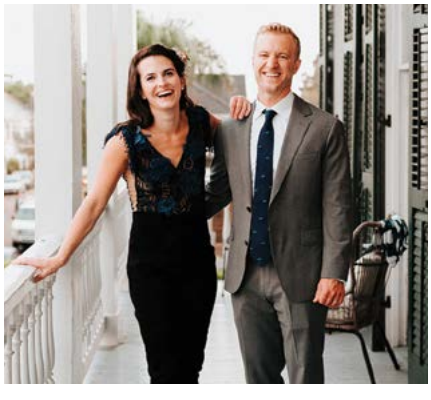
Petros Papazis (B.S. '03, M.S. '05) can be contacted at p.papazis@gmail.com.

Sunny Simpkins (B.S. '00) writes, "My family and I moved to Bend, Oregon last September from Portland to enjoy more outdoor activities. I took a remote position with the National Association of Flood & Stormwater Management Agencies (NAFSMA) as the Director of Government Relations and Member Programs. We represent public agencies around the country by advocating for effective public policy, securing essential funding, and promoting innovations that help flood and stormwater government agencies better serve their communities." Sunny can be contacted at sbsimpkins@yahoo.com.

2010's

Kaitlin Buzzetto (B.S. '13) can be contacted at kmbuzzetto@gmail.com.

Randy Caber (M.S. '10) exited the oil and gas industry over 2 years ago to begin a career with Amazon in Operations Management. After only 16 months, he was promoted to senior Operations Manager, having launched a building in his home area of Pittsburgh, PA in September 2020. Randy is now about to open the first fulfillment center in New Mexico in Albuquerque for Amazon as a member of the senior leadership at that facility, and provide over 3,500 job opportunities for the local area. Randy can be contacted at randycaber@gmail.com.



David Conwell (M.S. '15) married Liz Dewey on October 27, 2020 in New Orleans.

Tian Y. Dong (B.S. '13) says, "My wife and I moved back to Austin in July, 2020. I returned to the Jackson School to work as a NSF Earth Science Postdoctoral Fellow." Tian can be contacted at tian.tyler.dong@gmail.com.

Autumn Eakin (M.S. '11) shares, "The Eakins welcomed a baby girl last summer while working remote in Wyoming. Isla Eakin joins her brother Aksel (almost three!) in bringing joy and a fair bit of crazy to our lives. Dan is gearing up to begin a Chevron-sponsored program at Rice University where he will work toward a Master's in Data Science. We're grateful for the health of our family and friends and looking forward to the adventures ahead. Best wishes from Autumn & Dan."

Laura Pommer Fidler (M.S. '13) has recently started as CEO of EnergyFunders, an online platform for investing in oil and gas wells. Formerly, she was CEO, founder, and geologist at a Private Equity backed portfolio company called Century Natural Resources, exploring for Turner sands in the Powder River Basin. In May, she was presented the opportunity to head EnergyFunders. This was a compelling pivot to the future of oil and gas investing and deal financing. She is thrilled to be leading the team revolutionizing democratizing (crowdfunding) investing in oil and gas, and especially excited to be able to connect prospectors and deal makers with everyday investors, opening the path for even her father (a wannabe geologist) to have access to wellhead economics. She still lives in Houston, Texas, but makes it home to Colorado to visit her brother, Max Pommer (UT JSG MS) and sister in law, Rania Eldam Pommer (UT JSG BS), and their new baby Nailah (future UT JSG alum!). Laura can be contacted at laura.pommer@gmail.com.

James (Jake) Gearon (B.S. '19) can be contacted at jake.gearon@gmail.com.

Saygin Ileri (M.S. '15) can be contacted at ileri_1@hotmail.com.

Darby Lee (B.S. '19) says, "I am returning to UT to pursue my MBA through the McCombs Working Professional program in DFW." Darby can be contacted at dlee@forensixconsulting.com.

Justin Mauck (M.S. '17) shares, "Pivoting from oil to gold and heading to the mountains."

Will McCullick (B.S. '17) can be contacted at willmccullick@gmail.com.

Frank Morgan (B.S. '11) says, "After a wild 2020, I have settled in as VP of Geology at Century Natural Resources along with marrying my beautiful wife, Annie. We're currently looking forward to the next thrilling chapter in the oil & gas industry." Frank can be contacted at fmorgan@centurynr.com.

Katherine Newman (B.S. '15) writes, "I am the Geothermal Reservoir Engineer for the highly anticipated Tauhara Power Station development in New Zealand. I am primarily involved in the capacity testing and data analysis of newly drilled geothermal wells that will power our new 152MW power station. This $580-million investment is going to provide a renewable and low-emission energy source that will greatly help New Zealand transition towards a 100% renewable energy future, and it is one of the largest geothermal developments in the world right now. My path since graduating from JSG in 2015 has been unconventional (oil and gas, sales, marketing, and now this), but I couldn't be happier to have landed in a career that allows me to use my geoscience education on a daily basis. This has been the most thrilling, challenging, rewarding and inspiring experience of my life so far."

Evan Zachary Pearson (B.S. '10) finished law school in 2020. Evan clerked for Judge Alan D. Albright in Waco, Texas. Now that he's finished his clerkship, he is back in Austin and working at Quinn Emanuel Urquhart & Sullivan LLP with a focus on patent litigation. Though geology is no longer his focus, his degree at the Jackson School has proven invaluable to where he is today. On a personal note, he married his soulmate, Carley McCaw, on October 24, 2020 in a hotel room in San Antonio. Evan can be contacted at ezpearson@gmail.com.

Nicole (Hart) Wagoner (M.S. '15) moved to Reno, NV to pursue a Ph.D. in Geology at the University of Nevada, Reno. Nicole will join the team at the Great Basin Center for Geothermal Energy at the Nevada Bureau of Mines and Geology to work on the Innovative Geothermal Exploration through Novel Investigations Of Undiscovered Systems (INGENIOUS) project awarded to UNR by the U.S. Department of Energy in 2020. Nicole can be contacted at hartnic4@gmail.com.

2020's

Eiji Kawai (M.S. '21) can be contacted at ekawai@utexas.edu.

Friends

Tom Patty (M.A. '68 in Botany) says, "Covid-19 continued to reduce field time this year. Major fossil finds include an Edwards Fm. Rudist reef deposit in a limestone quarry in Lampasas County. Another was a strata of Lopha travisana in the Austin Fm. in northern Williamson County. Finally, this summer I was able to get a flight to Los Angeles to visit the LaBrea Tar Pits. Hopefully the 2021-22 school year will allow us to visit our friends at the BEG as well as offices on campus. I can still be reached at tspgeorock@gmail.com."

MEMORIALS

Abhaya "Ajay" R. Badachhape (M.A. '88) passed away on April 15, 2021. Ajay was born to Ramachandra Badachhape and Sarojini (Navgale) in Jalgaon, Maharashtra, India on October 9, 1960. Ajay's family emigrated to the United States shortly after his birth. Ajay excelled at academics at a young age and was a recipient of a National Merit Scholarship in 1978. Educated at Rice University and the University of Texas, Ajay became a gifted geophysicist who pioneered many advances in the field of seismic inversion. He authored multiple publications in leading geoscience journals and his work was featured at conferences throughout the world. His work was integral to the discovery of resource deposits that are critical to the energy needs of modern society. Ajay is survived by his wife, Sutapa Sur; son, Andrew Badachhape; his parents; sister, Maya Bledsoe; brother-in-law, Murff Bledsoe; niece, Grace Barr; and nephew, Nathan Lonsdale Bledsoe.

Walter V. Boyle (B.S. '54, M.A. '55) 89, passed away Friday, December 18, 2020. Walt was born July 23, 1931, to Wilma and Walter Jacob Boyle and grew up in San Antonio, Texas, where he graduated from Thomas Jefferson High School in 1949. He then attended Trinity University, San Antonio, before transferring to The University of Texas at Austin, where he graduated with honors with a B.S. and M.A. in Geology. While at UT, he taught Freshman Geology Lab. He joined Shell Oil Company and spent most of his career in New Mexico, Colorado, and Texas. After retiring in the early 90's Walt enjoyed many activities, especially traveling. He is survived by his wife of 48 years, Vada Adams Boyle, sister, Marilyn Gray Killinger and sister-in-law, Linda Adams Taylor and their families, including; several nieces and nephews, great nieces and nephews, and also cousins and many friends.

Ben Buongiorno (M.A. '55) passed away peacefully on February 19, 2021. The beloved husband, father, grandfather and great-grandfather was known to all as Granddad. Ben was born on January 29, 1931 to Joseph Buongiorno and Carmella Crisifulli Buongiorno in Albany. Ben's lifelong passion was baseball. He attended St. Lawrence University in New York on a baseball scholarship and earned a Bachelor of Science in Geology graduating in 1953. In addition, he was a member of Alpha Tau Omega fraternity. In 1954, Ben received a teaching fellowship from The University of Texas at Austin's geology department and earned his master's degree in 1955. Ben enjoyed a distinguished career in the oil and gas industry beginning in 1955 with the Standard Oil Company of Texas. Ben was an independent petroleum geologist until his retirement in 2015. The Grass Island Field formerly, the Espirito Santo Bay discovery, drilled by Harry Cullen, was one of Ben's greatest accomplishments. During his career, Ben was president of Gulf Coast Geological Library (formerly Houston Log Library), and a member of numerous organizations and societies, some of those being The Petroleum Club of Houston, Society of Independent Professional Earth Scientists (SIPES), Houston Geology Society (HGS), and American Association of Petroleum Geologists (AAPG). A member of Houston's First Baptist Church, Ben's life was one of faith, family and friends. Ben was a much-loved, husband, father, grandfather, great-grandfather, brother and friend. Ben is survived by his wife B.K. Buongiorno; his brother Santo and wife, Mary Buongiorno of Cambria, Calif.; his sister Ann Lawton of Albany; his two sons and wives, Brian and Lisi Buongiorno of Los Angeles, and Paul and Karen Buongiorno of Chatham, N.J.; daughter, Elizabeth and Clifford McDaniel of Houston, Texas; and stepdaughter, Kay Atkins of Pasadena, Texas; as well as nine adored grandchildren.

Dwight E. Cassell (B.S. '55, M.A. '58) was born on January 8, 1932 to Eugene and Myrtle Douglass Cassell in Dallas. He passed away on January 16, 2021 from complications of COVID-19. He was preceded in death by his elder daughter, Ellen. He is survived by his beloved wife of 64 years, Linda; his younger daughter, Sally, and her husband, Serge; and his two grandchildren, Wilfred and Emily. Also left behind are Linda's brother, Kent Stanley, and his wife, Clara; along with a host of dear friends, colleagues, and neighbors. Dwight served his country well, receiving honorable discharges from the US Navy, the US Army and the US Marine Corps. He received his Bachelor of Science degree in Geology in 1955 and his Master of Arts degree in 1958, both from The University of Texas at Austin. After finishing his bachelor's degree, his professor of Geology, Dr. Jack Wilson, recommended that Dwight call on a certain young lady whose name was Linda Kay Stanley. Thanks to Jack's playing matchmaker, Dwight and Linda were married on August 13, 1956. After receiving his master's degree, Dwight was hired by Humble Oil & Refining Co. and moved to Kingsville with Linda to begin his career and build their life. It was there that both their daughters were born and where they began a lifelong friendship with JoeAnn Wright. Dwight worked for Humble/Exxon for about 25 years, before he left to work with smaller companies where he could

get back to his real passion – Geology. In 1990, he and Linda moved to Austin to "retire", but instead of resting, he began his own oil exploration company. For those who knew him, the world will not be the same without Dwight. He touched so many people's lives with his kindness and generosity.

Robert C. Floyd (B.S. '58) passed away on Sunday, the 1st of November 2020, at home in Houston, Texas from complications of Alzheimer's disease. Bob was born in Oklahoma and grew up in Midland, Texas. After attending Midland High School, he went on to excel at basketball and other sports in the New Mexico Military Institute, qualifying for the Enlisted Reserve Corps. Bob then headed to The University of Texas at Austin. He joined the Phi Kappa Psi fraternity and earned a Bachelor of Science degree in Geology. While assisting his ranching family he found himself attracted to legal aspects of the family business, so he joined the International Legal chapter of Phi Delta Phi and went on to earn a Law degree from the University of Houston. Bob became an attorney in 1963, working as an Assistant District of Attorney in Harris County, Houston. He joined Butler & Binion for several years before opening his own legal practice with Floyd, Taylor and Riley. While in semi-retirement, he enjoyed assisting individuals with legal issues in a pro bono capacity. Bob never met a football game or golf course he didn't like. He was an active member of the Houston Country Club, supporter of the Houston Livestock Show and Rodeo, and a proud Texas Ex. Bob was preceded in death by his son, Charles Grant Floyd. He is survived by his daughters, Elizabeth Anne Floyd and Kathryn Allyson Floyd, and their respective spouses, James Thomas and Anthony Petruzzella, his brother Timber Floyd and Timber's wife Peggy as well as his beautiful granddaughter, Isabelle Eloise Petruzzella.

Fred M. Gibson (B.A. '51) passed away on May 18, 2021. After graduating from high school in 1942, Fred joined the United States Marine Corps and served through the end of World War II. During the first two years of his tour of duty, Fred was in the ground forces as part of the Fifth Amphibious Corps in the South and Central Pacific. During the last year of the war, Fred served aboard a Navy cruiser which was part of Admiral Halsey's Third Fleet. He was with the first American troops to land on the Japanese mainland. After World War II ended, Fred attended and graduated from The University of Texas at Austin. Fred held a bachelor's degree from the university and a Fellowship Degree in Life Insurance from The Life Insurance Institute. Fred worked for over thirty years in the life insurance business and retired as an assistant vice-president at American Founders Life Insurance Company in Austin. In his later years Fred stayed busy by working at the Internal Revenue Service Center in Austin, and he retired on December 31, 2005. Fred was preceded in death by his wife of 47 years, Mary Farris Gibson, whom he met and married while attending the University of Texas. He is survived by many nieces and nephews and great nieces and nephews. Fred was a member of Faith United Methodist Church and a Life Member of The University of Texas Ex-Student Association. Fred was a member of The Chancellor's Council of the University of Texas System, The Littlefield Society, The Texas Leadership Society and Longhorn Foundation.

Edwin F. Gilbert (B.S. '52) 91, of CO, formerly of Houston, TX, passed away peacefully at night at his daughter's, Lisa Damico Anderson's home on Saturday, November 7, 2020, with family at his side. He was the father of Lisa (Bill) Anderson and Amber Gilbert, and known as "Papa Texas" to his grandchildren Kellen and Krista Damico. He was also the former husband of Cathy Crosby. Eddie Gilbert was Texas state high school champion in the 100 freestyle in 1946 and 1947. He won the AAU title in the 200 freestyle in 1948 and swam the 4×200 freestyle relay at the 1948 London Olympics. Gilbert competed for the University of Texas in college. He was a Southwest Conference champion and All-American in each of his three seasons at Texas. He served in the Korean War and lived a lifetime of patriotism. Eddie joined the Naval ROTC program at the University of Texas and graduated as a naval officer. Following graduation, he was assigned to duty in Coronado, California. He served in the Navy for two years in both Japan and Korea. He also did a tour in Hong Kong before his discharge in 1954. He returned to Texas to begin what turned into an amazing career in the oil business. Eddie helped others through his philanthropy. After 9/11, he began donating to military charities including "Helping a Hero" to ensure that men and women who served had the resources they needed to begin their road to recovery. Eddie had a full life committed to service and his family and was an American Patriot.

Ernest R. Green (B.A. '58) was born on August 15, 1931, in Brownwood, Texas, and passed away on June 24, 2021 in Midland, Texas. His father was in the oil business and moved the family from Brownwood to Albany, Texas when he was a toddler. He graduated high school from the Texas Military Institute in San Antonio. He spent the years that followed at the Texas School of Mines (now UTEP) in El Paso working in the oil fields, on an oil pipeline in New Mexico, in a copper mine in Arizona, in magazine sales in Canada, and served two years in Germany in the U.S. Army during the Korean Conflict. Upon his return to the U.S., he ventured north to Nome, Alaska to work in a gold mine before returning to college at The University of Texas at Austin. While working at Cardinal

Chemical in Odessa, Texas, during a summer break from UT, he met and married Glenda (Sally) Breeze of Midland in 1956. They made their first home together in Austin where Ernest finished obtaining a B.S. in Geology. Ernest began his post graduate career with Halliburton Oil Well Servicing Company in Midland, Texas. The family moved to Long Beach, CA in 1959 after receiving an offer from an Independent oil man in Los Angeles to work as a geologist in the Wilmington Oil Field in Southern California. An opportunity arose to be a part of the THUMS Long Beach consortium composed of five major oil companies drilling for oil off the coast of Long Beach. Ralph spent 13 years in Long Beach during which time he obtained an M.S. in Petroleum Engineering from U.S.C. In 1972, Texas beckoned him home to Seminole, TX where he worked as a Petroleum Engineer for Amerada-Hess. The family then moved to Pampa, TX where he became Chief Reservoir Engineer for Cabot Corporation. After several years, they settled in Midland in 1979 where he worked as a Petroleum Engineer for the First National Bank of Midland before becoming an Independent Consulting Petroleum Engineer in 1981, with his wife joining him as his associate. They worked together until their retirement at the end of September 2019. During their nearly 65 years of marriage, they enjoyed many trips abroad including Canada, Hawaii, Scotland, England, Israel and New Zealand. He was a member of AAPG, SIPES, WTGS, PBPA, a 50 Year Legion of Honor Member of SPE, long standing member of the First Presbyterian Sanctuary Choir, and a Deacon and Elder in the Presbyterian denomination. He was preceded in death by his parents, Louis F. and Carrie M. Green; his brother Louis F. Green, Jr. and sister Carrie L. Green Bagley. Survivors include his wife, Sally of Midland; son Ralph and wife Lynn and grandson Christopher and wife Christin all of Ft. Worth, Texas; several grandchildren, great-grandchildren, cousins, nieces and nephews.

Willard R. Green (M.A. '55) 89, of Midland passed away Wednesday, December 23, 2020 in Midland.

Edgar H. Guevara-Sanchez (M.A. '72, Ph.D. '74) was born on July 18, 1942, and passed away on June 3, 2021.

F. Rosamond Haertlein (B.A. '47) died on Dec. 4, 2020, in Fredericksburg, Texas. Ros was born on July 28, 1925 in Laredo, Texas to Bryant and Ruth Allen. Her daughters, Alma and Waldine (Deeny); son, Albert and wife, Cala; grandsons, Bryant and Michael and his wife, Elizabeth; and Ros' sister, Jeanne, are the members of her immediate family. Ros spent her youth in Laredo and Tyler, Texas and Jackson, Mississippi. She attended Tyler Junior College, Belhaven College and graduated from The University of Texas at Austin with a B.A. in Geology. She joined Delta Gamma Sorority while at UT and was an active member for the rest of her life. Ros enjoyed a career as a geologist working for Gulf Oil in Shreveport, Louisiana. While on a field trip in 1949, she met Jim Haertlein, a geologist. They were married in May of 1950. The family grew as they moved from San Antonio, Texas to Casper, Wyoming, then Dallas, Plano and Fredericksburg, Texas. Ros' life was active. Surrounded by the family pets, she always enjoyed reading good mysteries. Ros enjoyed going to musicals in Dallas and letting loose listening to Duncan Holmes play her favorite tunes at the Officer's Club (the Hangar) in Fredericksburg. She would always ask people to come to the Hangar and "Dance off both your shoes" with her. Ros and Jim enjoyed their honeymoon in the Smoky Mountains so much that they traveled annually to the Smoky Mountains where they enjoyed hiking and the beautiful scenery. In addition to raising her family, she was devoted and enjoyed spending the rest of her time volunteering. She had a vibrant personality and brought much joy to those around her.

Ruben W. Knowles (B.S. '51) 94, of Lubbock, formerly of Houston, died Saturday, November 28, 2020 at the Carillon in Lubbock. He was born March 26, 1926 in Beaumont Texas, the son of Naomi Madeline Trowbridge Knowles and Lewis Winford Knowles. He was a United States Navy Veteran, having joined the Navy at 17 right out of high school, where he served for 3 years. He graduated from the University of Texas in 1949 with a degree in Geology. In 1956 he married his first wife, Gloria Novoa Brenner, and raised three daughters and one son in Houston, TX. He was preceded in death by his wife, Barbara Hutchinson Knowles, his brothers Lewis Denver Knowles, and Jay W. Knowles and his granddaughter Valerie Olson. Ruben was devoted to Barbara whom he married in 2000. They were accomplished bicyclists and rode daily for many miles and years together. In 1987 they rode across the United States from the Pacific Ocean in Huntington Beach, CA to the Atlantic Ocean in San Augustine, FL. They enjoyed driving from Lubbock to Zihuatenajo Mexico annually, and their Elder Hostel trips to Glacier Park, Washington DC, China, Alaska, Costa Rica, Australia, and New Zealand. Ruben leaves behind his stepson Sig Hutchinson and his wife Nancy Hutchinson of Raleigh, NC and six grandchildren and eight great grandchildren.

Don Morgan Lawler (B.S. '54) lived 96 amazing and honorable years and was endearing to so many. He was a highly respected leader, man of great character, and devoted husband and father. Don was born in Fayetteville, AR May 19, 1925 to Irene Morgan and Thomas Martin Lawler. He moved to Dallas at the age of 16 and graduated from

Highland Park High School in 1943. He enlisted in the Marine Corps and served on the USS Indiana in the Pacific Theater during WWII. He was one of the Marines put ashore on the island of Japan for the signing of the armistice to end the war. After returning home, he joined Geophysical Services Inc. (GSI), where he spent 15+ years leading crews along the Amazon River and jungles of Brazil, the Spanish Sahara desert, the Ganges of India and Alaska's North Slope. His stint with GSI was not consecutive as he paused in the early years to pursue a Bachelor of Science in Geology from The University of Texas at Austin, which is where he met his sweet wife, Beverly, of 64 years. He later joined General American Oil Co., where he was Vice President of Geophysics, held positions with Rosewood Resources and then joined Philips Oil Co. from which he retired in 1985. Don was a member of the Society of Exploration Geophysicists, American Association of Petroleum Geologists, Dallas Petroleum Club, Cadence Club, "Lunch Bunch" of dear friends, and Lovers Lane United Methodist Church. Don is survived by his loving wife, Beverly Williams Lawler, son Scott William Lawler, daughter Lynda Kathryn Lawler, daughter and son-in law, Amy Lawler and Charles Albert (Al) Good, and grandchildren Morgan Good and Kathryn Good. He is also survived by brothers, Lewis Lawler and Robert Lawler and his wife Jeanne, and sister-in-law, Lennie Lawler. He is preceded in death by his son David Steven Lawler and brothers, Thomas Lawler and James Lawler.

Richard P. McCulloh (M.A. '77) a resident of Baton Rouge, passed away March 4, 2021. Richard was born on June 6, 1951 in Stillwater, Oklahoma. He received his Bachelor's at Oklahoma State University and earned his Masters at the University of Texas. He was a Research Associate with Louisiana Geological Survey at Louisiana State University and was a member of the Union of Concerned Scientists. He was preceded in death by his brother, Scott McCulloh. He is survived by his wife Tomoko McCulloh; sisters: Joicelyn Schaefer, Glynden Bode, and Kristin Reed; one brother: Russell McCulloh; step grandchildren: Hana Marino and Kacie Kozman and one step great grandchild: Shiloh Kozman.

Arnold P. Milton (M.A. '64) a true renaissance man of great integrity and dignity passed away peacefully at home on April 9, 2021 with his loving wife by his side. Although born in New York City on November 11, 1938, while his father was attending graduate school, Arnold staked his claim as a proud fourth generation Texan, not born, but bred. His educational journey began in Tyler, Texas and Panama, while his father was in the Navy, then Houston where he attended Lamar High School through his junior year. He graduated from Longview High School before attending The Colorado School of Mines where he achieved a degree in Geological Engineering and completed his ROTC. He chose The University of Texas at Austin, where he earned a Master of Arts and met the love of his life, Jennie, and continued his active membership in Sigma Alpha Epsilon. Arnold fulfilled his ROTC obligation by serving in Korea for 13 months where he obtained his black belt in Karate. He began his career as a petroleum geologist in Corpus Christi, Texas before moving to Houston and then abroad for assignments in Tripoli, Libya, and Sumatra, Indonesia. Arnold's move abroad with his family enhanced their lives. His professional associations included: American Association of Petroleum Geology, Society of Exploration Geophysicists, Association of International Petroleum Negotiators and Houston Geological Society. Known to his beloved grandchildren as Papa, he was a devoted husband, father, father-in-law, grandfather and friend. The family were long time members of St. Francis Episcopal Church and then Palmer Episcopal Church. Preceded in death by his mother Helen Powell Milton and his father Taylor Milton, he is survived by his wife Virginia Phillips Milton, his daughter Melissa Milton Knauth, son-in-law Joseph Barnard Knauth, Jr, his grandchildren Taylor Milton Knauth and Lucy Rives Knauth, his brother Jarad Sayers Milton and cousins Helen Powell Hayes and John Timothy Post.

James R. "Jim Bob" Moffett (B.S. '61) died on Friday, January 8, 2021 at Seton Memorial Hospital in Austin, Texas of complications from COVID-19. He was 82 years old. Jim Bob was born at home in Houma, Louisiana and at a very young age moved to Houston, Texas with his single mother, Mary, and his sister, Marilyn. Jim Bob received a football and academic scholarship from The University of Texas at Austin. He graduated in 1961 with an award for excellence in geology. Jim Bob later received a Masters Degree in geology from Tulane University. After college Jim Bob continued his close relationship with renowned coach and mentor, Darrell Royal, until Coach's death in 2012. Jim Bob received the UT Distinguished Alumni award in 1981 and remained one of the school's most notable supporters. He began his oil exploration career as a bottom-rung roustabout in the rough-and-tumble Louisiana oil fields by lugging pipe, unclogging pumps and digging ditches. By 1969, he formed an exploration company with two partners, W. K. McWilliams, Jr. and B.M. Rankin, Jr. They took the first two letters of each of their last name and called it the McMoRan Oil & Gas Co. In 1981, with Jim Bob as Chairman and CEO, McMoRan Oil & Gas merged with Freeport Minerals Co. to form Freeport-McMoRan Inc., a Fortune 500 company. Jim Bob sat on a number of non-profit boards including Horatio Alger Association, Children's Tumor Foundation supporting NF-1 research, The University of Texas at Austin, Tulane University, Wildcatter's Club, Alfalfa Club, Audubon Nature Institute and many others throughout the years. Jim Bob was preceded in death by his

mother Mary Pollack and is survived by his wife, Laurée Zachariah Moffett, son, Jordan Moffett, daughter, Corinne Moffett, daughter, Crystal Lourd, and son, Bubba Moffett (wife Blair), six grandchildren and his sister, Marilyn Krause.

John S. Orr (B.S. '59) died on Jan. 31, 2021. John was born on June 19, 1933, in Enid, Oklahoma, to William H. and Naomi Williams Orr. He moved to Houston, Texas, with his family, where he attended grade school and high school. After high school, John spent two years on active duty in the U.S. Navy. John graduated from the University of Texas with a Bachelor of Science degree in Geology. He spent the next 10 years working in Mexico and the Middle East. He later worked in Houston; Jackson, Michigan; and Billings. John enjoyed hunting, fishing, hiking, bicycling and gardening in Montana and at his residence in Pipe Creek, Texas. John's parents, older brother Bill and his sister Mary Katherine Lance preceded him in death. John is survived by his brother, Jim and his wife Sue of Austin, Texas; and several nieces and nephews and extended family.

Bernard W. Reiss (B.S. '51) 99 1/2, died on Monday, July 19, 2021, at home in San Antonio, TX. Bernie was born January 18, 1922 in Plainfield, NJ, and was the son of Elizabeth and Philip Reiss. In 1942 he enlisted in the Army Aviation Cadet program and graduated as a 2nd Lieutenant and navigator in January, 1943. He was assigned as an instructor and check rider until January, 1945 when he went overseas to the Pacific as a navigator on B-24 bombers with the 400th Squadron, 90th Bomb Group of the 5th Air Force, flying missions to Borneo, Taiwan and China from Mindoro in the Philippines. He completed 19 combat missions and was awarded the Air Medal with two Oak Leaf clusters. In late July, 1945 his group was transferred to the island of lejima, previously romanized in English as le Shima, just off the coast of Okinawa. He returned to the States in November, 1945 and was assigned to Lackland AFB in San Antonio, TX. He was separated from active duty in January, 1947 but remained in the Air Force Reserve. He briefly attended Rutgers University, transferring and graduating from UT Austin in January, 1951 with a BS degree in Geology. Bernie worked for several companies as a petroleum geologist in subsurface exploration and development, retiring after 34 years in the oil and gas business. Bernie was a member of the American Association of Petroleum Geologists since 1954. In April, 1952 Bernie married Dolores Bading, enjoying a happy, 30+ year marriage until Dolores' passing in January, 1984. After Delores' passing, Bernie married longtime friend Elward Schneider. They shared almost 35 years of love, families, friends and lots of travel. When the course of Bernie's life reached the end, it was in a comfortable place, in the loving home he shared with Elward for more than 30 years. With him in person and in spirit were his beloved spouse, their wonderful caregivers, treasured nieces and nephews and families as well as "inherited" children and families, including precious grand and great grandchildren from coast to coast. Bernie's parents and siblings as well as his first spouse all preceded him in death.

Michael R. Rosen (Ph.D. '89) passed away April 27, 2021 at the Mayo Clinic in Rochester, Minnesota from complications following surgery for pancreatic cancer. He was a Research Hydrologist at the United States Geological Survey (USGS) and was based in Carson City since 2001. Before arriving in Carson City he had worked over 10 years in Australia and New Zealand for various scientific organizations. Michael was born January 19, 1961 in Philadelphia, the youngest of four sons born to David and Gloria Rosen. He was raised in Swarthmore where he attended the public K-12 schools and graduated from Swarthmore High School in 1978. He continued his education while majoring in Geology at Haverford College (BA 1982), University of Rochester (MS 1984) and The University of Texas Austin (PhD 1989), and did postdoctoral research at the University of Minnesota. Michael is survived by his wife of 29 years, Laura Gibson, his children Nick and Emma, and his brothers (Carl, Ralph and Paul) and their families.

John S. Runge (B.S. '50) 93, of Casper, Wyoming, died January 26, 2021 at his home in Casper. John was born November 16, 1927 in Houston, Texas to Frank and Catherine Runge. He had one brother, Frank Runge, Jr. of Fort Worth, Texas. John attended schools in Houston graduating from San Jacinto High School in 1944. He served in the U. S. Army of Occupation in Sasebo, Japan in 1946 and 1947. John was united in marriage to Patricia Claypool on July 16, 1949 in Wichita Falls, Texas. They had four children Margaret Ann, John Jr. (Jay), Ellen and Paul. After graduating with a Bachelor of Science Degree from the University of Texas in January of 1950, John worked in Odessa and Midland, Texas and Hobbs, New Mexico for Phillips Petroleum, Skelley Oil and British-American Oil Companies until his transfer to Casper in 1960. In 1964 he became a consultant in petroleum geology and in 1974 he formed a partnership with several other geologists doing consulting in petroleum, uranium, coal and hydrology. In 1978 John left the consulting field and merged his oil and gas interests with LR Company in 1979. He served as president of LR Company. John was active in geological groups serving as secretary of the West Texas Geological Society in 1958, as president of the Wyoming Geological Society in 1968, as president of the Rocky Mountain Section of the AAPG in 1973, and as treasurer of the American Association of Petroleum Geologists in 1980-1982. He served on the Advisory Board of the Wyoming Geological Survey from 1969-1976 and received the Frank Morgan

Award from the Wyoming Geological Society for Outstanding Achievement in 1974. He was an honorary member of the Wyoming Geological Society. John's wife, Pat Runge, died in 1988. John then married Emily Snapp on May 12, 1989. They lived together in Casper until his death. John's survivors include his wife, Emily Runge of Casper; daughter, Margaret Ann Burnett (Michael Reimann) of Denver, Colorado; daughter, Ellen Ventura (Michael Ventura) of Koloa, Hawaii; son Paul Runge (LeAnn Runge) of LaPine, Oregon; six grandchildren and seven great grandchildren. John was preceded in death by his parents, his wife, Pat Runge, his brother, Frank Runge, and his son, John Jr. (Jay) Runge.

James W. Sansom (B.S. '63) was born in Austin, Texas on January 15, 1937 and lost his battle with Covid 19 on February 27, 2021. His parents were James W. Sansom, Sr. and Genia Jones Sansom. He always liked to say that he grew up in the shadow of the Tower of the University of Texas. In his youth he lived across the street from the UT Memorial Stadium and played there and at the Memorial Museum and on Waller Creek. He graduated from Austin High School in 1954 and received his Bachelor of Science Degree in Geology from UT in 1963. He was a lifetime member of the UT Ex-Students Association. He began his geological career with the Texas Highway Department in February 1962. During this time, Inner Space Cavern in Georgetown was discovered while he was supervising the drilling of the core holes for Interstate Hwy. 35 bridges. This discovery would be one of the highlights of his career. From 1980 until he retired from the State in 1989, he worked for the Texas Railroad Commission in their Surface Mining and Reclamation Division. After retiring from the State, Jim worked as an independent consulting geologist providing environmental geologic assessments for engineers, city and state agencies, and individuals. He was an active member of the Austin Geological Society from 1965 until his death. He was also a member of the American Institute of Professional Geologists and the Association of Engineering Geologists. In 1996 he received the AIPG Public Service Award for his outstanding contributions to achieve a Registration Act for Geologists in the State of Texas and also the AEG award as the Outstanding Engineering Geologist in the Texas Section for his tireless effort for registration. In the past decade, Jim enjoyed volunteering with the UT Jackson School of Geosciences to help with their GeoFORCE educational program to encourage minority students to obtain careers in science, technology, engineering and math. He enjoyed working with the young students and staff of GeoFORCE and was excited with the success of those students. On August 12, 1961 he married Minnie Faye Edwards in Colorado City, Texas. They lived in Austin, and in the 1960's they had two sons, Alan and Marc Sansom. In 2001 they moved to Liberty Hill, Texas. Jim is survived by his wife Faye; his sister Elouise Denton of Dallas; his sister-in-law Dalphene Bruton of Marlin; his son James Alan Sansom and his wife Mesrain (Jeanette) of Austin; his three grandchildren and his greatgrandson; and many cousins, nieces and nephews. He was preceded in death by his parents, his son Marc Hamilton Sansom, sister-in-law Olga Edwards, his brothers-in law Spinks Edwards, Joe Don Denton and John Dexter Bruton Jr.

Judith A. Schiebout (B.A. '68, M.A. '70, Ph.D. '73) was born on October 16, 1946, in Tampa, FL, to Joseph and Helen Mae (Castenholz) Schiebout. Judith earned a B.A., M.A. and Ph.D. from The University of Texas at Austin. Judith's vertebrate paleontology doctoral studies were centered in Big Bend National Park, TX. Her most recent research interest involved fossil mammals from the Miocene period of LA. Judith joined the LSU Dept of Geology & Geophysics in August of 1976 and rose to the rank of Associate Professor in 1979. She became director of the LSU Museum of Geoscience that year and later an Associate Curator in the LSU Museum of Natural Science. She retired from LSU in 2016. Judith was a researcher and published 100+ journal articles, reports, and book chapters, either as sole author or in collaboration with colleagues and her graduate students. Judith's students were dear to her, and she often offered wise advice and career guidance to them. She chaired 15 Master or PhD graduate committees for her students. Retirement did not mean a halt to her research as she was actively advising an LSU undergraduate researcher at the time of her death. Her teaching won national and regional recognition: 2001 Assoc. for Women Geoscientists & 2002 Gulf Coast Assoc. of Geological Societies Outstanding Educator awards. She was an active and enthusiastic member of the Delta Kappa Gamma Society, Sigma XI Chapter. Frontiers did not deter Judith. She earned a PhD in geology when few women were in the field. Judith was known for her intelligence, keen wit, tenacity, generosity and kindness. She enjoyed lunches with friends and students, beautiful plants and flowers, and conversations over the phone. She especially loved her constant companions, Loki & Cassia, her cats. Judith entered the hospital with breathing problems not related to COVID-19 on July 29, 2020. She was discharged to a rehab facility where she later contracted COVID-19 in August, 2020. While she recovered from the initial infection, she died of complications on September 24, 2020. She is beloved by many. She will be remembered and greatly missed.

Walter Lee Siler (B.S. '60) passed away on March 27, 2021 at the age of 98 in Moss Point, Mississippi. He was preceded in death by his parents, Gordon Siler and Ruth Ellington Siler. He is survived by his

friend Ina Johnson; his children, Barry Siler (Alicia) and Stefanie "Stevie" McCain (Dave); his grandchildren, Abby Browne (Jonathan), Emily Higdon (Billy), Abby Tilley and Colby Breland; and his great grandchildren: Maddy, Jonas, Evan, Stephen, Grace, Azlynn, Claire, William and Owen.

B. Dixie Smith (B.S. '58) was born in Tyler, Texas on Feb 12, 1935, and passed away peacefully in Houston, Texas on Feb 21, 2021. He was preceded in death by his mother, Opal Collins Smith, and his father, Frank Dixie Smith. He is also preceded in death by his sister, Jeanne Ann Smith Morris, and is survived by his loving wife of 45 years, Marja Smith and numerous dear and loyal friends. Dixie earned his undergraduate and law degree from The University of Texas at Austin. He joined the firm of Fulbright and Jaworski out of law school and was made partner in 1975. He was proud to be the first Fulbright attorney to win a case in front of the United States Supreme Court in 1974. He retired from the firm in 1997. Dixie enjoyed his retirement years traveling extensively with Marja, cooking, drinking Chardonnay and graduating from a language school on the French Riviera (with limited success, considering his Texas accent!). He also loved gardening and was very popular during tomato and cucumber season.

Daniel L. Smith (B.S. '58) was born on the 23rd of August 1936, to Virgil Lee Smith and Virginia Lee Whipple Smith. He graduated from Lamar High School in 1954. He attended and graduated from The University of Texas at Austin with a BS in geology in 1958. Dan met Laura Ney Rosemary Heath while attending UT, where Dan was a member of Theta Xi Fraternity. They married on the 7th of March 1960, and were together for 53 years, until Laura's death. Dan then married Betty Joan Hall on the 31st of August 2013. They were married until his death. Still serving as the Executive Vice President of Exploration for Sandalwood Oil & Gas, Inc. when he passed, Dan was a widely respected and prominent member of the oil and gas industry in Houston and around the world. Upon graduation from UT, Dan began his long and distinguished career at Amoco, moved to Roberts and Whitson Corporation, and eventually became Executive Vice President and Exploration Manager for Texoil Company, including having a part ownership of the company. He moved to Texas Meridian Resources Corporation in 1992, where he served as Vice President, Exploration. Dan then joined Sandalwood in 2001. Dan held numerous leadership positions, including Chairman of the House of Delegates for American Association of Petroleum Geologists (AAPG); stints as both President and Chairman of the AAPG; Secretary of the Society of Independent Professional Earth Scientists (SIPES); President of the SIPES Foundation; and President of the Houston Geological Society. He also contributed his time and leadership skills to GCAS, AIPG, NOGS, and LGS. His greatest achievement was receiving the 2011 Halbouty Outstanding Leadership Award, given in recognition of outstanding and exceptional leadership in petroleum geosciences. Dan was passionate about promoting education in the field of Petroleum Geology and mentored numerous young geologists through the years. He was a long-serving trustee and former Chairman of the University of Texas Geosciences Endowment Fund and Member of the Geology Foundation Advisory Council for the Jackson School of Geosciences. His love for geology extended into his extracurricular activities where family vacations became educational, rock-hounding excursions. His wit and fun-loving spirit provided hours of entertainment for his family. Dan is preceded in death by his parents, Virgil and Virginia Smith; sister, Gini Hill; wife, Laura Ney Rosemary Heath Smith; and granddaughter, Hailey Kathleen Bunch. He is survived by his wife, Betty Joan Smith; brother, Virgil Raymond Smith and his wife Cecilia; children, James Raymond Heath Smith, Rosemary Kathleen Smith Bunch and her husband Mark, Heather Courtney Smith Vacker, and Laura Leanne Smith Davis and her husband Rick; step-son, Alan Bradley Hall and his wife Kelly; grandchildren, United States Navy Petty Officer Second Class Austin Rogers Heath Smith, Courtney Alaine Vacker, John Daniel Bunch, Laura Victoria Bunch, Ian Jackson Davis, and Heath Andrew Davis; step-grandson, Bradley McMahon Hall; great-grandchildren, Kaydin Nicole Smith and Zane Michael Emory Smith; and numerous nieces and nephews.

Winston L. Stokes (B.S. '57) best known as "Skip" to his family and friends, peacefully went to be with our Heavenly Father on August 6th, 2021. Skip was born in Houston, Texas, to Winston L. Stokes of Lafayette, Louisiana, and Marquerite Taylor of Ennis, Texas. He grew up as a kid in Ennis, working at his mother's hotel and playing football through high school and into college. He received his Bachelor of Science in Biology from East Texas State University in 1952 and a Bachelor of Science in Geology from The University of Texas at Austin in 1957. He served his country proudly as a member of the United States Air Force and was a Korean War veteran. He had been living in The Woodlands, Texas since 1979. He was a Certified Professional Landman and spent over 35 years working in the oil industry, finishing his career with Tenneco Oil Company. A devoted follower of God, Skip was an Elder at The Woodlands Christian Church for many years and more recently attended The Woodlands United Methodist Church. He is survived by his beloved wife of 66 years Kathryn Fay (Love) Stokes of Waxahachie, Texas; his brother George Stokes and sister Lynette Clark; 3 children, Beverly (husband Ray), Michael (wife Colleen), and Robert (wife Julie); 7 grandchildren, Nathan

(wife Mandy), Rebecca (husband Jordan), Shannon (husband Santi), Logan, Allyson, Ashley, and Nicholas; and 3 great grandchildren, Lucas, Charlie, and Emma.

Jesse L. Taylor (B.S. '59) was born in Houston on March 31, 1935. He was the son of Jesse Louis Taylor, Sr. and Zonetta Frankie (Blair) Taylor. He was a 1953 graduate of Jefferson Davis High School (now known as Northside High School), where he played basketball and served as the president of the senior class. He graduated from the University of Texas with a degree in Geology. He briefly attended law school at South Texas College of Law. J.L. worked for the Houston Chamber of Commerce for 27 years, ultimately serving as the International Director under former Houston mayor, Louie Welch. J.L. was a long-time member of Houston's First Baptist Church. He loved sports and the Texas Longhorns, and had season tickets to football games in Austin for many years. Watching the Texas Longhorns win the Rose Bowl in person was one of his happiest moments. He took great pride in teaching his sons to play and love baseball, basketball, football and other sports. He believed deeply in the importance of a college education and graduate degrees where possible. In addition to his wife, J.L. leaves a legacy in his children, Darrell Taylor and his wife, Lisa; and David Taylor and his wife, Marsha; and in his brother Jim Taylor and his wife Margaret. He also leaves his grandchildren, Morgan Taylor Pruet and her husband, Ronald (Tripp); Brooks Taylor and his wife, Lamar; Catherine Taylor Brown and her husband, Will; Graham Taylor; Caroline Taylor; and Colton Taylor; and one great grandchild, Turner Burton Pruet. He also leaves behind numerous nieces, nephews and cousins.

Craig A. Tips (B.S. '48) 95, of Bandera, Texas died peacefully at San Antonio's Methodist Hospital on Wednesday, January 13. Born October 19, 1925 in San Antonio, Texas, he was the youngest son of Frederick Julius Tips, Sr. and Margaret Chambers Tips. His two brothers, Will Chambers Tips and Fred Julius Tips, Jr. preceded him in death. Survivors include his second son, William Ratcliffe Tips of Bandera, Texas, and eldest son, John (Jack) Craig Tips of Austin, Texas and his granddaughter, Lauren Elisa Tips Smith of Leander, Texas, and grandchildren, Jaxon Lovelle Smith, and Preston Adams Smith. Craig attended both The University of Texas at Austin and Rice University at Houston and earned two Ph.D.'s, one in geology and the other in electrical engineering. He worked in the oil and gas industry with Schlumberger and Sun Oil Company as an electrical log interpreter. He served his country in the Navy at the close of World War II. A man of great faith, he attended the First Baptist Church in Bandera where his beloved wife, Ruth Ann Tips who preceded him in death, taught Bible class.

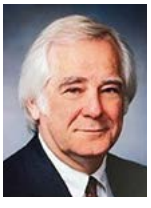
Herbert S. Travis (B.S. '60) age 87, of DeSoto Texas passed away on February 5, 2021. He died at Dallas Presbyterian Hospital surrounded by loved ones. Herbert aka Sam Travis was born in Waco, Texas on January 14, 1934 to Thomas and Ruby Mae Travis. Sam had many achievements in life and was very generous with multiple charities. Sam graduated from Waco High School in 1951. After High School Sam went into the Airforce where he was an air traffic controller stationed in Duncanville Texas. From there Sam attended The University of Texas at Austin. He earned a Bachelor of Science Degree in Geology. He furthered his education at Rice University years later. Sam had a successful career in the computing world. After retirement Sam continued to work to expand his Luther Lane RV park where he helped many people. Sam was preceded in death by his mother, father, brother Charles Travis and brother Richard Travis. Sam is survived by his children Cheryl Travis Farmer, Robin Travis, Janis Travis, Tommy E. Travis and Leigh Travis Hickey. He is also survived by brother Ed Travis and grandchildren, Thomas A. Travis, Mathew Travis, Drew Travis, Dylan Travis, Travis Hickey, Melissa Findley and Tisha Kiser and multiple great grandchildren.

Everette L. Tucker (B.A. '58) was born April 20, 1935 and passed away October 17, 2020.

Robert S. Weatherall (B.S. '51) passed away in Houston on Friday the July 30, 2021. He was 92 years of age. Bob was born in Birmingham, Alabama on September 23, 1928. His family moved to Houston where he attended Poe Elementary, Lanier Junior High and Lamar High Schools. He attended Baylor University and the University of Texas, where he received a Bachelor of Science in Geology. During the Korean War, he studied Russian at the Army Language School in Monterey, California. Upon graduation, he served as a Russian language intercept operator in various remote locations around the globe. He returned to the University of Texas Law School in 1954 where he received a LLB with honors in 1957. He was a member of Alpha Tau Omega Fraternity. While in law school, he was also a member of the editorial staff at the Texas Law Review, and a member of Phi Delta Phi Legal Fraternity. He joined Andrews Kurth Law Firm in 1957, where he was a partner for over 30 years. Bob was a lover of all things golf. He enjoyed playing the game, but he enjoyed equally the role of a spectator. He and his beloved Alicia attended US Opens around the country as well as a number of British Opens. He loved music of all kinds, but his special love was Hymns, Big Band, Country and Dixieland. He and Alicia traveled to various climes around the country in order to hear special musical performances. Above all, however, was his love of his Lord and Savior, Jesus Christ. Bob is preceded in death by his wife and love, Alicia Fernandez Weatherall. He is survived by children, Stacy Dardar and husband

Floyd, Cary Davis and husband Louis, Michael Weatherall Holloway and wife Susan, George Weatherall and wife Suzanne, Mathis Weatherall and wife Shannon; 14 grandchildren and 11 great-grandchildren.

John S. Westmoreland (B.S. '59) passed away peacefully on November 13, 2020, in his home. John was born on June 19, 1935, to Wesley and Lucille Westmoreland in Dallas. He attended University and Highland Park schools. John graduated from the University of Texas in 1959 with a Bachelor of Science Degree in Geology. He spent two years in the Army of which 13 months were served in Korea. He worked for 42 years in the hearing aid industry, seven of which he was National Sales Manager and Director of Marketing for Beltone Hearing Corporation. Following that time, he owned and managed Beltone Hearing Aid Center in Waco, Texas, with 6 offices in Central Texas, along with his wife, Sandra. John was an avid rock hunter who loved rock hunting expeditions in Big Bend. He was preceded in death by his parents. He is survived by his wife, Sandra; two sons, Douglas Westmoreland and his husband, David Guisinger, from New York; and David Westmoreland of Waco, and his children, Alex Westmoreland and wife, Molly, of Ft. Worth, Texas, and Dr. Kathryn Pechacek and husband, Cory, of Garland, Texas; stepson, Danny Stevens and wife, Carolyn, of Des Peres, Missouri, and their children, Hannah, Parker, Connor, and Eli Stevens; and stepson, Andrew Stevens and wife, Leah, of Sugar Land, Texas, and their children, Lauren and Emily Stevens; his brother, Wesley Westmoreland 111 of Las Vegas, Nevada; and nephew, Wesley Westmoreland IV. He is also survived by Carmen Capps, the mother of his two sons.



Rex H. White (B.S. '56, M.A. '60) passed away peacefully surrounded by his loving family on April 4, 2021. Rex is survived by his devoted wife, Brenda; sons and daughters-in-law Rex III and Terri White; Eric and Mary Polnau. Lovingly known as Pop Pop, he is blessed by his eight amazing grandchildren, Rankin, Annabelle, Allison, Ella Grace, Katie, Julia, Hannah, and Samuel. Rex Jr. was born in Houston, Texas on September 27, 1932, to Rex and Bernice White. His three great passions were his family, his church and his profession. He lived an amazing adventure, touching so many people along the way. Rex earned a Bachelor of Science and Masters in Geology from The University of Texas at Austin, and worked as a petroleum geologist-geophysicist for Mobil Oil Corporation. This experience led to adventures as a diver in the Gulf of Mexico, working the oilfields and walking the reservations of New Mexico. Rex later returned to Austin to earn his law degree from UT, graduating in 1967 and embarking upon a 53 year legal career focused on oil and gas. He began at the Texas Attorney General's Office and then served as Special Counsel to the Texas Railroad Commission. This led to a brilliant 40+ year career as a Partner in private practice, ultimately opening an independent practice at 65 years old. He continued this for the next 22 years. Rex was a passionate member of the Texas Independent Producers & Royalty Owners Association, serving as a three term President and later as Chairman of its Board of Directors. Rex loved his church, St. Mark's Episcopal in Austin. It was here, along with Brenda, that they found their true community. His family was his greatest love and passion. He and Brenda had an amazing marriage of over 40 years. His grandchildren loved him, and were so blessed to have him in their lives. He leaves a legacy of love, graciousness, patience, and honor that will carry on for many generations.

Robert R. Williams (B.S. '54) 90, died peacefully Sunday, March 7, 2021 in Ridgeland, MS. He was a kind, honest, gentle man who loved God, his country and his family. Born January 26, 1931 in Jefferson, TX to the late Robert Leon and Texie Rogers Williams. In high school, Robert was captain of the Jefferson Bulldogs football team, playing both quarterback as well as defense, and was on the baseball team, too -- all the while graduating as Salutatorian and voted Class Favorite. The first member of his family to attend college, Bob graduated from The University of Texas at Austin with a B.S. in Geology in 1953. Through the G.I. program, he drilled water wells in France at Dreux AFB as a First Lieutenant in the U.S. Army Corps of Engineers, and courted his future wife, Robin Richey, who was studying music in nearby Paris. They married June 17, 1956, achieving 64 anniversaries. Also in 1956, he began work with Humble Oil (later Exxon) in Grand Isle, LA. He celebrated all three of their daughters' births in New Orleans, while he gained the title of Division Exploration Staff Geologist. In 1968 Robert and Robin relocated to Dallas as he became Manager of Texas Offshore Exploration for General American Oil. Through his career he was Chief Geologist with W.R. Grace Natural Resources, Vice President of Exploration for May Petroleum, was a founder of Woodbine Petroleum, and then started his consultancy with several clients and was one of the first to gain his Environmental Certification. He was extremely active in the AAPG, SIPES, DGGS, the Houston Geological Society and the Dallas Geological Society, serving as its Vice President. Far beyond his career, his wife, daughters, family and his faith in Jesus were most important. In addition to his parents, he is preceded in death by his younger brother, Jerry L. Williams. He is survived by his wife Robin; his beloved daughters; Claire Williams Aiken (Richard) of Jackson, MS, Alison W. Hogan Vinson (Wade) of Houston, TX and Susan Williams Haas (John) of Austin, TX; grandchildren Robert Aiken (Corey) of Jackson, Elizabeth "Beth" Aiken Hudspeth (Seth) of Jackson; Claire Hogan, Rob Hogan, and Lauren Hogan, all of Austin, TX; Andrew Haas (Eliana) of Long Island City, NY, and Erin Haas and Benjamin Haas, both of Austin, TX, as well as five great grandchildren.

Gary P. Woody (B.A. '58) 87, passed away at his home in Fort Worth, Texas on April 5, 2021. He was born December 21, 1933 in Girard, Texas. Gary graduated from the University of Texas with a degree in Geology and was a member of the Phi Gamma Delta Fraternity, enjoying a life time of friendship with its many members. He also served his country in the U.S. Army. Gary was a hard worker; he retired from IBM after 30 years of service as a successful salesman and later served on the Tarrant County Review Board. His love for God and family was exemplified by the way he lived his life. He was a longtime member of the First United Methodist Church in Fort Worth. Gary enjoyed hiking and spending some of his leisure time visiting with friends at the Colonial Country Club, where he was a member. He was also a member of the Fort Worth Boat club where he enjoyed racing sail boats on Eagle Mountain Lake and won the 1975 Fort Worth Regatta race. He was preceded in death by his parents, B.P. Woody and Idell Cooper Woody, and brother Ben Woody of Wichita Falls. Gary is survived by his two sons, Brett Woody of Houston and Bruce Woody of Dallas, and his wife of 62 years, Lucy Bonner Woody.

Stephen S. Wright (M.A. '80) 67, of Eagle River, Alaska, passed away at Providence Alaska Medical Center with his wife of 34 years Sarah and his daughter Chelsea at his side. He was born on March 12, 1954, in Denver, CO, to Marjorie (Midge) and Valdon (Rocky) Wright. He spent his early years in Colorado. The family moved to Shaker Heights, Ohio, in 1965. With a fascination in the natural world around him, Steve graduated from the University of Michigan with a Bachelor's Degree in Oceanography Engineering in 1976, and from The University of Texas at Austin with a Master's Degree in Geology. He began his 40-year career as a professional geologist in Denver in 1980. In 1982, while living in Boulder, CO., he met the love of his life and future wife, Sarah Thompson. Steve and Sarah were married in 1986, and became parents in 1988 with the birth of their beautiful daughter Chelsea Paige Wright. In 1996, the family traveled to Alaska to celebrate their 10th anniversary. While sitting at the light at Eagle River Loop and Montague, Sarah mused "how people get to live in a place like this." One year later Steve was transferred to the newly opened Anchorage office and we purchased a home within a mile of the intersection. With their fourlegged pack-mates always ready to go, they began to explore and enjoy adventures throughout Alaska. Whether cross-country or downhill skiing and snowboarding in the winter, or hiking, paddling any and all floating craft and camping in the summer, Steve loved sharing every aspect of life in the Last Frontier with his family. Steve was a strong and active proponent for the power of education throughout his adult life. He took elementary school students fossil-collecting while in grad school in Austin, recruited and mentored young geologists starting their careers from many U.S. universities, led world-wide groups of professional colleagues on annual geology field seminars and served on many boards and committees for the University of Alaska, the Alaska Geological Society, the Municipality of Anchorage and the State of Alaska. He is survived by his loving wife, Sarah; daughter, Chelsea; and brother, Brent.

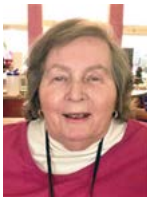
Spouses & Friends

David Bailey (Spouse of Robbie R. Gries, M.A. '70) was born on February 2, 1943 in Denver, Colorado, and died in his winter home in Tucson, Arizona surrounded by his wife, Robbie Gries, his son, James Bailey, his daughter, Anne Auld, his step-daughter, Lynn Gries and his brother, Steven Bailey. David graduated from St. Peters High School in Roswell, New Mexico in 1961 and attended the New Mexico Military Institute from 1961 to 1963. He transferred to the University of Denver and graduated with his Bachelor's degree in business and education in 1966. He and Julie Norton were married soon after graduation and joined the Peace Corps. Their two years of service were spent in Limón, Costa Rica where he was tasked with establishing a credit union. He always thought he was much more successful creating a championship basketball team. David and Julie had two children, James David Bailey and Anne Elizabeth Auld. After a divorce, David was married to Susan Storla from 1982 until her death in 2006. In 2008 he married Robbie (Ruth Roberta) Gries. David's career in banking began with Denver US National which became United Banks of Colorado where he became a senior officer. Later he became President of Norwest Bank and when he retired in 2002 he was President of Wells Fargo Colorado/ Wyoming. Professionally, he was most proud of his support for individuals and families fulfilling their dreams of opening small businesses. He enjoyed advocating and facilitating gender and racial equity. David and Robbie split their time between Denver and Tucson and shared their love of travel, both having visited over 60 countries—twenty of those during their 15 years together. David is survived by Robbie, his son, James, his daughter, Anne, his brother Steven Bailey (Sharon), his sister, Judy Serby (Bruce) and stepdaughter, Lynn Gries. He greatly enjoyed his grandchildren, LaTieka Hubbard, Shawnessee Bailey, Aleonya Hunter, James Hubbard (Samone), Ryan Auld, Grace Auld, Joseph Auld, Katie Auld and five great grandchildren.

Stephen L. Crane (Friend) was a loving husband, father, and grandfather who passed away on Sept. 7, 2020 at the age of 73. Stephen was born on Oct. 13, 1946 in Ft. Worth, TX to Frank and Mary (Spears) Crane. He graduated from Woodrow Wilson High School in 1964, SMU in 1968, and received his DDS degree from Baylor College of Dentistry

in 1973. He had a private dental practice for 20 years and taught at Baylor College of Dentistry for 18 years. In 1976, he married Annette Magill Crane. They raised two daughters, Allison and Adrienne. He was a loving grandfather to Frank Salas. Stephen was an avid fossil collector, and found and named numerous new echinoid species. He was a friend to all animals, and rescued countless cats and dogs. He is survived by his wife, Annette Crane, daughter and son-in-law, Allison and Alex Salas, daughter, Adrienne Crane, grandson, Frank Salas, and several cousins. He leaves behind his beloved pets: Persia, Flopsy, China, and Sophie.

Marion W. DeFord (Spouse of the late Professor Ronald K. DeFord) 93, passed away peacefully at home on January 2, 2021, surrounded by family. She was born November 6, 1927 in San Angelo, Texas to John L. Wier and Mabel Alice Perkins Wier. She attended Trinity University in San Antonio for one year and then transferred to The University of Texas at Austin. Marion graduated with Honors in 1946 with a BA in English and worked as a secretary for the BioMedical Engineering Department of the University of Texas. Marion was a longtime resident of Austin, but had also lived and raised her family in numerous oil company camps in Venezuela, Kuwait and Saudi Arabia. She had previously worked as a secretary for ARAMCO in Saudi Arabia and Gulf Oil Co. in Venezuela, as well as being a homemaker in between. Marion's memberships and activities included Headliners Club, Magna Charta Dames Society, Gamma Phi Beta Sorority, the Waltz Club, Austin Women Club, Longhorn Club, ARAMCO Retirees, and the Covenant Presbyterian Church Choir. She and Ronald DeFord were founding members of the Austin Lyric Opera. She was an avid giver to UT Austin, primarily to Geosciences and Texas Exes but also to the Athletics; Natural Sciences, Fine Arts Blanton Museum, Wildflower Center and many other UT colleges and institutions. Her husband, Ronald K. DeFord preceded her in death, as well as her former husband, William B. Rich. She is survived by her dear friend of many years, Col. William Gregory, USAF Retired; her children, Stephen Rich and Lisa Rich Beck Hunter; son-in-law Sun Down Hunter, grandchildren, Karl Beck (Tara), Sundown West Hunter (Elisabeth), Devlin Hunter and Lindsey Hunter; great-grandchildren, William, Henry and Charlotte Beck; sister and brother-in-law, Marjorie Wier Eason and John Eason; and nieces and nephews, Erik Eason and John and Evelyn Eason, and many other wonderful extended family.



Ruth C. Doney (Spouse of Hugh H. Doney, Ph.D. '66) 90, passed away peacefully at her home in Keller, Texas on July 24, 2021. She was surrounded by the love of her family at the time of her passing. Ruth was born September 14, 1930, at her family home in Palmerton, Pennsylvania. She was the youngest of five children born to Samuel and Cora Costenbader. Upon graduating from Stephen S Palmer High School in 1948, Ruth went on to earn a Registered Nursing (RN) degree from Easton Hospital School of Nursing in 1951. After nursing school, Ruth moved to Carlisle, Pennsylvania to attend Dickinson College to study Biology. While at Dickinson, Ruth met the love of her life Hugh Doney. The two wed on June 12, 1955, which also happened to be the day Ruth graduated from Dickinson with a B.S. in Chemistry. Ruth and Hugh moved to Austin, Texas in 1956 for both to attend The University of Texas at Austin. Ruth received her M.A. degree in Experimental Zoology in 1958 and Hugh earned a PhD in Geology in 1966. After a 5-year stint in Corpus Christi, Texas where two of their three children were born, Hugh and Ruth moved to Monroe, Louisiana in 1964. Monroe was home for Hugh and Ruth for 50 years and the birthplace of their third child. While Hugh taught Geology as a professor at ULM, Ruth worked for 40 years in many local hospitals as an RN in the ICU, CCU and Emergency Room. Ruth is preceded in death by her mother and father, Cora and Samuel Costenbader and her siblings, Catherine Barstow, Earl Costenbader, Carl Costenbader and Ralph Costenbader. Ruth is survived by her beloved husband Hugh, her three children Kim Doney Champine, Carl Doney and Deborah Doney Walker and their respective spouses Art Champine, Elena Doney and Joel Walker. Ruth is also survived by her five grandchildren, Morgan Champine, Branden Champine, Austin Champine, Kendall Walker and Quinn Walker.

Edith J. O'Donnell (Friend) On November 14, 2020, Texas lost a champion of education, science, and the arts. Edith O'Donnell was a respected philanthropist whose generosity, vision and commitment to education have made lasting impacts on The University of Texas at Austin. She was 94.

O'Donnell and her husband Peter O'Donnell Jr. left a lasting legacy of support and philanthropy at UT, including the Jackson School of Geosciences. One of their enduring legacies is UT's Oden Institute for Computational Engineering and Sciences. Over more than two decades, the O'Donnells' generosity led to the creation of multiple endowed faculty chairs, graduate fellowship programs, postdoctoral fellowship programs, endowed visitors' programs, excellence funds, and even the building the Oden Institute calls home—the O'Donnell Building for Applied Computational Engineering and Sciences.

"The generosity of Peter and Edith O'Donnell led to the creation of an institute that was ahead of its time in challenging the traditional boundaries between mathematics, computing, and scientific and engineering applications," said Omar Ghattas, the John A. and Katherine G. Jackson Chair in Computational Geosciences and Director of the Oden Institute's Center for Computational

Geosciences and Optimization. "The result has been remarkable in advancing both the foundations of the field of computational science and the applications of computational science to achieve tremendous societal impact across engineering, science, medicine, and the geosciences. None of this would have been possible without Peter and Edith's vision and support."

O'Donnell was also known for playing a pivotal role in advancing educational and arts endeavors in her adopted city of Dallas. O'Donnell and her husband co-founded the O'Donnell Foundation in 1957, and for many years most of their gifts—which total $780 million, according to her husband's published memoir—were anonymous, according to her obituary in the Dallas Morning News.

One exception to O'Donnell's anonymous style of largesse came in 2014, when she gave $17 million to The University of Texas at Dallas for the creation of the Edith O'Donnell Institute of Art History. But by no means did O'Donnell limit her philanthropy to the arts. O'Donnell and her husband also made major contributions to the UT Southwestern Medical Center and the Perot Museum of Nature & Science.

Born on Aug. 27, 1926, to Percy Jones and philanthropist and civic leader Ruth Leggett Jones, Edith Jones attended public schools in Abilene before graduating from the Hockaday School in Dallas in 1944. She attended Mills College in Oakland, California, and later graduated from UT Austin in 1948. On Nov. 22, 1952, she married Peter O'Donnell Jr.

Her commitment to philanthropy extended to the AT&T Performing Arts Center, Big Thought, Booker T. Washington High School for the Performing and Visual Arts, the Dallas Museum of Art, Meadows School of the Arts at Southern Methodist University and the College of Fine Arts at UT.

She also never forgot her hometown. She made frequent contributions to the Grace Museum and the Paramount Theater in Abilene. She arranged for the contribution of 2,000 volumes from the University of Texas Libraries to establish an art history library at the Grace Museum and enhance the museum's distance learning program for the benefit of rural communities.

Her most prominent awards included the Linz Award, the University of Texas Distinguished Alumnus Award, the Hockaday Medal, the Doty Award from UT Austin's College of Fine Arts and an honorary doctorate in humane letters from Southern Methodist University.

O'Donnell is survived by her husband and their daughters, Ann Stevanovich of Dallas; Carol Kradolfer of Boise, Idaho; Ruth Mutch of Dallas; and six grandchildren.

James C. Patterson (Friend) passed away on September 29, 2020 in Houston Texas after complications due to kidney issues. Jim was born May 8, 1929 in Oxford, Arkansas, to Davis S. and Vera M. Patterson. He is survived by son Mark Patterson, and daughter in law Laura Patterson of Houston Texas; daughter Nancy Patterson of New Orleans, Louisiana; son in law Ben Cleary and grandson Alexander Cleary of Mechanicsville Virginia and many more nieces, nephews and friends. He was preceded in death by his wife Marjorie and daughter Catherine Cleary. Jim attended primary and secondary school in Jonesboro and Little Rock Arkansas. He graduated in 1947 from Little Rock senior high school. Following high school graduation, he began studies at Little Rock Junior College transferring to the University of Arkansas at Fayetteville, where he received a Bachelor of Science degree in zoology and chemistry in 1950. When the Korean war started June 25, 1950, Jim received notice from his draft board to report for duty. He trained for 13 weeks at Chaffee Arkansas and Fort Sill Oklahoma before he shipped out for Korea. He was subsequently assigned to the 64th field hospital in Pusan as a chief medical laboratory technician, a position he held until his honorable separation on December 30, 1952. Military service completed, he traveled to Dallas, Texas and was hired by National Geophysical Company (NGC) to work on seismic crews. In May 1954 he accepted a job with Continental Oil Company again working on seismic crews. While working for Continental (later Conoco) he developed a passion for geology and geophysics. Jim worked 37 years for Conoco retiring in October 1991 as vice president for Exploration and Production North America. Jim's job with NGC brought him to Rawlins Wyoming in 1953 where he met and married Marjorie Davis, his wife for 57 years. They moved frequently living in Los Angeles, New York, and many places in between. In 1969 Jim received a promotion and moved to London, England with his family. The family lived overseas for about 12 years with residences in London, England and Cairo, Egypt. These were exciting times, made even more so by the many close friends they made in diverse parts of the world. Jim was a member of numerous professional organizations including the S.E.G., AAPG "Associate Member", G.S.H., H.G.S. and the University of Texas (UT) Geology Foundation Advisory Council where he served as chairman for 2 years. He established the James C. Patterson endowment fund for excellence in the geophysical sciences at UT.

Peter Van Metre (Spouse of Barbara J. Mahler) was born January 18, 1956, and died on May 8, 2021 in a tragic motor vehicle accident in East Texas, en route to visit his oldest daughter and her family. He was 65. His wife Barbara Mahler was critically injured and remains hospitalized. Their beloved dog Bella was also killed. Born in Waterloo, the youngest son of Judge and Mrs. Peter and Lucie Van Metre, Pete graduated from West High School in 1974, where he was a champion wrestler and average student, before going onto college at the U. of Iowa and then the U. of South Florida. He married Lynn Elikan and raised 3 children. He married Barbara in

2007, his partner in work and in life. Pete was active, thoughtful, supportive, and kind, a good person, and a great dad. Pete's 40-year career at the U.S. Geological Survey began as a technician and ended as scientist emeritus. Along the way, he earned an M.S. in Hydrology from the U. of Arizona at age 33 and a Ph.D. in Geology from the University of Rouen, France, at age 51. An athlete and outdoorsman in his youth, he became a pioneering environmental scientist, authoring over 100 scientific articles on water quality, and beloved as a mentor and colleague. His discovery that polycyclic aromatic hydrocarbons (known human carcinogens) were increasing in U.S. water bodies over time due to the coal-tar sealant used on parking lots and other surfaces led him to testify before Congress and to state and municipal bans that protect 25 million Americans today and counting. When not Thinking Great Thoughts, Pete was planning to work with Barbara in their heirloom apple orchard in southwestern New Mexico, enjoy life off the grid in the south of France, relax with friends at their home in Austin, paint more, talk politics with his brother, and spend time with his 3 grown children and 3 young grandchildren. Pete is survived by his wife Barbara, his brother Joseph (Susan), his former wife Lynn and their children Laura (Aaron Baum), Emily (Jordan Krinsky), and Sam and grandchildren (Mira, Yael, Miles), and his stepmother Jan Van Metre of Waterloo. He is preceded in death by his brother Charlie, father Peter Van Metre, and mother Lucie (Chapman) Rathert.

Staff

David Douglas Boling, 53, of Vidor, passed away May 17, 2021. David was born on Jan. 25, 1968, in Leavenworth, Kansas to Donald Dean Boling and Nancy Louise White.

David Boling was a man of steadfast dedication, devoting his life to God and his family. He met the love of his life, Diane, in 1990 at a Christian roller-skating night. Her family became his shortly after, and he spent his time working persistently to provide for them. David was a highly intelligent man, but he was still notorious for making silly jokes that would make everyone who heard them (including himself) laugh uncontrollably. His endless talents never failed to amaze. Whether he was performing magic tricks, singing, or playing any type of instrument he could find, his antics would always leave people with a smile on their face. Spending 27 years at The University of Texas at Austin, David easily cultivated a varied array of friends and colleagues over his many years of hard work. David was an avid collector of coins and deeply appreciated the beauty and history they held. He was an adventurer at heart and could often be found on cruises or cross-country trips with his beloved family. His love for God was genuine and deep. He used his talents to worship the Lord by singing in the choir at his church. David Boling was a Godly man who could light up a room with his contagious smile, his kindness and selflessness is embodied in every person whose life he touched, and he will not be soon forgotten.

Left to cherish his memory is his loving wife Angeline Diane Boling; sons Deniquan Boling and Chris Boling; daughters Alicia Blackshear and husband George, Christie Barnhart and husband Stephen, Nicole Townsley and husband Justin, and Casondra Wood; brothers Dan Heath and Darrell Boling; nine grandchildren and four 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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Print Preferred Email Address in Alumni News?
❍ Yes
❍ No

Class Notes for the 2022 Newsletter

Attach a separate sheet or use the online form at **www.jsg.utexas.edu/alumni** for longer entries.

Check if you would like more information on:
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MAXIMIZE YOUR IMPACT

The University of Texas at Austin and the Jackson School of Geosciences have several philanthropic opportunities that can significantly increase your impact on students and research on the Forty Acres.

Legacy Challenge

Document a new planned gift of $100,000 or more, and an immediate donation will be made to the department, program, project or area of your choosing within the Jackson School. Contact us today to join the challenge!

Rapid Response

"There is no more societally relevant research activity than learning from, and learning to live with, natural disasters," said Jamie Austin, a senior research scientist at the Institute for Geophysics who helped create the program. But, many research opportunities are missed because of the difficulty of finding research funding on the fly. In June 2021, Austin put up a $1 million match for any gifts to the Rapid Response Program. Help us prepare the next generation of geoscientists by making your gift in this critical initiative today!

Texas Challenge

The University of Texas at Austin educates the future leaders of Texas, our nation and the world. But recruiting high-potential students gets more challenging each year as top universities offer more financial incentives. Strong scholarship packages ensure that UT can compete with other universities to recruit the best and brightest students. If you've been considering giving, now is the time. You can double your impact through the Texas Challenge. Make a gift to create a scholarship endowment and your gift will be matched dollar-for-dollar to support high-potential Texas students from middle- and low-income families.

GeoFORCE

Thanks to an anonymous donor, the Jackson School has established a GeoFORCE challenge match of $750,000 for the next four years. Funds will support GeoFORCE Texas summer academies and annual programs. All new gifts will be eligible for the match. This includes new corporate or foundations sponsors, individual donors or "in kind" donations.

For more information or to get involved today with these exciting initiatives, please contact Andrew West at ***awest@jsg.utexas.edu***

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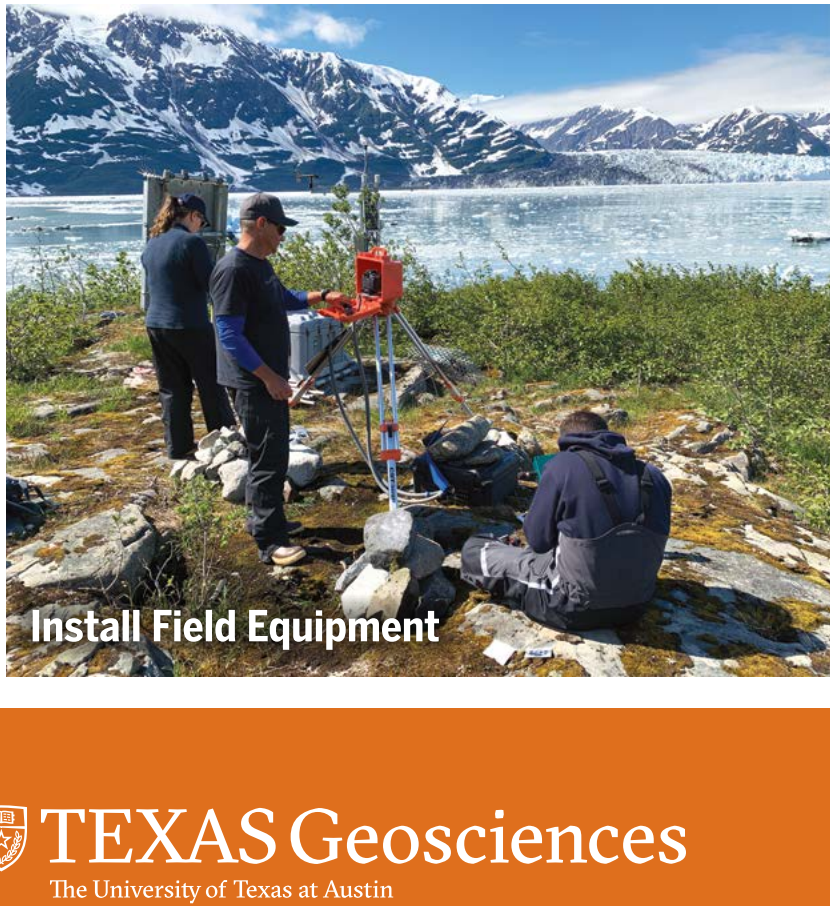

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