THE UNIVERSITY OF TEXAS AT AUSTIN · JACKSON SCHOOL OF GEOSCIENCES · 2016 NEWSLETTER

2016

Newsletter

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

THANK YOU!

Your annual gifts make a difference

WELCOME

Dear Alumni and Friends

TOP: AN INTENSELY DEFORMED GABBRO ALONG THE COAST OF NEWFOUNDLAND. COVER: ISOCLINALLY FOLDED AND REFOLDED GREENSCHISTS.

As you look through the pages of this year's *Newsletter*, I think you will agree that it's been another exciting and productive year at the Jackson School of Geosciences.

One of the highlights for me occurred this summer when I was fortunate enough to travel to Newfoundland with graduate students on an amazing trip led by John Dewey—a giant in the field of plate tectonics, and someone I have known since my student days. The picture on the *Newsletter* cover and the photos on this page are from that trip. You can see more and read the students' thoughts on the trip on page 52.

Going to Newfoundland exemplified the foundational geology experience that we provide students. But as we continue this tradition, we are also leading the conversation on the knowledge, skills and experiences that geosciences students need to succeed in the future. In January, I hosted an NSF-sponsored national summit for department heads and chairs on this issue. I also travelled to Mexico in a delegation with UT Austin President Greg Fenves to discuss strengthening research ties. You can read about both events in the Outreach section (starts page 28).

Our 10-year symposium was also in January. It was a fun and informative gathering that allowed us to look back on what we've accomplished and discuss our vision for the future. We heard from distinguished speakers and a group of Jack Jackson's old friends who discussed how he helped create one of the most prestigious geosciences programs in the world. You can read about the event on pages 28 and 29, and watch it on the Jackson School YouTube page.

I appreciate the positive feedback I received from an external visiting committee that evaluated the school in April, and I'm looking forward to incorporating their advice as we finalize the five-year strategic plan.

The Jackson School was behind many important and high-profile research projects this year—you may have heard about some of them in the news. These include the expedition to take core samples from the crater left by the asteroid that killed the dinosaurs (page 62); and our CT-lab helping solve the mystery of what killed Lucy, the world's most famous fossil (page 85). On a statewide level, our BEG is leading the investigation into what's causing earthquakes in Texas (page 58).

I am very proud of the accomplishments of our students, researchers and faculty. Thank you for the support that makes it possible. Enjoy the *Newsletter.*

Sharon Mosher, Dean

FEATURES

INVESTIGATING MASS EXTINCTION

CROSS-CULTURAL EXCHANGE

LOOKING FOR ANSWERS UNDER THE GULF

NEWSLETTER HIGHLIGHTS

IN EVERY ISSUE

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EDITOR: ANTON CAPUTO

ASSOCIATE EDITOR: MONICA KORTSHA

CONTRIBUTING WRITERS: ANTON CAPUTO, RACHEL GRIESS, JOHN HOLDEN, CHARLES KERANS, MONICA KORTSHA, BARBRA RODRIGUEZ, DENNIS TROMBATORE

ART DIRECTION: RYAN GOELLER

GRAPHIC DESIGN: DANA TAYLOR

AD DESIGN: LAURA MARTIN

SEND COMMUNICATIONS TO:
NEWSLETTER EDITOR
THE UNIVERSITY OF TEXAS AT AUSTIN
JACKSON SCHOOL OF GEOSCIENCES
2305 SPEEDWAY, STOP C1160
AUSTIN, TX 78712-1692

PHONE: 512-471-6048
FAX: 512-471-5585
EMAIL: ANTON.CAPUTO@JSG.UTEXAS.EDU
WEB: JSG.UTEXAS.EDU

UTJSG @TXGEOSCIENCES JSGUTAUSTIN

RESEARCH HIGHLIGHTS

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

THE RESEARCHERS TOOK SAMPLES FROM THIS CAVE IN PUERTO PRINCESA SUBTERRANEAN RIVER NATIONAL PARK IN PALAWAN, PHILIPPINES.

Ancient Cold Period Could Provide Clues About Future Climate Change

Climate, Carbon & Geobiology

Researchers have found that a well-known period of abrupt climate change 12,000 years ago occurred rapidly in northern latitudes but much more gradually in equatorial regions.

The research, published Sept. 2, 2015, in *Nature Communications,* focuses on the Younger Dryas, a cooling period that started when the North Atlantic Current stopped circulating, causing Earth's northern hemisphere to enter into a deep chill. Temperatures in Greenland dropped by approximately 18 degrees Fahrenheit in less than a decade.

The event also caused rainfall to decrease in places as far away as the Philippines. However, whereas temperatures in Greenland responded quickly to the ocean current shutdown and subsequent reboot 1,000 years later, it took hundreds of years for rainfall in the Philippines to be affected and to recover.

"We found that the temperature in Greenland is like a small ship that you can stop and turn quickly because of the influence of sea ice in the region, while rainfall in the tropics is like a big ship that takes a long time to course correct," said lead researcher Jud Partin, a research associate at the Institute for Geophysics (UTIG).

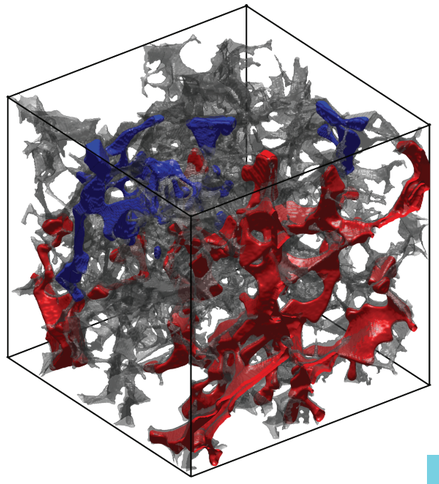
The shutdown of the current was triggered by the world warming after the last ice age. Melted glaciers diluted northern seawater with freshwater and changed ocean water density. This change disrupted the current and the climate. The Younger Dryas events inspired the 2004 disaster flick "The Day After Tomorrow," which exaggerates the speed and strength of the cooling by depicting the planet entering an ice age in a matter of weeks.

This new study concludes that these changes do not occur or recover at the same rate, as had been previously assumed.

The researchers discovered rainfall in the Philippines was affected by analyzing minerals deposited in a stalagmite from a cave in Puerto Princesa. They found that it took more than 550 years for drought conditions to reach their full extent, and about 450 years to return to pre-Younger Dryas levels after the current began circulating again.

Partin conducted the work with UTIG Director Terry Quinn and collaborators from the National Taiwan University and the University of the Philippines-Diliman. The study was funded by a grant from the National Science Foundation.

ANCIENT COLD PERIOD: JUD PARTIN; RETHINKING NUCLEAR WASTE STORAGE: COCKRELL SCHOOL OF ENGINEERING; BIG HOLES FOUND IN GULF: JOHN A. GOFF.



A GRAPHIC SHOWING THE DISPLACEMENT OF OIL BY BRINE IN THE ROCK SALT'S PORE SPACE (GRAY). THE OIL IS REPRESENTED BY THE BLUE AND RED COLOR, AND WATER OCCUPIES THE PORE SPACE WHERE THERE IS NO VISIBLE OIL.

Rethinking Nuclear Waste Storage

Energy Geosciences

Research from The University of Texas at Austin shows that rock salt, used by Germany and the United States as a subsurface container for radioactive waste, might not be as impermeable as thought, or as capable of isolating nuclear waste from groundwater in the event that a capsule or storage vessel failed.

Researchers used field testing and 3-D micro-CT imaging of laboratory experiments to show that rock salt can become permeable. Their findings, published in the Nov. 27, 2015, issue of *Science*, have implications for oil and gas operations, and, most notably, nuclear waste storage. The team includes researchers from the Jackson School of Geosciences and the Cockrell School of Engineering.

Salt generally blocks fluid flow at shallow depth, a feature that allows oil reservoirs to form. But scientists have long suspected that salt becomes permeable at greater depth. Jackson School Professor James E. Gardner confirmed this theory through laboratory experiments with synthetic rock salt. Cockrell School doctoral student Soheil Ghanbarzadeh tested the idea against field data from natural rock salt. Researchers were surprised to find that fluids were sometimes able to flow through salt at shallow depth.

In the study, they explain that deformation of rock salt may be the culprit. Previous work has focused on cracks induced by the creation of the nuclear waste repository itself. The study, however, demonstrates that undisturbed rock salt can become permeable.

"The critical takeaway is that salt can develop permeability, even in absence of mining activity," said Associate Professor Marc A. Hesse of the Jackson School's Department of Geological Sciences. "Further work is necessary to study the quantity of flow that can occur."

The project was sponsored by Statoil North America through the Statoil Fellowship program at UT Austin.

EXAMPLES OF SOLUTION PANS AT ENCHANTED ROCK STATE NATURAL AREA IN CENTRAL TEXAS.

Big Holes Found in Gulf

Marine Geosciences

Researchers have discovered large pot-hole-like rock features called "solution pans" in the Gulf of Mexico. Their existence means this region was once exposed to an arid climate above ground.

The research was led by scientists at the University of Texas Institute for Geophysics (UTIG) and published in the journal *Continental Shelf Research* on April 1, 2016.

Solution pans are rock features formed by pooling rainwater, primarily in limestone. The rainwater slowly dissolves limestone in an outward motion, creating shallow "craters" or "potholes" in the rock. On land, the pans reach a maximum of six meters wide. The Gulf of Mexico pans, which were discovered by the researchers on Campeche Bank, reach up to 15 meters wide.

"What is startling about our discovery is the size of these features is much larger than anything we've seen before," said lead author John Goff, a senior research scientist at UTIG.

Goff and colleagues from UTIG and the National Autonomous University of Mexico discovered the pans while conducting a hazards assessment survey in advance of the International Ocean Discovery Program drilling project into the Chicxulub impact crater.

"What we do know is solution pans only form in arid environments, so the conclusion can be drawn that this area was once above water must have been very arid for a long period of time. It has great climactic implications," Goff said.

SCIENTISTS DEPLOY AN OCEAN BOTTOM SEISMOMETER AND ABSOLUTE PRESSURE GAUGE OFFSHORE GISBORNE, NEW ZEALAND FROM THE R/V TANGAROA.

Slow-Motion Earthquakes Detected in New Zealand

Marine Geosciences

Research published in the May 6, 2016, edition of *Science* indicates that slow-motion earthquakes or "slow-slip events" can rupture the shallow portion of a fault that also moves in large, tsunami-generating earthquakes.

The discovery was made by conducting a detailed investigation of centimeter-level seafloor movement at an offshore subduction zone. Researchers from the U.S., Japan and New Zealand collaborated on the research.

"These data have revealed the true extent of slow-motion earthquakes at an offshore subduction zone for the first time," said lead researcher Laura Wallace, a research scientist at the University of Texas Institute for Geophysics.

The world's most devastating tsunamis are generated by earthquakes that occur near the trenches of subduction zones, places where one tectonic plate begins to dive beneath another. Using a network of highly sensitive seafloor pressure recorders, the team detected a slow-slip event in September 2014 off the east coast of New Zealand. The study was undertaken at the Hikurangi subduction zone, where the Pacific Plate subducts beneath New Zealand's North Island.

The slow-slip event lasted two weeks, resulting in 15-20 centimeters (about 6-8 inches) of movement along the fault, a distance equivalent to three to four years of background plate motion. If the movement had occurred suddenly, it would have resulted in a magnitude 6.8 earthquake.

Slow-slip events are similar to earthquakes but they occur over days to weeks, creating quiet, centimeter-sized shifts in the landscape. The event the team studied occurred in the same location as a magnitude 7.2 earthquake in 1947 that generated a large tsunami. The finding increases the understanding of the relationship between slow-slip and normal earthquakes by showing that the two can occur on the same part of a plate boundary.

The research was funded by the National Science Foundation; the Japan Society for Promotion of Science; Japan's Ministry of Education, Culture, Sports, Science and Technology; and grants from participating universities and research institutions.

Droughts Make Space for Water Storage

Surface & Hydrologic Processes

Although years of drought and over-pumping have significantly depleted groundwater in Arizona and California, a new study shows the situation has an upside: It has created underground reservoirs where extra surface water can be stored during wet times so it is available during drought.

The study, published in the journal *Environmental Research Letters* in March 2016, also found that regions that actively store surface water in underground aquifers have increased their groundwater supply over time, even as surrounding areas depleted theirs.

"In many regions now we're dealing with these extremes of drought and then intense floods, and that's a real challenge for water resource managers," said lead author Bridget Scanlon, a senior research scientist at the Bureau of Economic Geology. "To try and resolve this disconnect between supply and demand, we can store water in depleted aquifers."

The study examined decades' worth of groundwater data from California's Central Valley and active management areas across central Arizona—both regions that collect extra water from surface reservoirs and store it in underground aquifers.

Robert Reedy and Kristine Uhlman from the bureau and Claudia Faunt and Don Pool from the U.S. Geological Survey in California and Arizona also worked on the study. The study was funded by the State of Texas Advanced Resource Recovery Program and the Jackson School of Geosciences.

SLOW-MOTION EARTHQUAKES: TAKEO YAGI. VOLCANOES TIED TO SHIFTS IN EARTH'S CLIMATE: BRIAN HORTON.

LICANCABUR, AN ACTIVE VOLCANO IN THE ANDEAN CONTINENTAL VOLCANIC ARC ON THE CHILE-BOLIVIA BORDER.

Volcanoes Tied to Shifts in Earth's Climate Over Millions of Years

Climate, Carbon & Geobiology

A study in the April 22, 2016, edition of *Science* reveals that volcanic activity associated with plate-tectonic movement may be responsible for climatic shifts from hot to cold over tens and hundreds of millions of years throughout much of Earth's history.

The study addresses why the Earth has fluctuated from periods when the planet was covered in ice to times when even the polar regions were ice-free. It explores very long-term shifts in Earth's baseline climate, not short-term or human-induced climate change.

Lead researcher Ryan McKenzie, who began the work as a postdoctoral researcher at the Jackson School of Geosciences and finished the study at Yale University, said the team found that periods when volcanoes along continental arcs were more active coincided with warmer, or greenhouse, conditions over the past 720 million years. Conversely, periods when continental arc volcanos were less active coincided with colder, or icehouse, conditions.

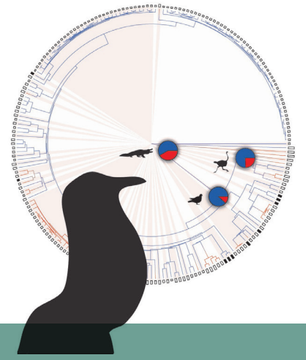
Continental volcanic arc systems such as the Andes Mountains are created at active continental margins where two tectonic plates meet and the oceanic plate descends under the continental plate, forming a subduction zone. When this happens, magma mixes with carbon trapped in the Earth's crust and releases carbon dioxide (CO_2) gas into the atmosphere when volcanoes in the system erupt.

Using nearly 200 published studies and their own fieldwork and data, researchers created a global database to reconstruct the volcanic history of continental margins over the past 720 million years.

"The distinguishing part of our study is that we looked at a very long geologic record—720 million years—through multiple greenhouse-icehouse events," said co-author Brian Horton, a professor in the Department of Geological Sciences and Institute for Geophysics

Specifically, researchers looked at the uranium-lead crystallization ages of the mineral zircon, which is largely created during continental volcanic arc activity. For the study, they looked at data for roughly 120,000 zircon grains from thousands of samples across the globe.

Jackson School postdoctoral researcher Shannon Loomis and Professor Daniel Stockli, Yale University's Noah Planavsky, and Rice University's Cin-Ty Lee also worked on the study. The research was funded by the National Science Foundation.



A GRAPHIC INIDICATING THE PROBABILITY THAT THE ANCESTORS OF BIRDS AND CROCODILES, PALAEOGNATH BIRDS, AND NEOGNATH BIRDS USED CLOSED-MOUTH VOCALIZATION.

Some Dinosaurs Likely Cooed

Climate, Carbon & Geobiology

Dinosaurs are often depicted in movies as roaring ferociously, but it is likely that some dinosaurs mumbled or cooed with closed mouths, according to a study published online in the journal *Evolution* in July 2016.

The research examines the evolution of a specialized way birds emit sound—closed-mouth vocalization. The study emerges from a new collaboration, funded by a grant from the Gordon and Betty Moore Foundation, to understand the origin and evolution of the unique vocal organ of birds and the large array of sounds it can produce. Because birds descended from dinosaurs, the research may also shed light on how dinosaurs made sound.

Closed-mouth vocalizations are sounds that are emitted through the skin in the neck area while the beak is kept closed. The coos of doves are an example of this behavior. Birds making closed-mouth vocalizations usually do so only to attract mates or defend their territory. At other times, they emit sounds through an open mouth.

To understand when and how closed-mouth vocalization evolved, researchers with the Jackson School of Geosciences, Midwestern University in Arizona, Memorial University of Newfoundland and the University of Utah used a statistical approach to analyze the distribution of this vocal ability among birds and other reptilian groups. In total, the researchers identified that 52 out of 208 investigated bird species use closed-mouth vocalization.

"Looking at the distribution of closed-mouth vocalization in birds that are alive today could tell us how dinosaurs vocalized," said Chad Eliason, a postdoctoral researcher at the Jackson School and the study's co-author. Julia Clarke, a professor in the Jackson School's Department of Geological Sciences, was also a co-author.

Unstable Glacier Caused Past Sea Level Rise

Surface & Hydrologic Processes

Research published in the journal *Nature* on May 19, 2016, has revealed that vast regions of the Totten Glacier in East Antarctica are fundamentally unstable and have contributed significantly to rising sea levels several times in the past.

Totten Glacier is the most rapidly thinning glacier in East Antarctica. This study raises concerns that a repeat transition between stable and unstable states could be underway as the climate warms.

The University of Texas Institute for Geophysics (UTIG) led the research and data collection for the study. Alan Aitken of the University of Western Australia's School of Earth and Environment is the lead author.

Totten Glacier is East Antarctica's largest outlet of ice and a key region for understanding the large-scale and long-term vulnerabilities of the Antarctic Ice Sheet. Whereas other studies have indicated that this region of the ice sheet may have retreated in the past, this study reveals direct linkages between the modern Totten Glacier and the eroded landscape currently buried in ice hundreds of kilometers inland.

"We now know how the ice sheet evolves over the landscape in East Antarctica and where it is susceptible to rapid retreat, which gives us insight into what is likely to happen in the years ahead," said Donald D. Blankenship, lead principal investigator of ICECAP (International Collaboration for Exploration of the Cryosphere through Aerogeophysical Profiling) and a senior research scientist at UTIG.

The UTIG-led ICECAP project collected the data during five Antarctic field campaigns using an aircraft equipped with instruments to assess the ice and measure the shape of the landscape and rocks beneath it. ICECAP is a long-term international collaboration with the United States, Australia, the United Kingdom and France.

TOTTEN GLACIER'S ICE SHELF.

SOME DINOSAURS LIKELY COOED: TOBIAS RIEDE. UNSTABLE GALCIER: JAMIN GREENBAUM. HUNTING FOR DINOSAURS IN ANTARCTICA: JULIA CLARKE AND AP3 RESEARCH TEAM.

ABOVE: RESEARCHERS ON THE ANTARCTIC MISSION SCOUT OUT A LANDING SPOT.
RIGHT: TENTS AT THE RESEARCH CAMP.

Hunting for Dinosaurs in Antarctica

Climate, Carbon & Geobiology

An international team of researchers journeyed to Antarctica in February 2016 to search for evidence that the now-frozen continent may have been the starting point for some important species that roam the Earth today.

Millions of years ago Antarctica was a warm and lush environment ruled by dinosaurs and inhabited by a great diversity of life. But today, the fossils that could reveal what prehistoric life was like are mostly buried under the ice of the harsh landscape, leaving the part that Antarctica played in the evolution of vertebrates as one of the great unknowns in the history of life.

Leading the team were paleontologists from the Jackson School of Geosciences, Carnegie Museum of Natural History, Ohio University and the American Museum of Natural History. Other collaborators included scientists from museums and universities across the U.S., Australia and South Africa.

Aided by helicopters, scientists conducted research on James Ross Island and other nearby islands off the tip of the Antarctic Peninsula, one of the few spots in Antarctica where fossil-bearing rocks are accessible.

The team was specifically searching for fossils from the Cretaceous through Paleogene, a span of about 100 million to 40 million years ago that includes the end of the Age of Dinosaurs and the beginning of the Age of Mammals. Among the questions the team hopes to answer: Did Antarctica play a critical part in the origins of certain modern bird and mammal groups, or was the evolution of species there more similar to what was happening in other parts of the world?

The expedition was part of a research initiative funded by the National Science Foundation.

"It's impossible not to be excited to reach remote sites via helicopter and icebreaker to look for dinosaurs and other life forms from over 66 million years ago," said Julia Clarke, a professor and paleontologist in the Department of Geological Sciences. "The Earth has undergone remarkable changes, but through all of them, life and climate and geologic processes have been linked. A single new discovery from this time period in the high southern latitudes can change what we know in transformative ways."

Julia Clarke

Noble Gas Detectives

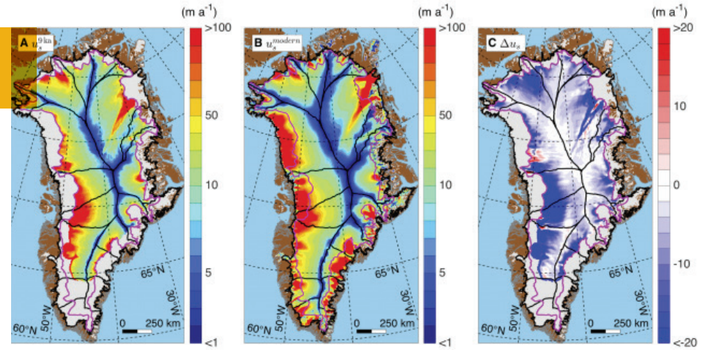
Energy Geosciences

JACKSON SCHOOL UNDERGRADUATE ESBEN PEDERSEN SAMPLING DISSOLVED GASES.

Noble gases in the Earth's crust can provide information about the origin of dissolved natural gas found in shallow groundwater, and can be used to monitor the performance of a geological storage operation. However, the correct interpretation of the observed noble gas chemistry requires understanding the behavior of noble gases during subsurface migration.

An interdisciplinary team from the Jackson School of Geosciences looked into this problem with funding from the Center for Subsurface Energy Security (CFSES). In a paper published in *Earth and Planetary Science Letters* in September 2016, the team brought together field data, laboratory experiments and theory to show that noble gas chemistry patterns are characteristic of gas migration distances and volumes of gas storage reservoirs. Similar to snow piling up in front of a snowplow, migrating noble gases accumulate at the front of a gas plume, and the size of the accumulation correlates to the distance traveled. The researchers conducted laboratory experiments that demonstrate these noble gas enrichment patterns and point to field data from naturally-occurring CO_2 fields, as well as shale gas plays that show similar patterns.

The study was led by graduate student Kiran Sathaye. Department of Geological Sciences Associate Professor Marc Hesse and researcher Toti Larson also contributed.



LEFT: GREENLAND'S AVERAGE ICE SPEED. CENTER: CURRENT SPEED. RIGHT: THE DIFFERENCE BETWEEN THEM.

Map Shows Slowdown of Ice Sheet

Surface & Hydrologic Processes

Scientists have created the first map that shows how the Greenland Ice Sheet has moved over time, revealing that ice in the interior is moving more slowly toward the edges than it has, on average, during the past 9,000 years.

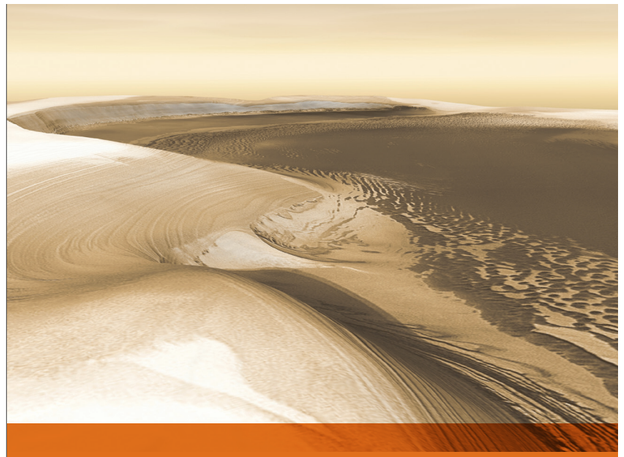
The findings, which researchers said don't change the fact that the ice sheet is losing mass overall and contributing to sea-level rise, were published in the Feb. 5, 2016, issue of Science. Along Greenland's periphery, many glaciers are rapidly thinning. However, the vast interior of Greenland is slowly thickening, a process the new study clarifies.

"Scientists are very interested in understanding how ice sheets flow and how that flow may have been different in the past. Our paleo-velocity map for Greenland allows us to assess the flow of the ice sheet right now in the context of the past several thousand years," said lead author Joe MacGregor, a research associate at the University of Texas Institute for Geophysics (UTIG).

The study builds on earlier UTIG-led research that developed a database of the many layers within Greenland's ice sheet. Using this database, the scientists determined the flow pattern for the past 9,000 years—in effect creating a "paleo-velocity" map.

UTIG Research Associate Ginny Catania, who is also an associate professor in the Department of Geological Sciences, and scientists from University of Alaska Fairbanks, University of California Irvine and The University of Kansas worked on the study. This study was supported by the National Science Foundation and NASA's Operation IceBridge.

NOBLE GAS DETECTIVES: JACKSON SCHOOL. MAP SHOWS SLOWDOWN OF ICE SHEET: JOSEPH A. MACGREGOR. MARTIAN ICE AGE RECORD FOUND: NASA/JPL.



CLIMATIC CYCLES OF ICE AND DUST BUILD THE MARTIAN POLAR CAPS AND PERIODICALLY WHITTLE DOWN THEIR SIZE WHEN THE CLIMATE CHANGES.

Martian Ice Age Record Found

Planetary Sciences

Scientists using radar data from NASA's Mars Reconnaissance Orbiter (MRO) have found a record of the most recent Martian ice age in the planet's north polar ice cap.

The results, published in the May 27, 2016, issue of the journal *Science*, agree with previous models that indicate a glacial period ended about 400,000 years ago. The research team included scientists from the Southwest Research Institute, The University of Texas Institute for Geophysics (UTIG) and Washington University.

Scientists use data from MRO's Shallow Subsurface Radar (SHARAD) to produce images called radargrams that show vertical slices through the layers of ice and dust that comprise the Martian polar ice deposits. For the new study, researchers analyzed hundreds of such images to look for variations in the layer properties.

On Mars, ice ages occur when–as a result of the planet's increased tilt–the planet's poles become warmer than lower latitudes. During these periods, the polar caps retreat and water vapor migrates toward the equator, forming ground ice and glaciers at mid-latitudes. As the warm polar period ends, polar ice begins accumulating again, while ice is lost from mid-latitudes. This retreat and regrowth of polar ice is exactly what researchers see in the record revealed by the SHARAD radar images, said planetary scientist Isaac Smith, the study's lead author.

Smith led the work while at Southwest Research Institute in Boulder, Colorado. He came up with the idea for the research at the Jackson School of Geosciences, where he received his Ph.D. in 2013.

SHARAD is one of two radar sounders in orbit around Mars, but it is the only one that approaches the resolution of airborne radar sounders on Earth, said Jack Holt, a study author and research professor at UTIG. The radar allowed researchers to detect and study layering within the polar caps on Mars.

"By applying basic principles of stratigraphy, we can unravel the record of ice deposition and removal at the poles of Mars," Holt said.

Data Lacking for Human-Caused Earthquake Studies

Solid Earth & Tectonic Processes

The most comprehensive analysis to date of a series of earthquakes that included a 4.8 magnitude event in East Texas in 2012 has found it plausible that the earthquakes were caused by wastewater injection. The findings also underscore the difficulty of conclusively tying specific earthquakes to human activity using currently available subsurface data.

The study, conducted by the Bureau of Economic Geology, was published April 13, 2016, in the *Journal of Geophysical Research: Solid Earth*.

The researchers built the first computer model for this site that simulates the effects of fluid injection on the stability of the fault that potentially generated the earthquakes. In their simulations, researchers used a range of likely values for input parameters, including physical properties of the reservoir and the orientation of the fault. Earthquakes were generated using a certain range of input parameters, but no earthquakes were generated using a wider set of equally probable parameters.

The 4.8 magnitude earthquake occurred on May 17, 2012. It was the largest ever recorded in the area and followed a series of smaller earthquakes that started in April 2008, some 17 months after two wastewater injection wells began operating nearby.

The researchers tested a number of likely scenarios to assess if the volume and rate of fluid injected into the disposal wells were high enough to cause nearby faults to slip. This is the first study to simulate the mechanics of an earthquake generated by water injection for this site.

"It is part of a continuing research effort by The University of Texas at Austin," said Peter Eichhubl, a bureau senior research scientist. "We used a more rigorous approach than previous studies, but our analyses are limited by the availability of robust, high-quality data sets. This study demonstrates the need for more and higher-quality subsurface data."

Bureau researchers Zhiqiang Fan and Julia Gale co-authored the report. Funding was provided through the Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program.

JACKIE WATTERS AND STEPHEN CHIGNELL DESCEND INTO THE GARWOOD RIVER FLOODPLAIN TO INVESTIGATE THE RECENTLY RE-EXPOSED MASSIVE ICE CLIFF IN GARWOOD VALLEY IN ANTARCTICA.

Soil Moisture Melting Ancient Ice

Surface & Hydrologic Processes

Antarctica's McMurdo Dry Valleys host landscapes that have been frozen solid for more than a million years.

But on a recent expedition, scientists with the University of Texas Institute for Geophysics (UTIG) found that ice beneath the valleys' soil is melting.

"There are places where buried ice is melting 10 times faster than it ever has since the last ice age," said Joseph Levy, a UTIG research associate.

Buried and insulated by glacial sediment since the last ice age, ice in the valleys has been protected from recent warming trends. On this expedition, scientists soon realized that enhanced soil moisture had changed the conductivity of the glacial sediment. It was no longer insulating and protecting the ice as it had been, but rather melting it by pumping heat into it.

"It's like using a cloth pot holder; it's great until it gets wet and then it transfers heat instead of blocking it," Levy said.

Though the implications of permafrost melt are concerning, Levy is encouraged by the findings and looking forward to the published research.

"Parts of Antarctica that have been stable since the last ice age are beginning to melt," Levy said. "Once this ice is gone, it is not renewable, it doesn't come back. You can bury it and that will keep it around longer, but ultimately it is all going to melt out."

The month-long research project was funded by the National Science Foundation and included Jackson School of Geosciences undergraduate Logan Schmidt and UTIG post-baccalaureate student Jackie Waters.

SOIL MOISTURE MELTING ANCIENT ICE: LOGAN SCHMIDT. GRINDING DOWN MOUNTAINS: KEN RIDGWAY. AEROSOLS STRENGTHEN STORMS: BRIAN KHOURY.

Aerosols Strengthen Storms

Climate, Carbon & Geobiology

An abundance of aerosol particles in the atmosphere can increase the lifespans of large storm clouds by delaying rainfall, making the clouds grow larger and live longer, and producing more extreme storms when the rain finally does come, according to research from the Jackson School of Geosciences.

The study, published in the journal of the *Proceedings of the National Academy of Sciences* on June 13, 2016, is the first to address the impact that aerosol particles have on the lifespans of large thunderstorm systems called mesoscale convective systems.

The research looked at satellite data from 2,430 convective cloud systems and found that aerosols can help increase the lifespans of convective cloud systems by as much as three to 24 hours, depending on regional meteorological conditions.

"A cloud particle is basically water and aerosols. It's like a cell," said lead author Sudip Chakraborty, who recently received his Ph.D. from the Jackson School. "The more aerosols you have, the more cells you get. And if you have more water, you should get more rain."

Researchers from the University of Colorado Boulder and NASA's Jet Propulsion Laboratory also worked on the study.

This study is the first to try to look at aerosols' relative importance in the lives of storm clouds compared with meteorological conditions such as relative humidity, available convective energy and wind shear, said Rong Fu, a professor in the Jackson School Department of Geological Sciences and co-author of the study.

Grinding Down Mountains

Solid Earth & Tectonic Processes

Researchers for the first time have attempted to measure all the material leaving and entering a mountain range over more than a million years and discovered that erosion caused by glaciation during ice ages can, in the right circumstances, wear down mountains faster than plate tectonics can build them.

The international study conducted by the Integrated Ocean Drilling Program and led by scientists from the University of Texas Institute for Geophysics (UTIG), University of Florida and Oregon State University, adds insight into a longstanding debate about the balance of climate and tectonic forces that influence mountain building. The research was published on Nov. 23, 2015, in the *Proceedings of the National Academy of Sciences*.

Researchers studied the St. Elias Mountains on the Alaskan coast and found that erosion accelerated sharply about 1 million years ago when global climate cooling triggered stronger and more persistent ice ages than times past.

They used seismic equipment to image and map a huge fan of sediment in the deep sea in the Gulf of Alaska caused by erosion of the nearby mountains and took short sediment cores to understand the modern system. They then collected and dated almost four kilometers of sediment from the floor of the gulf and the Alaskan continental shelf, revealing millions of years of geologic history.

"It turned out most (sediments) were younger than we anticipated, and most rates (of sediment production and thus erosion) were higher than we anticipated," said lead author Sean Gulick, a research professor at UTIG. "Since the big climate change during the mid-Pleistocene transition when we switched from short (about 40,000-year) ice ages to super-long (about 100,000-year) ice ages, erosion became much greater."

Since the mid-Pleistocene, erosion rates have continued to beat tectonic inputs by 50 to 80 percent. The study was funded by the National Science Foundation and the Integrated Ocean Drilling Program.

TOP: ALASKA'S YAHTSE GLACIER TRANSPORTS SEDIMENT FROM THE ST. ELIAS MOUNTAINS TO THE SEA.
BOTTOM: THE BERING GLACIER WINDS DOWN FROM THE ST. ELIAS MOUNTAINS.

NEW RESEARCH SHOWS THAT AEROSOLS CREATE LARGER STORM CLOUDS CAPABLE OF PRODUCING MORE RAIN.

Scientists Make Middle Crust Model

Solid Earth & Tectonic Processes

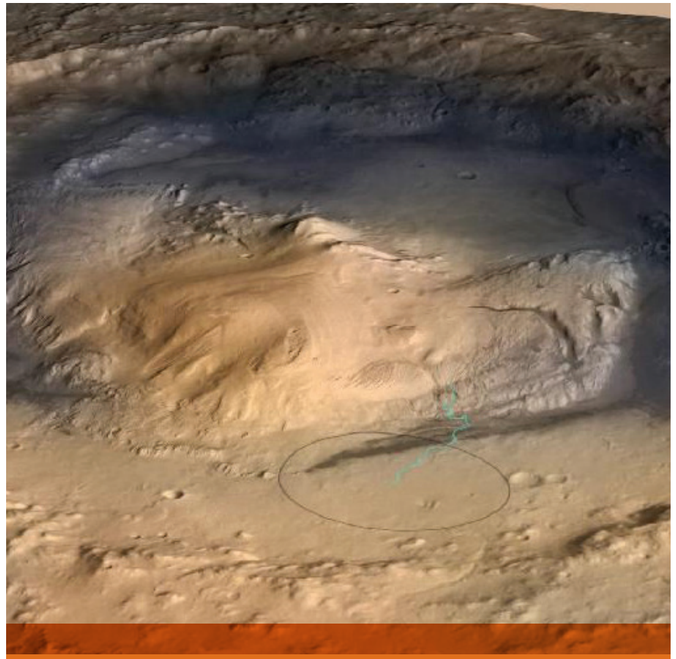
Researchers have for the first time been able to measure a material's resistance to fracturing from various types of tectonic motions in the Earth's middle crust, a discovery that may lead to better understanding of how large earthquakes and slower-moving events interact.

The University of Texas Institute for Geophysics (UTIG), spearheaded the discovery, which was published in the September 2015 edition of *Nature Geoscience*.

Scientists conducted the research using Carbopol, a gel-like substance that can simulate the characteristics of rock formations in the Earth's middle crust because it is simultaneously brittle and malleable. Researchers performed shear tests on the Carbopol, where a portion of the material is pulled in one direction and a portion is pulled in the opposite direction. This is similar to what happens to rock formations in the middle crust during earthquakes or slow-slip events, a type of tectonic movement that resembles an earthquake but happens over a much longer period of time.

The tests showed viscous deformation and constant creep movement at lower yield stress and slip-stick, or earthquake-like, behavior at higher yield stress. This highlights the importance of a material's often complex properties for determining the manner and speed it will respond to stress.

Jacqueline Reber, the study's lead author, performed the research as a postdoctoral fellow at UTIG and is now an assistant professor at Iowa State University. The research team included Luc L. Lavier, of the Jackson School's Department of Geological Sciences and UTIG, and Nicholas W. Hayman, a UTIG research scientist. Funding came from UTIG and Petrobras, a Brazilian energy corporation.



GALE CRATER, THE LANDING SPOT OF NASA'S CURIOSITY MARS ROVER, HAS A THREE-MILE-HIGH MOUND AT ITS CENTER CALLED MOUNT SHARP.

Miles-High Mars Mounds Built by Wind

Planetary Sciences

New research has found that wind carved massive mounds of more than a mile high on Mars over billions of years.

The findings, published in *Geophysical Research Letters* on March 31, 2016, show the importance of wind in shaping the Martian landscape, said lead author Mackenzie Day, a graduate student at the Jackson School of Geosciences.

"On Mars there are no plate-tectonics, and there's no liquid water, so you don't have anything to overprint that signature and over billions of years you get these mounds," Day said. "Wind could never do this on Earth because water acts so much faster, and tectonics act so much faster."

Jackson School professors Gary Kocurek and David Mohrig of the Department of Geological Sciences and University of Texas at Dallas researcher William Anderson also worked on the study.

Recent analysis by the Mars rover Curiosity of Mount Sharp, a mound over three miles high inside Gale Crater, has revealed that the thickest mounds are made of sedimentary rock, with bottoms made of sediments carried by water that used to flow into the crater and tops made of sediments deposited by wind. However, how the mounds formed inside craters that were once full of sediments was an open question.

To test whether wind could create a mound, the researchers built a miniature crater 30 centimeters wide and 4 centimeters deep, filled it with damp sand, and placed it in a wind tunnel. The model's sediment eroded into forms similar to those observed in Martian craters.

The research was funded by NASA, the National Science Foundation and The University of Texas at Dallas.

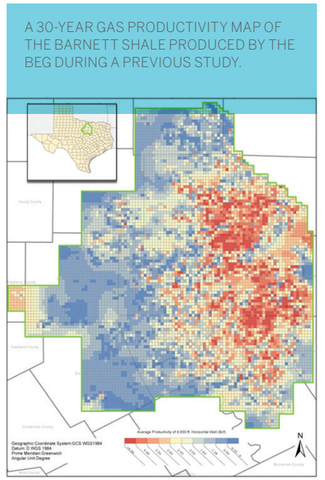
MILES-HIGH MARS MOUNDS: NASA/JPL. BEG MAP: SVETLANA IKONNIKOVA. NATURE RULES THE RIVER: U.S. GEOLOGICAL SURVEY.

A Harder Look at Gas Plays

Energy Geosciences

The Bureau of Economic Geology Shale Production and Reserves Study at The University of Texas at Austin has been awarded a $350,000 grant by the U.S. Department of Energy to conduct an 18-month review of prior analysis of major American shale gas plays.

The main objective of the update is to enhance resource assessment work that the bureau's shale study team conducted with funding from the Alfred P. Sloan Foundation on the Barnett, Fayetteville, Haynesville and Marcellus natural gas plays. The study will help to ensure consistency of approach across the four shale gas plays and will incorporate recent data, allowing researchers to capture new market dynamics, emerging technologies and company strategies, which drive shale resource development.



A 30-YEAR GAS PRODUCTIVITY MAP OF THE BARNETT SHALE PRODUCED BY THE BEG DURING A PREVIOUS STUDY.

"Our current outlooks were built on relatively short production histories: six years of intense horizontal drilling in the Barnett; five years in the Fayetteville and Haynesville; and four years in the Marcellus," said co-principal investigator Svetlana Ikonnikova. "Since we completed these studies, more wireline logs and core analyses have been released, allowing for more accurate geological and petrophysical characterization."

The addition of four extra years of production data for the Barnett gas play, three years of data for the Fayetteville, and two years of data for the Haynesville and Marcellus shale plays enable the study of emerging drilling and completion technologies.

LAKE MEAD, THE LARGEST MAN-MADE RESERVOIR IN TERMS OF CAPACITY IN THE U.S.

Nature Rules the River

Surface & Hydrologic Processes

Researchers have found that the water supply of the Colorado River basin is influenced more by wet-dry periods than by human use, which has been fairly stable during the past few decades.

The study, led by the Bureau of Economic Geology, took the most comprehensive look to date at the state of a water source that serves 40 million people in seven southwestern states.

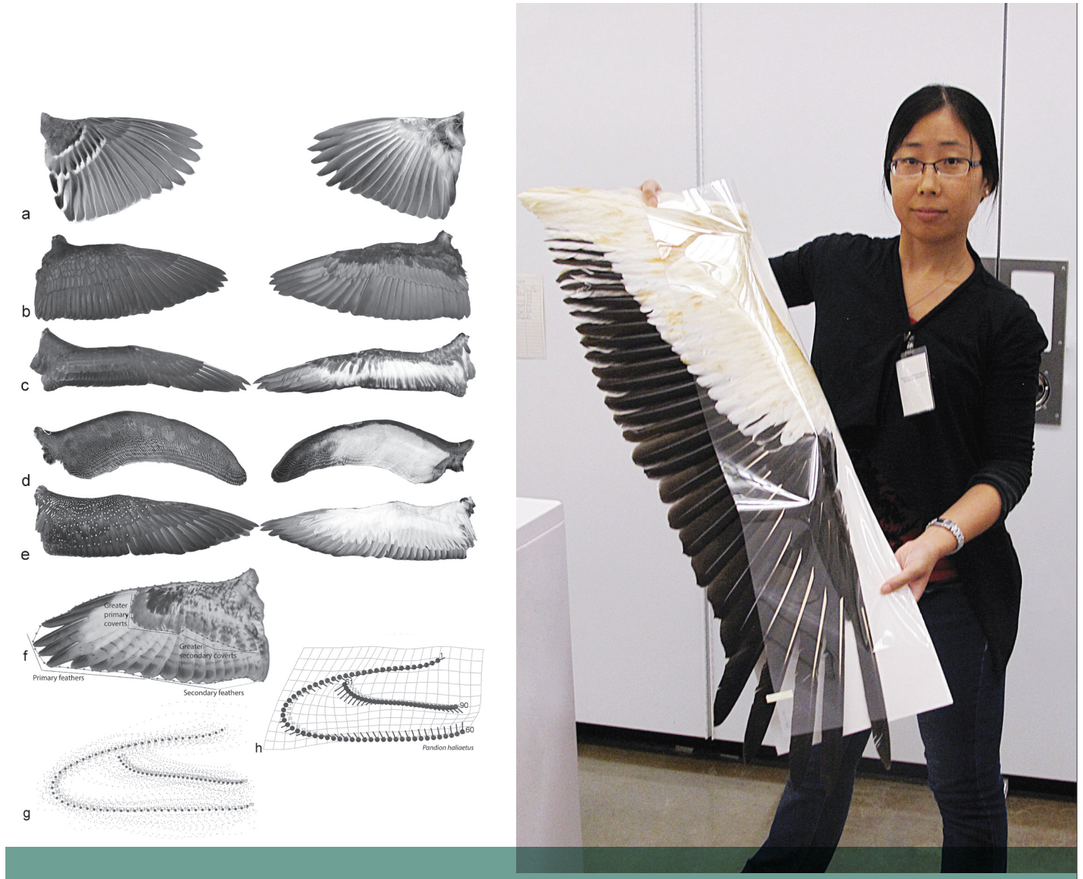
Researchers used 30 years of local water monitoring records and more than a decade of data from the NASA satellite system GRACE to reconstruct changes in the basin's water storage since the 1980s.

The U.S. Geological Survey, NOAA, UT Center for Space Research, the Arizona Department of Water Resources and Tsinghua University were part of the team. The findings were published online in *Water Resources Research Journal* on Dec. 10, 2015.

The team found that water storage decreased by 50 to 100 cubic kilometers (enough water to fill Lake Mead as much as three times) during droughts that occur about every decade. The big difference between recent and previous droughts is that there have been few wet years since 2000 to replenish the water. In contrast, multiple wet years followed drought years in the 1980s and 1990s.

Researchers also found that total water storage changes are controlled mostly by surface reservoir and soil moisture changes in the upper basin.

"This study explains how the system works, what's important and what to look out for," said lead author Bridget Scanlon, a bureau senior research scientist. "The upper basin is critical. Eighty percent of the runoff in the basin comes from the upper basin, so the climate of the upper basin is really important."



LEFT: SAMPLES OF BIRD WING SPECIMENS, AS VIEWED FROM THE TOP AND BOTTOM, COMPARED WITH CONSENSUS WING SHAPES GENERATED BY ANALYZING THE WING SHAPE OF 105 BIRD TAXA. **RIGHT:** XIA WANG, A POSTDOCTORAL RESEARCHER IN THE DEPARTMENT OF GEOLOGICAL SCIENCES, WITH BIRD'S WING.

BIRD WING SHAPE DEPENDS ON FAMILY: XIA WANG. SODERLUND: UTIG. RIVER EROSION: BRENDAN MURPHY.

Bird Wing Shape Depends on Family More than Flight Style

Climate, Carbon & Geobiology

In a finding that could change the way scientists think about bird evolution, researchers have found that the shape of bird wings is influenced more by how closely related species are to one another than by flight style.

The research challenges scientific beliefs that assume the way a bird species flies—whether it primarily dives, glides or flaps, for instance—plays the primary role in the evolution of its wing shape. It also indicates that it may be more difficult than previously thought to infer flying behaviors of early birds and the first flying dinosaurs from fossils alone.

Julia Clarke, a professor in the Jackson School of Geosciences Department of Geological Sciences, conducted the work with Xia Wang, a postdoctoral researcher who led the study. Their research was published in the journal *Proceedings of the Royal Society B: Biological Sciences* in October 2015.

The study is the first to analyze wing geometry across all major groups of birds. By comparing geometry across species and clades–groups of organisms that evolved from a common ancestor–the researchers found that birds that are closely related evolutionarily have similar wing structures, even if the birds show very different flight styles. For example, albatrosses, penguins and loons, despite looking very different from one another, all belong to the clade Aequornithes and have a wing shape that is very similar.

Preparing for Ice Giant Exploration

Planetary Sciences

Krista Soderlund, a research associate at the University of Texas Institute for Geophysics (UTIG), is helping NASA plan missions to giant, icy planets, such as Neptune and Uranus.

In February 2016, she was selected by NASA to be a part of the Science Definition Team for Ice Giants Mission Studies.

"Uranus and Neptune are the only two planets of their kind in our solar system, yet ice giants appear to be the most popular type of planet in our galaxy. In that way, they're an archetype for other planets," said Soderlund, who is also a NASA Early Career Fellow. "Beyond having the opportunity to contribute to the science community, I want to help make a mission to Uranus and/or Neptune happen."

The team, comprised of 14 members from across the United States and Europe, will address the goals of exploring ice giant systems and the engineering choices that will help accomplish those goals. The team will build upon NASA's decadal survey that outlines goals for the planetary science community over the next 10 years.

"Krista's selection is an affirmation of her scientific gravitas and respect in the field," said UTIG Director Terry Quinn. "This is truly a remarkable achievement for Krista, and speaks volumes about the planetary geophysics program at UTIG."

At UTIG, Soderlund is a science team member for the ice-penetrating radar instrument selected by NASA for the upcoming Europa mission.


Krista Soderlund

VIEW OF THE HEADWATERS OF WAIANAIA GULCH IN HAWAII.

River Erosion Controlled by Chemical Weathering

Surface & Hydrologic Processes

Chemical weathering can control how susceptible bedrock in river beds is to erosion, according to new research published in *Nature* on April 14, 2016.

"Our research presents a specific, process-based mechanism to explain how and why river erosion depends on climate," said Brendan Murphy, a Ph.D. student at the Jackson School of Geosciences who led the research.

Murphy conducted the research with Joel Johnson, an assistant professor in the Department of Geological Sciences, Nicole Gasparini of Tulane University and Leonard Sklar of San Francisco State University.

Chemical weathering occurs when a rock's susceptibility to erosion is increased by exposure to water. Water weakens the rock by interacting with the minerals it's made of.

To explore the extent to which chemical weathering influences river erosion, the team travelled to the Big Island of Hawaii to collect data on chemical weathering, rock strength and erosion rates in streams across wet and dry regions of the island.

"Hawaii is a simple, natural laboratory for studying how climate controls river erosion because it has uniform lithology and a very extreme precipitation gradient," Murphy said.

Consistent with their hypothesis, they found that bedrock was more chemically weathered and physically weaker where local precipitation rates were greater. More significant, Murphy said, was finding that high precipitation locations could maintain high erosion rates despite continuously exposing "fresh rock"–rock that was previously below the eroded surface and is not chemically altered.

The research was funded by the National Science Foundation and a Tulane Research Enhancement grant.

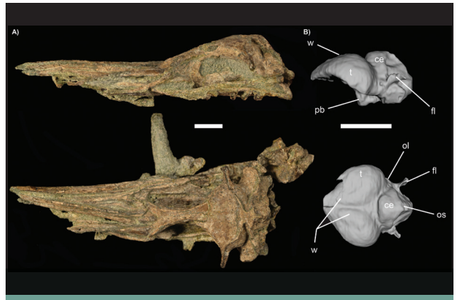
Penguin Brains Not Changed By Loss of Flight

Climate, Carbon & Geobiology

Losing the ability to fly gave ancient penguins their unique locomotion style. But leaving the sky behind didn't cause major changes in their brain structure, researchers from the Jackson School of Geosciences suggest after examining the skull of the oldest known penguin fossil.

The findings were published in the *Journal of Anatomy* in February 2016.

"What this seems to indicate is that becoming larger, losing flight and becoming a wing-propelled diver does not necessarily change the (brain) anatomy quickly," said James Proffitt, a graduate student at the Jackson School of Geosciences who led the research. "The way the modern penguin brain looks doesn't show up until millions and millions of years later."



ANCIENT PENGUIN SKULL AND ENDOCAST. SCALE BAR IS 2.5 CM AND LETTERS INDICATE PARTS OF THE BRAIN.

Proffitt conducted the research with Julia Clarke, a professor in the Department of Geological Sciences, and Paul Scofield, of the Natural History at the Canterbury Museum in Christchurch, New Zealand, where the skull fossil is from.

"It's the oldest (penguin) following pretty closely after the loss of flight and the evolution of flightless wing-propelled diving that we know of," Proffitt said.

The research was funded by the National Science Foundation.

Monsoon Intensity Enhanced by Heat Captured by Desert Dust

Climate, Carbon & Geobiology

Variations in the ability of sand particles kicked into the atmosphere from deserts in the Middle East to absorb heat can change the intensity of the Indian Summer Monsoon, according to Jackson School research published July 28, 2016, in *Scientific Reports*, an open access journal from the publishers of *Nature*.

The Indian monsoon is a period of intense rainfall that more than a billion people rely on to bring rains to farmland. The results of the study could help improve monsoon prediction models, which usually use a constant value for sand particles' heat-absorbing ability. Because the absorbing ability varies greatly with region and time, assigning a constant heat-absorbing ability for the particles tends to underestimate the impact that absorbed heat can have on the monsoon system, the authors said.

The study was led by Qinjian Jin, a postdoctoral researcher at the Massachusetts Institute of Technology, who conducted the research while earning his Ph.D. at the Jackson School of Geosciences. He collaborated with Zong-Liang Yang, a professor in the Jackson School's Department of Geological Sciences, and Jiangfeng Wei, a research scientist in the department.

MONSOON RAINS FALL ON THE GREEN VALLEYS OF MADHYA PRADESH, INDIA.

PENGUIN BRAINS: JAMES PROFFITT. MONSOON INTENSITY: RAJARSHI MITRA. WIND CAUSES CALIFORNIA DROUGHT: NASA. GETTING A BETTER LOOK AT SHALLOW: TIP MECKEL AND FRANCIS J. MULCAHY.

Wind Causes California Droughts

Climate, Carbon & Geobiology

Droughts in California are mainly controlled by wind, not by the amount of evaporated moisture in the air, new research has found.

The findings were published in *Geophysical Research Letters*, a journal of the American Geophysical Union, on June 30, 2016. The research increases the understanding of how the water cycle is related to extreme events and could eventually help in predicting droughts and floods, said lead author Jiangfeng Wei, a research scientist in the Jackson School's Department of Geological Sciences.

The researchers analyzed 30-year data sets that recorded precipitation, ocean evaporation, surface wind speed and atmospheric pressure on and near the west coast of the United States. These are all factors that influence the water cycle in California.

CALIFORNIA FROM SPACE.

Their analysis showed that although moisture evaporated from the Pacific Ocean is the major source for California precipitation, the amount of water evaporated did not strongly influence precipitation in California, except in the cases of very heavy flooding. Instead, the researchers found that disturbances in atmospheric circulation, the large-scale movement of air, have the most effect on drought because they can impact factors that will cause it to rain more or less.

The study co-authors are Qinjian Jin, a postdoctoral researcher at the Massachusetts Institute of Technology who earned his Ph.D. at the Jackson School; Zong-Liang Yang, a professor in the Jackson School's Department of Geological Sciences; and Paul Dirmeyer, a professor at George Mason University.

Getting a Better Look at Shallow Subsurface Geology

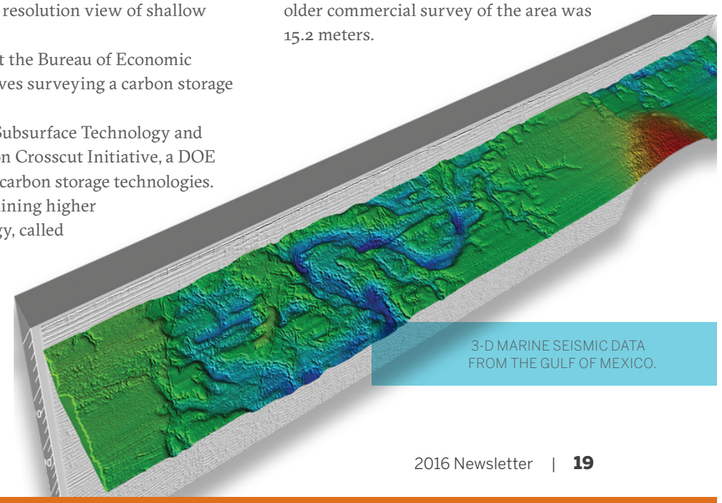
Energy Geosciences

Researchers at the Bureau of Economic Geology received $2.5 million in July 2016 from the U.S. Department of Energy to evaluate a new 3-D seismic imaging system that could improve subsurface resource exploration and carbon storage–a potential strategy to battle climate change–by providing a higher resolution view of shallow subsurface geology.

The project is led by Tip Meckel, a research scientist at the Bureau of Economic Geology's Gulf Coast Carbon Center (GCCC), and involves surveying a carbon storage site offshore of Japan.

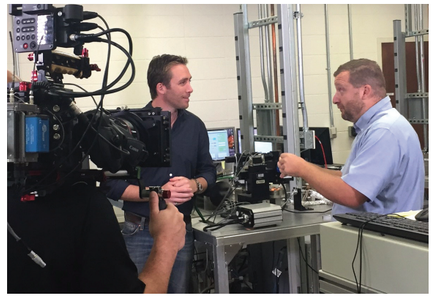
The survey is one of eight projects sponsored by the Subsurface Technology and Engineering Research, Development, and Demonstration Crosscut Initiative, a DOE program focusing on furthering geothermal energy and carbon storage technologies.

Traditionally, seismic technology has focused on obtaining higher resolution at deeper depths. The new imaging technology, called P-Cable high resolution 3D (HR3D), is specialized for capturing data in the relatively shallow subsurface interval between ultra-shallow systems and the deep water. Compared to older methods, the new system results in a much finer resolution. For example, in a 2013 survey of an area in the Gulf of Mexico, the HR3D system produced data with a vertical resolution of 2.5 meters. The vertical resolution from an older commercial survey of the area was 15.2 meters.



3-D MARINE SEISMIC DATA FROM THE GULF OF MEXICO.

NEWSMAKERS



TV SHOW HOST PHILIPPE COUSTEAU WITH DANIEL STOCKLI.

Jackson School faculty, researchers and students made headlines in over 100 news outlets across the globe from fall 2015 to summer 2016. From internationally reaching publications such as The New York Times and the BBC, to local Texas news sources like KUT, the Austin American Statesman and the Houston Chronicle, news from the Jackson School was shared with the community and the world at large.

Research discoveries dominated coverage. But reporters also turned to experts in the Jackson School to provide insight on natural disasters, the environment, energy issues and other vitally important and timely subjects.

"Sheikhs and shale caused this. They are both producing more oil. That is the fundamental driver."

Scott Tinker
Director of the Bureau of Economic Geology, January 2016

The New York Times

"This paper presents solid evidence that there has been rapid retreat here in the past, in fact, throughout the history of the ice sheet,"

Jamin Greenbaum
UTIG Research Engineer, May 2016

The Washington Post

"Wind is powerful but it's slow...On Mars these craters have been exposed to the surface for 3 billion years so there's a lot of time to do that work and to get that material out of there in a way that we've never really seen on Earth."

Mackenzie Day
Ph.D. Student, April 2016

SCIENTIFIC AMERICAN

"Our study provides evidence that major changes in Earth's climate over the past ~700 million years were driven by changes in the emission of carbon dioxide from volcanoes."

Ryan McKenzie
Former Postdoctoral Researcher, April 2016

CBS NEWS

COUSTEAU AND STOCKLI: JACKSON SCHOOL.

MAKING NEWS WORLDWIDE

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THORSTEN BECKER

by John Holden

Cross-collaboration may be all the rage in academia these days, but Thorsten Becker has embodied this approach to research his entire career. At the expense of being considered a 'Jack of all trades but master of none', he has pursued interests in geodynamics, fault dynamics, seismology and high-performance computing, regardless of any perceived labels.

It doesn't seem to have done damage to his career. His research has led him across the globe to Japan, Morocco, Ethiopia, Italy, Colombia, his homeland Germany, and most recently, Southern California.

Becker's openness to outside influences is one of the reasons why he has been drawn towards the Lone Star State to take up the position of Shell Distinguished Chair of Geophysics at the The University of Texas at Austin's Jackson School of Geosciences. Becker, who started at the school in summer 2016, holds the position in the Department of Geological Sciences as well as a position as a researcher at the University of Texas Institute for Geophysics (UTIG).

"My expertise in structural seismology, geodynamics, computing and fault dynamics means I fit in between a lot of other people here," he said. "I'm hoping that will give me the chance to facilitate cutting-edge research."

CLAUDIO FACCENNA.

Becker's appointment was announced as the Jackson School works to promote interdisciplinary research and implement initiatives to foster transformative research at the interfaces between traditional scientific disciplines.

"Recruiting Thorsten was a tremendous coup for the Jackson School," explained Professor Richard Ketcham, associate dean for academic affairs at the Jackson School. "He is an internationally famous geodynamicist whose star is still ascending. It's clear that he will bring extraordinary energy to our faculty."

Becker will help create a new lithospheric dynamics group that will bring together faculty, research scientists and students across a range of fields to use an interdisciplinary approach to attack questions spanning the crust and upper mantle.

"We expect that this will create a dynamic environment that will push forward Jackson School research while giving our students' education a new dimension," Ketcham said.

Things are being shaken up on a more basic level, too. UTIG is already in the process of reconfiguring office space to bring people with similar research interests closer together, and the department has similar plans.

Becker believes his skills will fit in well with the school's push to increase interaction between research disciplines.

"I tend to work collaboratively, mainly because I don't have any good ideas of my own," he said with a laugh. "There are different ways of conducting science. I've written a number of papers as a single author, but I've completed many more in groups. At the University of Southern California, where I just moved from, I wrote papers with nine different faculty."

For Becker, collaboration is the fun part because it allows researchers to gain expertise across disciplines and provides greater context to the research.

"There's an academic model where the single faculty builds its little empire, which is really high and impressive," he said. "But it has a big wall around it. I'm not that guy. Answering some of the bigger, more fundamental questions which we face will, I believe, require much greater collaboration."

Becker's openness is reflected in his research. A physicist by training, he got his master's in physics from Frankfurt University in 1997, which included a geophysics-focused thesis.

"I was interested in pursuing non-linear dynamics, chaos, stuff like that, but changed my mind after taking a field class that involved doing applied geophysics measurements outdoors," he said. "I thought, 'wouldn't it be great to be able to combine my love of physics with being outdoors?'"

Despite his love of the outdoors, Becker spent the following 15 years indoors mainly focused on computer modelling.

"It's only recently that I've been able to go back to why I got into geophysics in the first place," he said. "I got a Ph.D. at Harvard and started working on upper-mantle geodynamics, and ever since I've been focused on mantle dynamics, but always with some earthquake research on the side."

In order to cover all bases, his approach in the past has been to assign one student with a fault line problem while the rest of the group looks at how plate tectonics works and how deep-mantle dynamics is expressed at the surface.

> "The University of Texas in Austin is a great place where you can do things you simply couldn't do anywhere else."
>
> *-Thorsten Becker*

"That is how I'll be able to bring field observations in at UT," he added. "I'm going to be running both computational modelling programs and a structural seismology program."

Becker's "earthquake research on the side" has become more than a hobby and demonstrates once again his desire to look at his discipline as more than the sum of its parts.

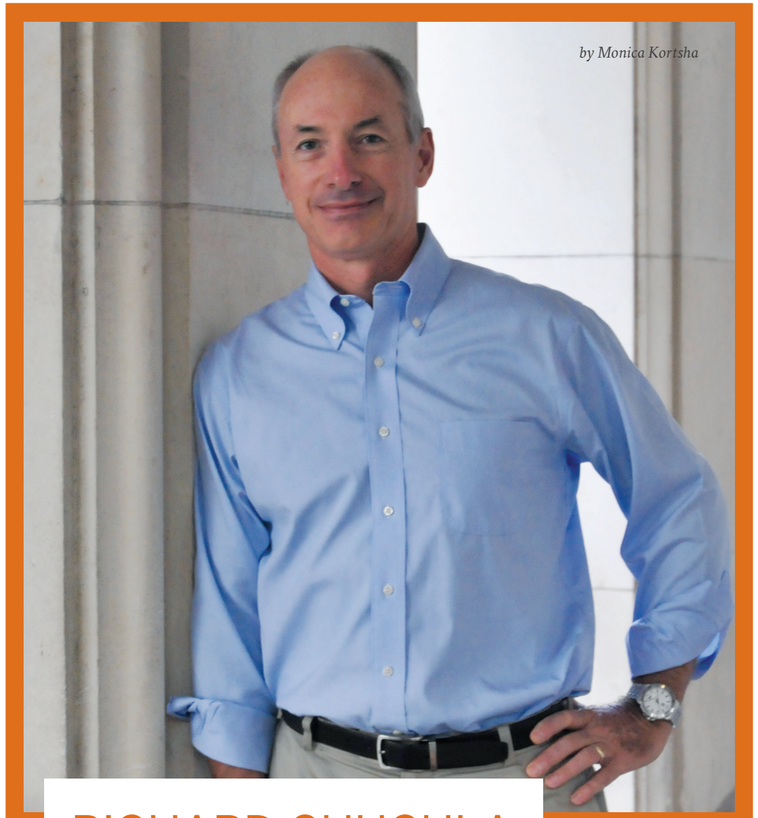
"I'm fascinated by how the mantle talks to the surface," he said. "How do you go from a 1 million year time-scale deformation to the shorter term, 100 year time-scale seismic cycle? How does the long term plate motion work itself into earthquakes?"

The Jackson School was the only place where he believes there is enough critical mass in terms of research expertise to be able to answer the big questions.

"The University of Texas in Austin is a great place where you can do things you simply couldn't do anywhere else," he said. "It has such a wide range of specialist research and, given my interest in transitions and how the mantle talks to the surface, this is the only place to be. Here there are experts who legitimately cross the entire research range—erosion, hydrology, tectonics, faulting, dating of the uplift, etcetera. There are so many great people here. I'm just looking forward to being in the middle of all of that."

After completing his Master of Science in physics from the J.W. Goethe University in Frankfurt in 1997, Thorsten went to Harvard to obtain a Ph.D. in geophysics, which he completed in 2002. He spent the following two years as a postdoctoral scholar at the IGPP Scripps Institution of Oceanography, based at the University of California, San Diego. He now joins the Jackson School of Geosciences after spending the past 12 years at the University of Southern California where he was professor of Earth Sciences. His research has also led him into a number of visiting appointments, including ones at the University of Tokyo, Universitá di Roma TRE, Princeton and GFZ Potsdam.

OPPOSITE PAGE: BECKER STANDING ON EXPOSED VOLCANIC DIKE, ETHIOPIA. **LEFT:** BECKER WITH LOCAL VILLAGE CHILDREN AT AN OUTCROP IN ETHIOPIA.



by Monica Kortsha

RICHARD CHUCHLA

During his 35 years at ExxonMobil, Richard Chuchla helped find and develop energy and earth resources around the world.

A geologist by training, with an undergraduate degree from Cornell and a master's from the Jackson School of Geosciences, he started in base and precious metals, moved to coal, and then oil and gas, working in exploration, development and research. The assignments took him from Tucson, Arizona—where he accepted his first industry job two days after earning his master's—to Europe, Latin America and West Africa. It was then back to the United States, where he spent the better part of his last 10 years launching ExxonMobil's unconventional resources program including two years at the corporate headquarters in Dallas advising the management committee and CEO.

Just retired from industry, Chuchla is applying his broad experience to his new position as the director of the Jackson School's Energy and Earth Resources (EER) master's program.

"I'm coming back here to continue to learn and share what I've learned with others," Chuchla said. "The fact that I'm able to return to the Jackson School is a piece of good fortune, because if I think about places that I owe a lot, this institution would be at the very top of the list."

Although administered by the Jackson School, EER students take classes from across UT Austin's different schools to build expertise in one or more of the following topics: geosciences, engineering, business, finance, economics, law, policy and the environment.

Chuchla was in graduate school when he first met Bill Fisher, the EER director for the past four years. But Fisher said that he got to know him—and his energy and expertise—when Chuchla served on the Jackson School's Advisory Council as the ExxonMobil representative from 2005 to 2016, and on the Bureau of Economic Geology's Visiting Committee for several years.

"We are very, very fortunate to have a guy of the standing and the breadth of Richard Chuchla," said Fisher, who is also a professor and Leonidas T. Barrow Centennial Chair in Mineral Resources. "He's bright, intelligent and tremendously insightful fellow...and I think he will bring to the program great leadership and, more importantly than anything else, a lot of excitement that is contagious to the students and the fellow faculty."

Those who watched Chuchla serve on the Jackson School Advisory Council, particularly during his term as chair from 2010-2013, are convinced he'll excel in the position.

"He was a dynamic leader who helped shape the direction of the school," said Jackson School Dean Sharon Mosher. "I'm thrilled to have someone of Richard's caliber leading EER."

Current Advisory Council Chair Brian Reinsborough agreed.

"Richard has expansive experience to bring to the table after serving over 35 years in the oil and gas industry with ExxonMobil in all aspects of their business," he said. "We saw Richard's experience and leadership shine at the advisory council when he was chairman. He will be a great addition to the EER leadership team and a mentor to young professionals."

Richard Kyle, a professor in the Department of Geological Sciences and Bureau of Economic Geology, is also joining EER as the graduate adviser and, coincidentally, was one of Chuchla's instructors and thesis advisors 35 years ago.

"Taking the reins from Bill and working with Rich is a privilege. It's a dimension of the job that made it all the more attractive," Chuchla said.

Chuchla's connection to geosciences stems from his earliest days. The son of a mining engineer, Chuchla was born and spent his childhood in Chile, collecting rocks and fossils in the Atacama Desert and learning about the copper deposits that brought his family to South America from their native Poland.

"I grew up in the shadow of El Salvador, probably one of the most studied porphyry copper deposits in the world, and my best friend was the son of the chief geologist of the Anaconda Copper Mining Company," Chuchla said. "That's how it started."

At ExxonMobil, changes in the market, and new technologies and concepts made for a dynamic business environment. Chuchla said that he was always ready to take on new assignments because each was a chance to learn something new in a different part of the world. He said he feels incredibly lucky to have played a role in starting deepwater oil and gas exploration in Africa, and spearheading the global development of unconventional oil and gas resources, most notably shale.

> "Most of what you learn at the end of the day is from other students or fellow employees."
>
> *–Richard Chuchla*

"I spent much of my last decade of employment with ExxonMobil leading our global unconventional resources effort. It was a wonderful challenge, personally and professionally," Chuchla said. "It made me rethink much of what I had learned and to humbly accept how much of this complex Earth I do not understand. And my team and I had to convince a lot of skeptics in our company that shale resources were going to be a big business. Our only mistake was in understating just how big."

Whether at the research lab or at the exploration company, Chuchla said his leadership involved bringing people together to collaborate—a process that was always critical to success. As EER Director, Chuchla says he wants to promote a similar environment so students can learn from one another.

"I know EER students are here to get their individual degrees, but strengthening the level of interaction and collaboration will make it a more fulfilling endeavor and a more enriching learning experience," Chuchla said. "Most of what you learn at the end of the day is from other students or fellow employees."

Chuchla said that he is looking forward to learning from students himself. It's a great job perk for someone who lives for the eureka moments in life, no matter where they come from.

"It's hard to describe how exciting it is to learn new things," Chuchla said. "Sometimes it's a major oil field you've played a role in finding and sometimes it's understanding something very trivial that was previously nagging at you. When I go home at the end of the day after one of those eureka moments, I feel great."

JACKSON SCHOOL

WRITER-IN-RESIDENCE

ADAM PAPENDIECK

This fall I will begin my second year as the Jackson School's Writer-in-Residence, a forward thinking position funded by alumni and friends through the Jackson School's Writer-in-Residence Endowment and the Elias Sellards Writer in Residence Fund.

Strong writers in the geosciences are urgently needed, as are communicators who are able to collaborate across increasingly complex academic and industrial landscapes. We're taking a holistic, research-based approach to the development of effective writers and communicators, moving beyond traditional one-size-fits-all writing instruction towards a highly personalized program rooted specifically within geoscientific disciplines.

Since its publication in 1959, William Strunk Jr. and E. B. White's classic *The Elements of Style* has been prescribed to suffering writers of all types, ages and afflictions. That said, having owned a copy for over a decade, it was only upon arriving at the Jackson School last year I actually sat down to read it cover to cover. It's a good book: short, efficient and full of snappy aphoristic tidbits like "write with nouns and verbs" and "omit needless words." It's also an old, strange and frequently misleading book. Steven Pinker, a cognitive psychologist from Harvard, points out that the stylistic gems in *The Elements* are set amidst outdated trivia, questionable generalizations and some straight-up bad advice: "the word *people* is not to be used with words of number in place of persons." Perhaps most importantly, it is not quite clear how the book should be used by writers. It's not a standard, reference in the vein of the *MLA Handbook or Chicago Manual of Style*. Neither is it a beach read.

For many of us, the book may be less a reference or guide, and more a talisman which we place on our bookshelf to ward off evil writing spirits and pedants.

In the end, I think we simply expect far too much of this 85-page, 57-year-old booklet. The truth is that writing is a skill which, first and foremost, takes practice. Style varies from discipline to discipline, and our conception of "good" writing evolves as our language and culture evolve. David Russell, an influential professor of rhetoric and writing at Iowa State, draws an analogy between ball skills and writing skills to highlight how important it is to develop both athletes and writers within the specific games that they aspire to play. We would never expect to improve the performance of our football, basketball and volleyball players by enrolling them all in a general course called "Ball Skills." Neither should we expect general writing guides or courses to have a significant impact on disciplinary writing performance. At the Jackson School, this means that students must practice writing in geoscientific genres.

Educational researchers and learning scientists increasingly emphasize how we work and learn together in interdependent ways, and how important it is to develop students in communities of practice which resemble and overlap with the communities they intend to join as professionals. Through a process of synthesis and feedback, students develop characteristically geoscientific ways of knowing, seeing and working in the world. Learning scientists call this disciplinary perception, and in sports we call it things like downfield vision and court vision. Just as a quarterback learns to see the field through repetitive snaps and feedback from players and coaches, so does a young writer acquire disciplinary ways of seeing, knowing and communicating scientifically through cycles of drafting and feedback from peers and experts.

At the Jackson School, I work to make sure that students have a variety of significant opportunities to practice writing together. Over the summer we launched the Jackson School Blog, a student-driven writing initiative focused on communicating scientific activity at the Jackson School to broad audiences. I also work with faculty to proliferate writing and peer review activities throughout the core geosciences curriculum. I catalyze student writing groups and demand-driven communications workshops around real documents and scientific work, focusing for instance on specific fellowship proposals, conference presentations and posters for research symposia. I also meet individually with students to talk about goals, audience and what their piece of writing should do. I connect them with genre-specific resources, offer feedback on style, grammar and argumentation, and help them prioritize their time and energy as they iterate through drafts. Rather than handing them Strunk and White, I like to help them identify model writers in their field who they can emulate in form and style.

Above all, I try motivate student writers. Writing is hard, and while talent may be helpful to athletes and writers alike, cultivating a dedication to practice is the only way to master the game.

JACKSON SCHOOL.

FROM LEFT: LARRY FAULKNER, FORMER PRESIDENT OF UT AUSTIN; PETER FLAWN, FORMER PRESIDENT OF UT AUSTIN; TERRY QUINN, DIRECTOR OF UTIG; SHARON MOSHER, DEAN OF THE JACKSON SCHOOL; GREGORY FENVES, PRESIDENT OF UT AUSTIN; AND SCOTT TINKER, DIRECTOR OF THE BEG.

Symposium Commemorates a Decade of Excellence, Looks Toward the Future

When Jack and Katie Jackson made the decision to invest their fortune in The University of Texas at Austin, they envisioned the creation of a world-class school of geosciences to help solve problems important to Texas and the world.

Their vision guided a 10-year anniversary research symposium hosted by the Jackson School on Jan. 22, 2016, with research panels organized around the geosciences topics Jack specifically listed in the letter making his decision official: geology; geophysics; energy, mineral and water resources; and broad areas of Earth sciences including the environment.

While the event commemorated a decade of accomplishments at the school, the discussions that filled the day focused on the future.

"As we celebrate our 10th anniversary, I think it's only fitting that we look toward the future," said Dean Sharon Mosher at the welcoming event. "The future of the geosciences, the grand challenges that face society in the future, and of course, the role that the Jackson School could play in helping explore and solve these grand challenges."

The daylong symposium was attended by the Jackson School community and guests from around the country. Each panel, comprised of researchers, professors and graduate students, was kicked off by a short lecture by a distinguished speaker. The speaker for each panel was as follows:

- Energy, Mineral and Water Resources: Steve Koonin, founding director of NYU's Center for Urban Science and Progress and former Under Secretary of Energy;
- Geophysics: Mark Zoback, director of Stanford University's Natural Gas Initiative;
- Geology: George Davis, Geological Society of America past president, professor of structural geology and provost emeritus at University of Arizona, and alumnus of The University of Texas at Austin; and
- Broad Areas of the Earth Sciences Including the Environment: Marilu Hastings, Vice President of Sustainability Programs for the Cynthia and George Mitchell Foundation.

Gregory Fenves, the president of The University of Texas at Austin, also addressed the guests. He stressed the importance of geology as a basic science, as well as a profession, and how the gift of Jack and Katie Jackson jump-started geosciences research by uniting three geological research units—The Department of Geological Sciences, the Institute for Geophysics, and the Bureau of Economic Geology—as the Jackson School.

"My vision for the university is really built on interdisciplinary collaboration...and I think that was the founding idea in bringing together these three units together at the Jackson School," Fenves said.

FROM LEFT: SCOTT TINKER, DIRECTOR OF THE BUREAU OF ECONOMIC GEOLOGY; BILL FISHER, JACKSON SCHOOL INAUGURAL DEAN ; LARRY FAULKNER, FORMER PRESIDENT OF UT AUSTIN; PETER FLAWN, FORMER PRESIDENT OF UT AUSTIN; AND JAMES LANGHAM, JACKSON'S LONGTIME FINANCIAL ADVISOR AND EXECUTOR OF HIS ESTATE.

The Jackson Five

One of the highlights of the 10-year symposium was a special panel dedicated to remembering Jack Jackson and reflecting on his influence on the school today. The group, dubbed "The Jackson Five," consisted of five people who were close to Jackson later in life and helped secure his estate for the university. They were Larry Faulkner, former president of UT Austin; Peter Flawn, professor emeritus, former president of UT Austin; Bill Fisher, the Jackson School's inaugural dean and the Leonidas T. Barrow Centennial Chair in Mineral Resources; James Langham, Jackson's longtime financial advisor and executor of his estate; and Scott Tinker, director of the Jackson School's Bureau of Economic Geology.

The group reminisced about Jackson and his many years on the Geology Foundation. Jackson, who made his fortune in the gas fields of Wise County and later in Dallas real estate, and wife Katie were longtime philanthropists who gave generously to education, health care and other issues they cared about. Katie died in 2001. The following year, Jackson made the decision to leave their estate to The University of Texas at Austin after his death.

"These words that we're following today are partly Jack's words and the vision he had for science, integration and what he wanted to invest in," said Tinker, one of the symposium's chief organizers. "I think that's an important piece. He's not just someone who gave money, he actually had a vision for how it would play out."

DEAN SHARON MOSHER VISITING UNAM'S GEOSCIENCES LABORATORY FACILITIES WITH ELENA CENTENO GARCÍA, DIRECTOR OF UNAM'S INSTITUTE OF GEOLOGY AND ARTURO IGLESIAS, DIRECTOR OF UNAM'S INSTITUTE OF GEOPHYSICS.

Delegation Expands Research, Exchange Programs

In January 2016, Dean Sharon Mosher was part of a delegation led by University of Texas at Austin President Gregory Fenves to Mexico. The purpose of the visit was to help cement ongoing relationships and develop stronger collaborations for research and student exchanges.

Mosher attended a number of individual and small group meetings with geosciences leaders from the National Autonomous University of Mexico (UNAM) and Mexican government agencies. At SENER (Mexico's energy ministry) she met with Secretary of Energy Pedro Joaquín Coldwell and Deputy Secretary Leonardo Beltrán Rodriguez and at CONACYT (Mexico's national science foundation) she met with Director Enrique Cabrero Mendoza and Deputy Secretary Julia Taguena.

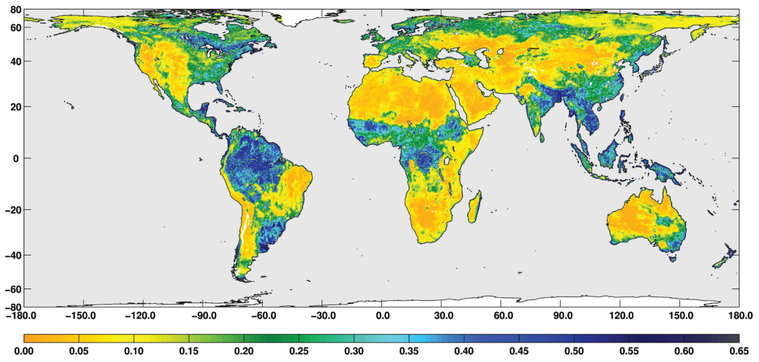
"Our research partnerships with Mexico are essential to advancing knowledge and fostering discovery in many fields."

Gregory Fenves, President, UT Austin

The delegation, the largest ever from the university to travel to a foreign country, included deans and faculty members from more than a dozen UT colleges.

About 400 Mexican nationals are enrolled at UT Austin, and nearly 100 UT Austin students study in Mexico each year.

"Mexico is our closest neighbor and one of our largest academic international partners. Our research partnerships with Mexico are essential to advancing knowledge and fostering discovery in many fields," Fenves said. "UT has educated thousands of Mexican students, many of whom have become leaders in their communities and professions. And many UT Austin students have deepened their educations by studying in Mexico. These ties are vital to our ambitions as a leading research university."



A THREE-DAY COMPOSITE MAP OF GLOBAL SURFACE SOIL MOISTURE RETRIEVED FROM THE NASA SATELLITE SMAP BETWEEN AUG. 25-27, 2015. DRY AREAS APPEAR YELLOW/ORANGE, WET AREAS APPEAR BLUE, WHITE AREAS INDICATE SNOW, ICE OR FROZEN GROUND.

Promoting Water Research

Top water experts from around the state and the nation converged on the Jackson School of Geosciences in April and August 2016 for three separate workshops on cutting-edge water research.

The first took place on April 4–5 and focused on research that used data from NASA's SMAP satellite, a soil-moisture sensing satellite that was launched in January 2015. The workshop was co-hosted with NASA and the Texas Water Development Board and served as a place for scientists to discuss how they used SMAP data to study drought and flooding in Texas. It included presentations from the Jackson School's Todd Caldwell, a research associate at the Bureau of Economic Geology, and Rong Fu, a professor in the Department of Geological Sciences. In addition, Dean Sharon Mosher participated in a discussion panel on SMAP progress and how the satellite could aid future water research.

The second workshop on April 21 brought together over two dozen water researchers to share their work on global water cycles and world water resources. The event was hosted by Zong-Liang Yang, director of the Jackson School's Center for Integrated Earth System Science. Presenters from the Jackson School included Jay Banner, director of the Environmental Science Institute; Todd Caldwell, bureau reseacher; Michael Young, associate director at the bureau; David Arctur, research scientist at the Center for Integrated Earth Systems Science; and Bayani Cardenas, Robert Dickinson, Rong Fu, Omar Ghattas, and David Mohrig, all professors in the Department of Geological Sciences.

The third meeting occurred on Aug. 18-19 as part of the Texas Water Research Network, a project led by the Jackson School-affiliated Environmental Science Institute. The effort, supported by the Cynthia and George Mitchell Foundation and the National Science Foundation, focused on addressing water issues in Texas by facilitating collaborative scientific research and communication.

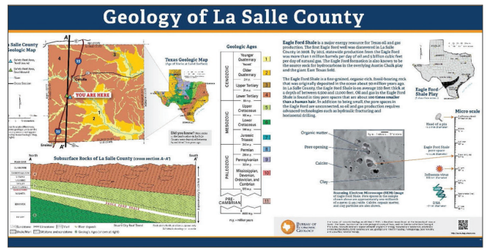
The meeting was highlighted by three guest speakers with experience organizing water research networks and conducting research on water in arid environments: Jay Famiglietti with the NASA Jet Propulsion Laboratory; Kelli Larson from Arizona State University; and Todd Halihan from Oklahoma State University.

BEG Promoting Roadside Geology in Texas

In 2016 the Bureau of Economic Geology partnered with the Texas Department of Transportation (TxDOT) to post geologic information signs at TxDot Safety Rest Areas. The work is part of the Texas GeoSign Project, a new initiative to engage the public and promote the understanding of geologic information.

Linda Ruiz McCall, an information geologist with the bureau, is leading the project with BEG team members Charles Woodruff, a geologist; Caroline Breton, a research scientist associate; Cathy Brown, a media manager; and Jamie Coggin, a senior graphics designer. Jackson School of Geosciences graduate student Heather Christensen also contributed to the project.

The long-term plan is to develop and post two signs per year with TxDOT and other partners across the state. In addition, the information and images on the signs will be uploaded on a website, allowing anyone to learn about Texas geology. Currently, signs are posted in Eastland and La Salle County safety rest area facilities.



THE GEOSIGN FOR LA SALLE COUNTY.

APRIL WATER: NASA/JPL-CALTECH/GSFC. BEG PROMOTING ROADSIDE GEOLOGY: BEG. SHAPING THE FUTURE: JACKSON SCHOOL. HOT SCIENCE-COOL TALKS: ENVIRONMENTAL SCIENCE INSTITUTE.

DAVID MOGK (LEFT), A PROFESSOR AT MONTANA STATE UNIVERSITY, AND ALEX MANDA, AN ASSISTANT PROFESSOR AT EAST CAROLINA UNIVERSITY, AT THE EDUCATION SUMMIT.

Shaping the Future of Undergraduate Geosciences Education

More than 100 academic leaders gathered at The University of Texas at Austin Jackson School of Geosciences in January 2016 to take on a critical task for the future of geosciences—developing strategies to promote and implement a collective vision for undergraduate education throughout the country.

The summit is part of a National Science Foundation effort to change undergraduate education to meet the needs of the workforce and society in the future. It followed a similar summit at the Jackson School in 2014, an employers' workshop in Washington D.C. in 2015, and a national survey of academics and industry representatives.

The national effort is a response to the growing realization that future generations of geoscientists will need a wider variety of skills than past generations, and a looming workforce shortage, in part because a large number of geoscientists are nearing retirement age.

The good news?

"There is amazing collective agreement," said Jackson School Dean Sharon Mosher, who hosted the summit. "We have a general consensus across the country as to what undergraduate students need to learn."

The three-day summit brought together heads, chairs and administrators of geoscience departments across the country from R1 research universities, four-year private and state colleges, and two-year community colleges. Each representative created a plan outlining how they would communicate and apply the collective vision at their school. Representatives from the American Geophysical Union and the American Geosciences Institute also attended.

Members will report on their progress in 2017.

For more information, including materials from the summit and a full webcast, go to jsg.utexas.edu and click on "Geoscience Education."

Hot Science-Cool Talks Gives 100th Lecture

The Environmental Science Institute (ESI), an affiliated program of the Jackson School, hosted its 100th Hot Science-Cool Talks event on Jan. 22, 2016.

Jackson School Professor Julia Clarke delivered the 100th talk, called "The Secret Lives of Dinosaurs." Over 1,000 people attended the talk, claiming all available tickets to the event.

Hot Science-Cool Talks is a science lecture series that connects the local community with scientific research happening at UT Austin and other prominent universities. The lectures are delivered by a scientific speaker and are free and open to the public.

ESI Director and Jackson School Professor Jay Banner started the program as a geology lecture series in 1999, but it has since expanded to include speakers from across scientific disciplines.

THE 100TH HOT SCIENCE-COOL TALKS WAS ABOUT "THE SECRET LIVES OF DINOSAURS."

Taking Questions from the Field

Stationed in Antarctica and on a research vessel in the Gulf of Mexico, Jackson School scientists answered questions about research and life in the field from hundreds of science enthusiasts around the world by participating in online Q&A sessions on the website Reddit.

Reddit users submitted hundreds of questions to each Q&A session, called an AMA or "Ask Me Anything." Those asking the questions ranged from other researchers to parents looking for answers on behalf of their young children.

Jackson School Professor Julia Clarke was part of a team that took questions on Feb. 11, 2016, while on a fossil hunting expedition in Antarctica. University of Texas Institute for Geophysics Research Professor Sean Gulick and Postdoctoral Researcher Chris Lowery, and Imperial College London Professor Joanna Morgan took questions on May 12, 2016, while in the midst of coring the crater left by the asteroid that killed all non-avian dinosaurs.

RESEARCHERS ON THE ANTARCTIC PENINSULA PALEONTOLOGY PROJECT TOOK QUESTIONS WHILE SEARCHING FOR FOSSILS IN THE SOUTH POLE. JACKSON SCHOOL PROFESSOR JULIA CLARKE IS FIFTH FROM THE LEFT.

GO TO THE ONLINE NEWSLETTER AT JSG.UTEXAS.EDU FOR A LINK TO THE Q&A.

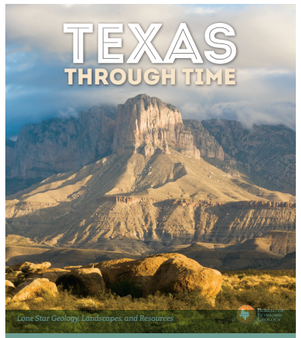
Texas Through Time

The Bureau of Economic Geology (BEG) has published a new coffee table book that explores the landscapes, rocks, resources and 1.7 billion years of Earth history in Texas. Written by noted geoscientist Thomas E. Ewing, "Texas Through Time" includes more than 500 full-color photos, illustrations and maps.

As described in its forward, the new book will allow readers to "visit the ancient rocks of the Llano and Van Horn areas, the legacy of now-eroded Himalaya-type ranges that initially rose over 1 billion years ago. Marvel at the giant West Texas Basin, so prolific in oil and gas, and the enigmatic Marathon and Ouachita Mountains. Watch North America separate from the supercontinent Pangea and create the enclosed, salt-rich Gulf of Mexico in its wake. Discover the vast carbonate platform that today makes up the Edwards Plateau and Texas Hill Country. And witness the complex story of mountain building, uplift, and delta building that formed today's Texas landscapes."

Ewing has been an Earth scientist in Texas for 35 years, first with the bureau and later as owner of Frontera Exploration Consultants and occasional lecturer at The University of Texas at San Antonio. He has given talks and led field trips across Texas for geologists and others, and his extensive publications include the "Tectonic Map of Texas" (BEG, 1990) and "Landscapes, Water, and Man: Geology and History in the San Antonio Area of Texas" (South Texas Geological Society, 2008). Ewing has held offices in the American Association of Petroleum Geologists, as well as in local and regional geology groups, and has received several awards for his service to the field.

The book can be ordered through the bureau's book store at begstore.beg.utexas.edu/store.



THE FRONT COVER OF "TEXAS THROUGH TIME."

Top Energy Officials from North America Collaborate on Carbon Capture Solutions at BEG

"Meeting the past day and a half was to generate other ideas, and I think we've been very successful in that."

Robert Wright, Senior adviser, U.S. Department of Energy

Energy officials from across North America met at the Bureau of Economic Geology on Dec. 2–3, 2015, to discuss how the United States, Canada and Mexico can collaborate to advance carbon capture and storage, a key technology to fight climate change and produce cleaner energy.

"We're really proud to host such a committed and dynamic group of countries interested in climate change mitigation through CCUS (carbon capture, utilization and storage)," said Susan Hovorka, a senior research scientist and principal investigator at the bureau's Gulf Coast Carbon Center.

Nineteen officials representing government, industry, policy and academic institutions attended the event to discuss their own experience in CCUS development and to plan best practices for collaboration between their countries and organizations. Representatives from the U.S. and Canada attended the event at the bureau, while Mexican officials participated remotely.

"Meeting the past day and a half was to generate other ideas, and I think we've been very successful in that," said Robert Wright, a senior adviser at the U.S. Department of Energy.

The meeting was part of the North American Energy Ministers' Working Group on Climate Change and Energy.

New Class Promotes Cross-Cultural Skill Exchange for Geoscientists

A new exchange program between UT Austin and the National Autonomous University of Mexico (UNAM) brought together students from both sides of the border to hone their geosciences and computer science skills during a six-week summer course.

Sixteen undergraduate students (eight from UT Austin, and eight from UNAM) enrolled in the course, called "Introduction and Application of Intelligent Systems for Geosciences."

Students conducted fieldwork for problem-based research projects in the Texas Hill Country and the Central Mexican Altiplano that ranged from evaluating risks from groundwater induced subsidence to capturing a detailed 3-D map of karst and caves. In the process of completing the research, they leveraged cloud services for data management and used the Stampede supercomputer at the Texas Advanced Computing Center (TACC).

Each project included data collection, integration, analysis, processing, visualization and preservation.

"A big part of the future of geosciences is about is figuring out how to efficiently merge data from across different sources, analyze it and recognize important patterns," said lead instructor Suzanne Pierce, a computational geoscientist at the Jackson School of Geosciences and TACC.

Class co-leaders were Ritu Arora, a computer scientist at TACC; Gibran Fuentes Pineda, a computer scientist at UNAM; and Enrique Cabral-Cano, a geoscientist at UNAM's Institute for Geophysics.

Pierce, the co-leaders, and a portion of the students will present class research findings at the American Geophysical Union's annual meeting in December.

The class was funded by a grant through 100,000 Strong, an education initiative launched by President Barack Obama that seeks to increase the number of U.S. student studying in Latin America and Latin American students studying in the U.S. The class will be offered again in summer 2017.

STUDENTS BY BUILDING TILTED BY SUBSIDENCE.

Kerans Heads Department of Geological Sciences

Charles Kerans, professor and Robert K. Goldhammer Chair in Carbonate Geology, is the new chair of the Department of Geological Sciences.

Kerans, a world-renowned carbonate sedimentologist, replaced interim Chair Richard Ketcham in August 2016. Kerans now heads one of the of the oldest, largest and most prestigious geosciences programs in the world.

"It's really a good fit because Charlie is recognized as the very best in the world at what he does," said Jackson School Dean Sharon Mosher. "To have someone of his caliber with his broad knowledge of research and his dedication to students and their education is an incredible boon for the school. I'd also like to thank Rich for his tremendous service to the school and the department."

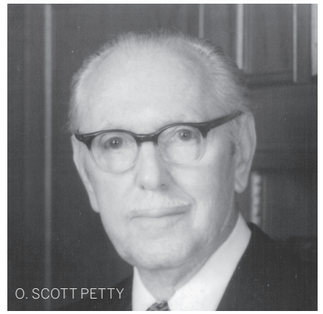
Kerans has been a part of the department since 2006 when he took a full-time appointment as the Goldhammer Chair. But he has been at the Jackson School since 1985, when he started as a research associate/research scientist at the Bureau of Economic Geology. He still holds the positions of senior research scientist and principal investigator in the bureau's Reservoir Characterization Research Laboratory.

Kerans has led the department's carbonate program since he arrived, developing and teaching courses in the graduate and undergraduate programs and supervising numerous students. He is also known for his role in leading the department's field courses, helping give students a hands-on geologic education and valuable experience with the challenges and rigors of fieldwork.

Kerans has won many major awards including the SEPM's Pettijohn Medal; APPG's Grover E. Murray Memorial Distinguished Educator Award; the Jackson School's Walter Award; and 14 best paper and poster awards.

"Charlie is a preeminent teacher whether in the university classroom, the corporate laboratory or with colleagues and students in the field," said Bill Fisher, Jackson School professor and Leonidas T. Barrow Centennial Chair in Mineral Resources. "He is widely respected and a great choice for the position."

JUDD OUALLINE



O. SCOTT PETTY

Oualline and Petty Inducted into Hall of Distinction

The Jackson School of Geosciences welcomed two new members into its Hall of Distinction in 2016.

Judd Oualline received his B.S. from the Department of Geological Sciences at UT Austin and had a distinguished career in the oil industry, including serving as vice president and general manager of Southern Exploration and Production Division with Getty Oil Company. He served on the Geology Foundation Advisory Council from 1980 to 1991 and provided funding to establish the Getty Chair, the Judd H. Oualline Endowment Fund, the Judd H. and Cynthia Oualline Centennial Lectureship in Geological Sciences, and the Judd H. and Cynthia Oualline Centennial Lectureship in Petroleum Geology.

O. Scott Petty earned his B.S. in civil engineering at UT Austin in 1917. After serving in WWI, he taught and studied physics at UT Austin. In 1925, he founded the Petty Geophysical Engineering Company, one of the first seismic service companies in the oil industry. Petty made many important early contributions and inventions in the field of geophysics and seismology. He served on the Geology Foundation Advisory Council from 1955 to 1969. Petty and his wife Edwina made significant contributions to geosciences at UT Austin, including establishing the Wallace E. Pratt Professorship in Geophysics. The Scott Petty Foundation continues that legacy of support. Both are posthumous inductions.

Behr Wins Donath and NSF CAREER Award

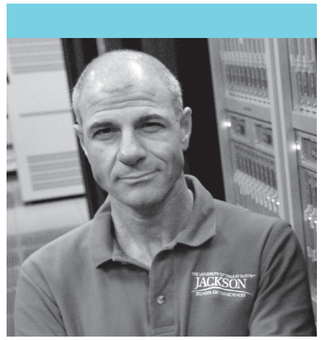
Whitney Behr, an assistant professor at the Jackson School's Department of Geological Sciences, was awarded the Donath Medal from the Geological Society of America and an NSF CAREER award.

The Donath Medal, or Young Scientist Award, was established in 1988 to be awarded to a young scientist (35 or younger throughout the year in which the award is to be presented) for outstanding achievement in contributing to geologic knowledge through original research that marks a major advance in the earth sciences.

The CAREER award is the NSF's most prestigious award in support of junior faculty research. Behr's award will fund a project investigating the rheological properties and evolution of subduction interfaces using exhumed rocks.

Behr also received a Jason Morgan Early Career Award from the Tectonophysics Section of the American Geophysical Union.

Behr completed her bachelor's degree at California State University Northridge in 2006 and her Ph.D. at the University of Southern California in Los Angeles in 2011. She then spent 11 months at Brown University as a postdoctoral fellow before joining the Jackson School in August 2012. Behr's research incorporates a variety of field, analytical and experimental techniques aimed at understanding deformation in both active and ancient plate margins.



Ghattas Wins Prestigious Super Computing Prize

Jackson School of Geosciences researcher Omar Ghattas and collaborators have won the 2015 Association for Computing Machinery's Gordon Bell Prize, super-computing's most prestigious prize, for a paper on high-performance modeling of the Earth's mantle convection.

Ghattas is the John A. and Katherine G. Jackson Chair in Computational Geosciences in the Jackson School's Department of Geological Sciences, and the director of the Center for Computational Geosciences and Optimization at UT's Institute for Computational Engineering and Sciences (ICES). He conducted the research with collaborators from ICES, New York University, IBM and the California Institute of Technology.

The team was awarded the prize for its paper "An Extreme-Scale Implicit Solver for Complex PDEs: Highly Heterogeneous Flow in Earth's Mantle." The paper describes high-performance computing methods that Ghattas and his team used to create a global model of the Earth's mantle convection and associated plate tectonics. The resolution of the model is detailed enough to show activity at plate boundaries.

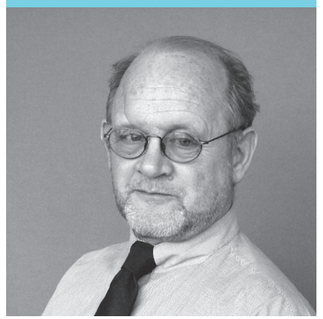
The Gordon Bell Prize recognizes the extraordinary progress made each year in the innovative application of parallel computing to challenges in science, engineering and large-scale data analytics. Financial support of the $10,000 prize is made possible by Gordon Bell, a pioneer in high-performance and parallel computing.

Banner Chosen as 2015 Kappe Lecturer

Jay Banner, a professor at the Jackson School of Geosciences and director of the UT Austin Environmental Science Institute, was selected to be the 2015 Kappe Lecturer by the American Academy of Environmental Engineers & Scientists.

This prestigious lectureship was endowed in 1989 to "share the knowledge of today's practitioners with tomorrow's environmental engineers and scientists" and involves a national university speaking tour. Banner is the first scientist to be honored as the Kappe Lecturer. All previous speakers were engineers.

Banner's research and teaching interests focus on Earth surface processes with the goal of understanding the interactions that occur between the atmosphere-land-ocean systems and how these interactions are preserved in the geologic record. As director of the Environmental Science Institute, a collaborative Jackson School and College of Natural Sciences program, Banner oversees a range of interdisciplinary programs for basic scientific research, education and outreach related to the environment and sustainability.



Steel Wins Twenhofel Medal

Ron Steel of the Jackson School of Geosciences has won the Twenhofel Medal, the highest honor given by the Society for Sedimentary Geology.

Steel, a professor and the Davis Centennial Chair in the Department of Geological Sciences, is a leader in the field of clastic sedimentology with a sustained record of fundamental contributions to the understanding of depositional systems ranging from fluvial through the coastal zone to deep-marine environments. Over his career, Steel has supervised more than 120 graduate students and post-doctoral fellows, many of whom have gone on to distinguished careers of their own.

"We are extremely proud of Ron," said Jackson School Dean Sharon Mosher. "He has had a long and distinguished career as an exceptional researcher, educator and mentor. I can think of no one more deserving of this honor."

Steel received both his bachelor's and doctoral degrees from the University of Glasgow in Scotland. He currently holds positions at the Jackson School of Geosciences, where he built the dynamic stratigraphy group and has served as chair of the Department of Geological Sciences, and is also an Honorary Professorial Fellow at Heriot-Watt University in Edinburgh. His career spans five decades and includes positions at the University of Aberdeen in Scotland, the University of Bergen in Norway, the University of Wyoming and at Norsk Hydro ASA, where he was the chief geologist.

Steel is known for being at the leading edge of new research developments, and publishing insightful, carefully documented studies that have advanced the development of emerging concepts, said longtime colleague Robert Dalrymple of Queen's University.

Among Steel's numerous publications are fundamental studies on sedimentation in rift basins and the associated alluvial-fan and fan-delta successions. He has also been at the forefront of research on autostratigraphy, and has made fundamental contributions to the study of tidal successions.

"Ron Steel is an intellectual giant in our field who has made many fundamental and lasting contributions to knowledge," Dalrymple said. "Our discipline is the richer for the contributions of this quiet yet incisive researcher."

AWARDS: JACKSON SCHOOL

Mohrig Elected AGU Fellow

David Mohrig, a professor in the Department of Geological Sciences, is a 2016 Fellow of the American Geophysical Union (AGU).

Fellows are elected based on their "remarkable contributions to their research fields, exceptional knowledge and visionary leadership," according to AGU. Each year only 0.1 percent of AGU members are elected fellows.

Mohrig's research focuses on unraveling the evolution of terrestrial and submarine landscapes on Earth and on Mars by studying sedimentary deposits and transport processes. He places a particular emphasis on studying processes that control channel formation, both on land and in the deep ocean. His work involves studying the behavior of topography generated at the interface between a granular material and a moving fluid from very short to very long time and space scales.

"We are very proud of David," said Dean Sharon Mosher. "He is an outstanding researcher and mentor to the dozens of students he has supervised at the Jackson School."

All 60 of this year's fellows will be recognized at the annual Honors Tribute event at the 2016 AGU Fall Meeting in San Francisco.

Scanlon Elected to National Academy of Engineering

Bridget Scanlon, a hydrologist and senior research scientist at the Bureau of Economic Geology, has been elected a member of the National Academy of Engineering (NAE), one of the highest professional honors accorded to engineers and scientists.

"I wish the process would recognize collaborative efforts because I would like to acknowledge my co-workers, particularly Bob Reedy and JP Nicot," Scanlon said.

Scanlon leads the bureau's Sustainable Water Resources Program, a research group that examines issues concerning water resources. Her work on aquifer recharge estimation methods, water use in energy production, impacts of land-use change, and the global recharge estimates for water-scarce regions has improved the understanding of groundwater depletion worldwide. It has also played an important part in informing U.S. water policy, particularly water management in California's Central Valley.

"I'm extremely proud of Bridget. She is one of the most diligent and hard-working scientists I have ever had the pleasure to work with," said Scott Tinker, director of the Bureau of Economic Geology. "She is also extremely humble, unassuming, a terrific team player and leads by example."

Much of Scanlon's work combines a variety of analysis methods—from local field measurements to data from NASA's GRACE satellite—to provide insight on water in the environment at a variety of scales. In spring 2016, Scanlon led the most comprehensive study to date on the water supply of the Colorado River Basin, a water source for over 40 million people (see page 15). Scanlon has also studied water use in energy production.

"Bridget's work on water issues is vitally important to all sectors of our society," said Sharon Mosher, dean of the Jackson School of Geosciences. "She is a world-class expert in her field and as dedicated a researcher as I have ever known."

Levy Named NASA Early Career Fellow

Joseph Levy, a research associate at the University of Texas Institute for Geophysics (UTIG), was named a NASA Early Career Fellow in February 2016 for his work looking at erosion on Saturn's moon Titan.

The NASA Early Career Fellowship Program was established in 2005 to provide funding for non-tenure track

scientists no more than seven years removed from receiving their Ph.D. Levy joins UTIG's Krista Soderlund, who was named an early career fellow in 2015 for her research surrounding the internal dynamics and dynamos of Uranus and Neptune. Like Soderlund, Levy's successful proposal involves the solar system's outer planets.

"Everyone knows how erosion works on Earth. You put cobbles or blocks of stone in a river and as they are tumbled downhill they get smaller and rounder. It's Geology 101 at its best," said Levy. "The NASA award is to explore the same process on Titan, where instead of rock there is ice and instead of water there is hydrocarbon soup."

Guerrero Named Outstanding Graduate Coordinator

The Jackson School's Philip Guerrero won the University of Texas at Austin Outstanding Graduate Coordinator Award. The honor recognizes the exemplary service of a graduate coordinator. Guerrero has worked at The University of Texas at Austin since 1984, and at the Department of Geological Sciences for 18 years.

Guerrero, the only person to win this award twice, is an active member of the university community and is known throughout campus for his knowledge and dedication as a graduate coordinator. In recent years, at the request of the Office of Graduate Studies, Guerrero has developed a series of trainings for graduate program coordinators. He is also a founding member of the Graduate Coordinator Network (GCN). The GCN is a nonprofit, voluntary, professional association of graduate coordinators representing over 10,000 graduate students in about 100 departments and programs at the university.

Tinker Receives Halbouty Award and Don R. Boyd Medal

The American Association of Petroleum Geologists (AAPG) has honored Scott W. Tinker, director of the Bureau of Economic Geology, with the Michael T. Halbouty Award for Outstanding Leadership—the second-highest honor given by the AAPG . Tinker also received the Don R. Boyd Medal from the Gulf Coast Association of Geological Societies (GCAGS), the organization's highest award.

"Scott is nationally and internationally recognized as a leader in petroleum geology and energy geosciences, and the bureau has thrived with him at the helm," said Sharon Mosher, dean of the Jackson School of Geosciences. "The university is fortunate to have someone of Scott's caliber on our team."

Tinker, who is also the state geologist of Texas, has served as president of AAPG, AASG, AGI and GCAGS, and continues to be a focal point for a path forward in the global energy debate. He was hired to lead the bureau in January of 2000 by then UT President Larry Faulkner.

Professor Bill Fisher, a former bureau director and the Jackson School's inaugural dean, said the search committee was looking for a leader that could help push the bureau into a national and international leadership role.

"Scott not only restored the bureau's prominence in short order, but has measurably enlarged it. That took substantial, perhaps unique, leadership and dedication," Fisher said. "He is one of the most articulate speakers and cogent thinkers in the area of energy geosciences that I have ever known. And he has probably reached more people than any geologist in history."

During Tinker's tenure, the bureau has excelled at its core strengths and grown in new directions. These include the development of a $50 million partnership with industry and international universities on advanced micro- and nano-subsurface sensors, a $50 million carbon management program recognized both nationally and internationally, a Center for Energy Economics and a major program in mudrocks and unconventional reservoirs. From 2000 to the present, the bureau's annual external funding has grown from $10 million to $35 million, its staff from 100 to 250 and its annual peer-reviewed publishing has grown tenfold.

Tinker has served as acting associate dean for research in the Jackson School for over five years, where he is also a professor and the Allday Endowed Chair.

AWARDS: JACKSON SCHOOL.

Mosher Honored as Distinguished Alum

Sharon Mosher, dean of the Jackson School of Geosciences, has been honored with the 2016 Alumni Achievement Award from the University of Illinois at Urbana-Champaign College of Liberal Arts and Sciences.

"Being recognized by my alma mater is a tremendous honor," said Mosher, who has been dean since 2009. "I am forever grateful for the excellent education I received at the University of Illinois. I often reflect on how important those years were to me both professionally and personally as I seek to create the best possible academic, research and learning environment at the Jackson School."

Mosher, a leading scholar in the field of structural geology, grew up in Illinois. She attended the University of Illinois, where she received her B.S. in Geology in 1973 and her Ph.D. in Geological Sciences in 1978. She came to The University of Texas at Austin in 1978, was promoted to full professor in 1990 and became chair of the Department of Geological Sciences in 2007.

Mosher has supervised 55 graduate students and authored dozens of peer-reviewed journal publications. But it was her leadership on a national scale that earned her the recognition, said Tom Johnson, head of the University of Illinois Department of Geology.

"The really big ticket item that inspired us to nominate her is her incredible service to the geosciences community," Johnson said. "It's over the top."

He specifically noted Mosher's terms as president of the Geological Society of America, chair of the Council of Scientific Society Presidents and president of the American Geosciences Institute. Mosher is also a founder of GeoScienceWorld, an international journal aggregation for geoscientists and is currently leading an NSF-sponsored effort to reshape undergraduate geosciences education around the nation.

"She really seems to have a magic touch with leadership and, obviously, abundant energy," Johnson said. "And of course, her work as dean of the Jackson School is impressive. It goes without saying that it's a big job and very high profile, because it's the biggest program in the nation."

Awards

Common Abbreviations:

AAPG	American Association of Petroleum Geologists
ACM	Association for Computing Machinery
AGS	Austin Geological Society
AGU	American Geophysical Union
AIPG	American Institute of Professional Geologists
BEG	Bureau of Economic Geology
DGS	Dept. of Geological Sciences
GCAGS	Gulf Coast Association Geological Society
GSA	Geological Society of America
GSEC	Graduate Student Executive Committee
SEG	Society of Exploration Geophysicists
SEPM	Society for Sedimentary Geology
UTIG	Institute for Geophysics

Faculty and Researchers

JAY BANNER
Kappe Lecturer, AAEES

JAIME BARNES
Knebel Outstanding Teaching Award, undergraduate course, DGS

THORSTEN BECKER
2015 Fellow, AGU

WHITNEY BEHR
CAREER Grant, NSF

Young Scientist Award (Donath Medal), GSA

Jason Morgan Early Career Award, AGU

Knebel Outstanding Teaching Award, graduate course, DGS

Faculty Annual Evaluation Award (Assistant Professor Level), DGS

CHRIS BELL
Knebel Outstanding Teaching Award, introductory course, DGS

TIMOTHY BARTHOLOMAUS
Outstanding Young Researcher, UTIG

Director's Circle of Excellence, UTIG

DON BLANKENSHIP
Director's Circle of Excellence, UTIG

BAYANI CARDENAS
Faculty Annual Evaluation Award (Associate Professor Level), DGS

ELIZABETH CATLOS
Outstanding Reviewer, Earth and Planetary Science Letters – Elsevier

DALLAS DUNLAP
Distinguished Service Award, GCAGS

NICHOLAS DYGERT
Dissertation Prize, Sigma Xi, Brown Chapter

PETER EICHHUBL
Runner-up, Tinker Family BEG Publication Award

ANDRAS FALL
Runner-up, Tinker Family BEG Publication Award

WILLIAM FISHER
AAPG Foundation Chairman's Award

PETER FLEMINGS
Tinker Family BEG Publication Award

Director's Circle of Excellence, UTIG

SERGEY FOMEL
Honorable Mention, Best Poster, SEG

CLIFF FROHLICH
Career Research Award, UTIG

JULIA GALE
Runner-up, Tinker Family BEG Publication Award

OMAR GHATTAS
Gordon Bell Prize, ACM

SEAN GULICK
Signature Course Essential Elements Award for Excellence in Teaching Oral Communication

Jackson School Outstanding Researcher Award

Director's Circle of Excellence, UTIG

PETER HENNINGS
Distinguished Service Award, AAPG

MARC HESSE
Outstanding Research Award, JSG

MICHAEL HUDEC
Tinker Family BEG Publication Award

RICHARD KETCHAM
Joseph C. Walter Jr. Excellence Award, JSG

J. RICHARD KYLE
Best Poster Award, GSA Energy Division

STEPHEN LAUBACH
Fellow, GSA

Distinguished Service Award, AAPG

A Peer Apart, Distinguished Service in Technical Editing, SPE

Award of Appreciation, Outstanding Technical Editor, SPE

Runner-up, Tinker Family BEG Publication Award

JOSEPH LEVY
NASA Early Career Fellow

Director's Circle of Excellence, UTIG

DAVID MOHRIG
2016 AGU Fellow

Faculty Annual Evaluation Award (Full Professor Level), DGS

SHARON MOSHER
Alumni Achievement Award, University of Illinois at Urbana-Champaign

MARIA-AIKATERINI NIKOLINAKOU
Tinker Family BEG Publication Award

STEPHEN PHILLIPS
Post-Expedition Activity Award, Expedition 353-IODP-U.S. Science Support Program

SUZANNE PIERCE
NAKFI Fellow/Selected Participant, Keck Foundation and the National Academy of Sciences

ERIC POTTER
Outstanding Service Award, JSG

BRIDGET SCANLON
Elected to National Academy of Engineering

MRINAL SEN
Outstanding Educator Award, JSG

Director's Circle of Excellence, UTIG

KRISTA SODERLUND
Director's Circle of Excellence, UTIG

RONALD STEEL
Twenhofel Medalist, SEPM

DANIEL STOCKLI
Fellow, GSA

SCOTT TINKER
Michel T. Halbouty Outstanding Leadership Award, AAPG

Honorary Member Award, AAPG

Don R. Boyd Medal, GCAGS

LUCA TREVISAN
Career Development Publication Award, BEG

LAURA WALLACE
Director's Circle of Excellence, UTIG

XINMING WU
Chevron Scholarship, SEG

Thomas A. Mazza Memorial Scholarship, SEG

MICHAEL YOUNG
Fellow, GSA

Promotions

JULIA CLARKE
Professor

BAYANI CARDENAS
Professor

QILONG FU
Research Associate to Research Scientist (BEG)

JULIA GALE
Research Scientist to Senior Research Scientist (BEG)

MARC HESSE
Associate Professor with tenure

SEYYED HOSSEINI
Research Associate to Research Scientist (BEG)

SVETLANA IKONNIKOVA
Research Associate to Research Scientist (BEG)

JIEMIN LU
Research Associate to Research Scientist (BEG)

Students

KIMBERLY AGUILERA
Best Undergraduate Student Poster, GSA

DANNY ANDERSON
Folk/McBride Petrography Contest, 2nd Undergraduate

HECTOR ARREOLA
AIPN Student Outreach Program

CHRISTIAN BAKER
Austin Geological Society Field Geology Scholarship

CHRISTIAN BLACK
Folk/McBride Petrology Contest, 1st Undergraduate

EMILIE BOWMAN
National Undergraduate Scholarship, AIPG

OWEN CALLAHAN
Outstanding TA, DGS

MIGUEL CISNEROS
Folk/McBride Petrology Contest, 1st Graduate

LAURA DAFOV
Intellectual Entrepreneurship Citizen Scholar

KRISTOPHER DARNELL
Best Paper Published by a JSG Graduate Student, JSG

Whitney Endowed Presidential Scholarship, UT Austin

BUD DAVIS
Student Service Award, GSEC

SARAH GEORGE
Gordon I. Atwater Memorial Grant, AAPG

Graduate Student Research Grant, SEPM

Ronald K. DeFord Field Scholarship, JSG

Early Career Graduate Best Poster Award, Jackson School Symposium

KIM GILBERT
Technical Sessions Best Speaker, Fall, Ph.D., DGS

PETER GOLD
Outstanding TA, DGS

KEALIE GOODWIN
Outstanding TA

CHAD GREENE
Outstanding Graduate Student Award, UTIG

National Science Foundation Young Investigator Travel Funding

Mathworks (Matlab) Award for Outstanding Contributions

MENAL GUPTA
Marshall Endowed Presidential Scholarship, 2015

Anadarko/SEG scholarship, 2016

ROMY HANNA
Second Place Poster Presentation, Late Career Ph.D., JSG

Vargas Endowed Presidential Scholarship, JSG

Pellas-Ryder Award for Best Student Paper in Planetary Sciences, Joint Award from Meteoritical Society and GSA Planetary Geology Division

EMMA HEITMANN
Groundwater Field Methods Award, Undergraduate, DGS

WOONG MO KOO
Duchin Endowed Presidential Scholarship for 2015-2016

JOHN LI
Edward C. and Caroline Beaumont Named Grant, AAPG

JOSHUA LIVELY
University Graduate Continuing Fellowship, 2016-17, UT Austin

Texas Academy of Science Ph.D. Student Research Grant

Ronald K. DeFord Field Scholarship Fund, JSG

Lundelius Award in Vertebrate Paleontology, JSG

ASHLYN MURPHY
R.E. McAdams Memorial Grant, AAPG

Graduate Student Research Grant, GSA

CASEY O'BRIEN
Technical Sessions Best Speaker, Spring, M.S., DGS

MIKE O'CONNOR
Outstanding TA

ANASTASIA PILIOURAS
Graduate Student and Early Career Travel Grant, Sediment Experimentalists Network, 2015

Mendenhall Postdoctoral Fellowship, United States Geological Survey, 2016

National Science Foundation Postdoctoral Fellowship, 2016

EDGARDO PUJOLS
Folk/McBride Petrology Contest, 2nd Graduate, DGS

ENRICA QUARTINI
Oustanding Graduate Student Award, UTIG

NATALIE RAIA
Houston Geological Society Scholarship

EVAN RAMOS
ExxonMobil/GSA Student Geoscience Grant

RACHEL RUTHVEN
Estwing Hammer, DGS

JULIANA SPECTOR
Graduate Student Research Grant, GSA

KELLY THOMSON
Statoil Graduate Student Fellowship

XINYUE (DENNIS) TONG
Outstanding Graduate Student Award, UTIG

KELSI USTIPAK
Technical Sessions Best Speaker, Fall, M.S., DGS

MADELEINE VADEBONCOEUR
Austin Geological Society Field Geology Scholarship

RAHUL VERMA
James W. McGrew Award

BENJAMIN WAGMAN
Gale White Fellowship, UTIG

NAPAT WANPIYARAT
Mineralogical Society of America Undergraduate Prize

JOHN WARDEN
Technical Sessions Best Speaker, Spring, Ph.D., DGS

ANNA WEISS
David Worthington Named Grant, AAPG

Muehlberger Field Scholarship, JSG

Lerner-Gray Memorial Fund, American Museum of Natural History, 2016

ZHIGUANG XUE
Best Student Poster Paper Award, SEG

Statoil Graduate Fellowship

Staff

NICOLE EVANS
Guion Library Staff Honors, DGS

TESSA GREEN
Picard Excellence Award, UTIG

PHILIP GUERRERO
Outstanding Graduate Coordinator, Graduate School

SCOTT KEMPF
Outstanding Support Staff, UTIG

KIMBERLY MILLER
Geoscience Information Society Best Paper Award

GREG NG
Outstanding Support Staff, UTIG

JUDY SANSOM
Outstanding Support Staff, UTIG

PATRICK STAFFORD
Staff Excellence Award, DGS

DEAN WILCOX
Guion Library Staff Honors, DGS

Staff Excellence Award, JSG

LEFT: SYMPOSIUM RESEARCH PARTICIPANTS. RIGHT: KELLY REGIMBAL SHOWS HER PRIZE-WINNING POSTER TO JACKSON SCHOOL DEAN SHARON MOSHER.

STUDENT RESEARCH SYMPOSIUM AWARDS

In February 2016 the Jackson School's Graduate Student Executive Committee organized its 5th Annual Research Symposium. Winners and honorable mentions are as follows:

LATE-CAREER PH.D. BEST POSTER AWARD

1st Place: Mason Fried. Mass loss down under: distributed subglacial discharge drives significant submarine melt at a tidewater glacier.

2nd Place: Romy Hanna. 3-D measurement of fine-grained rims in CM Murchison using XCT.

LATE-CAREER MASTER'S BEST POSTER AWARD

1st Place: Kelly Regimbal. Optimizing CMP stacking using the seislet transform.

2nd Place: Matt Ledvina. Investigating the pathways and P-T-X conditions of hydrothermal fluid flow responsible for Cu-Au mineralization in the Ertsberg East Skarn System, Papua, Indonesia.

EARLY-CAREER GRADUATE BEST POSTER AWARD

1st Place: Sarah George, Basin evolution in northern Peru: implications for the growth of topographic barriers linking the Central and Northern Andes.

2nd Place: Tomas Capaldi. U-Pb geochronology of modern river sands from wedge-top foreland depo-centers: when sinks becomes the source.

UNDERGRADUATE BEST POSTER AWARD

1st Place: Susannah Morey. The evolution of the surveyor fan and channel system, Gulf of Alaska, based on core-log-seismic integration at IODP site U1417.

2nd Place: Natalie Raia. Petrogenesis of cycladic serpentinites: understanding the tectonic history preserved in metamorphic rocks in Syros, Greece.

BEST REPRESENTED RESEARCH GROUP

1st Place: Whitney Behr's Research Group

2nd Place: Sergey Fomel's Research Group

SYMPOSIUM: JACKSON SCHOOL LIBRARY: JACKSON SCHOOL.

Walter Geology Library Reorganizes Collections

After a long dreary summer last year in a closed building, we are pleased to have new HVAC and power supplies. We dismantled the temporary air conditioning and dehumidifiers, and re-opened to the public in August 2015. We are all hoping that will be the end of that!

Nevertheless, we managed to get some special projects done last summer, including a rebuild of our website, and transferring the majority of our USGS materials to long-term storage, since those are now reliably online from the USGS publications warehouse. We also used this time to build our Facebook constituency, adding social media updates to our daily tasks, with great success. Follow the library at facebook.com/UTGeoLib.

The new University Libraries Vice-Provost Lorraine Haricombe initiated a management review and reorganization that will result in a number of changes to the organization, our collecting strategies and delivery of services. These changes are taking place this summer, and we will know more as the fall semester begins. We are streamlining and reducing our gifts processing, shifting more acquisitions to electronic materials and rethinking the use of space in campus libraries.

One project we are in the early exploration phase for is an effort to convert our periodicals reading area to a display space for the Barron Gem and Mineral Collection and a small seminar room. We would be able to put more materials out for more hours in a more secure environment than is now available, and the additional seating space will give us an opportunity to host small group meetings and instruction sessions.

To prepare for these various changes, the Walter Library is now completing the first phase of a de-duplication project, removing multiple copies of titles that are not circulating enough to warrant retention. The first phase (completed) was within the unit, and the next phase will be to examine multiple copies in libraries across campus to reduce the number of low circulation items. We will also be storing most of our legacy journal runs with stable online access, as the print copies are seeing less and less use. This will free up space, which we hope eventually to repurpose for other collaborative uses that will enhance student services.

WALTER GEOLOGY LIBRARY.

Looking ahead, the UT Libraries have been approved for a new library storage facility, LSF-3, at the J.J. Pickle Research Campus. We are already planning for LSF-4, as more and more of the physical collections are being moved to storage to create space for new materials and new opportunities for interaction, collaboration and online user space. Most journals are now in E-only formats, and we are increasingly acquiring E-books.

On other fronts, Mark Helper and his students compiled a GIS map of central Texas that can be found at lib.utexas.edu/geology/research-guide/maps/texas-gis-geologic-map-project.

Our Virtual Landscapes of Texas site and our thesis scanning project for Texas ScholarWorks (repositories.lib.utexas.edu) both continue to grow, though more slowly than we would like. We are proud to note that some of our ScholarWorks open access materials have been visited thousands of times! Last fall the UT Libraries, with some support from the Jackson School, sponsored a national map cataloging workshop with Paige Andrews of the Penn State Library. It was a big success, bringing more than 20 people from 11 institutions, and we hope to reprise the workshop in 2017.

Lastly, the newly published (and long awaited) UT Press book The Collections, edited by the Director of the UT Landmarks Public Art Program Andre Bober, features materials from our Tobin Map Collection and other collection materials.

In staff news, Stacy Ogilvie has completed her first year as the unit manager, and is working on several projects to improve our website. She also attended the Electronic Theses and Dissertations Association conference in Austin. Eleven student workers graduated over the course of this year after many semesters of service with us: Shelby Manford, Taylor Bruner, Rong Fu, Sandra Ogenche, Madeline Guy, Christine Nguyen, Catarina Silva, Olga Kotlova, Shakera Guidry, Hannah Johnson, and our GRA, Laura Mattys. We wish them well in their future endeavors. This year's winners of the Guion service award were Dean Wilcox and Nicolle Evans for all their assistance and support during the summer shutdown.

Head Geology Librarian Dennis Trombatore attended the GSA meeting in Baltimore, the American Institute of Archeology meeting in San Francisco, continued to serve as chair of the AGI GeoRef advisory committee, and joined with a classics department faculty member to do a demonstration on clay technology and clay tablets in the ancient world for Explore UT.

-Dennis Trombatore, Librarian

FIELD CAMPS

Geology field courses have been a part of geosciences education at UT for nearly a century. Students in the Jackson School's three summer field courses—GEO 660, Marine Geology and Geosciences, and Hydrology—continued the tradition.

TOP: COLTER BAY MARINA, JACKSON LAKE, GRAND TETON NATIONAL PARK. **MIDDLE:** (LEFT TO RIGHT) JACKSON ZERR, COLIN WHITE, R/V MANTA CREW MEMBER AND TAYLOR BORGFELDT. **BOTTOM:** HYDROLOGY STUDENTS AT THE VALLES CALDERA NATIONAL PRESERVE.

ALL FIELD CAMPS: JACKSON SCHOOL.

In 2016, the Marine Geology and Geosciences field course went to Freeport, Texas for the second time. The class examined the lower Brazos River and adjacent fluvial systems as well as the ancestral versions of these river systems where they carved into the Texas shelf during the Last Glacial Maximum 20,000 years ago when the continental shelf was above water. Like last year, the Brazos River went into flood stage due to rainfall caused by the major El Niño in May, providing opportunities for the students to study sedimentary processes in action using geophysical methods such as multibeam sonar, chirp sub-bottom profiling, high-resolution multichannel seismic, sidescan sonar, coring and sediment sampling.

"The Marine Geology and Geophysics Field Camp is one of the most valuable courses that the Jackson School of Geosciences offers. The course cultivates the hands-on experience of a scientific research cruise while providing the detailed instructor oversight of a superb graduate level course."

Bud Davis, graduate student

Marine Geology & Geosciences

TOP: LOGAN WEST WITH BAGGED SEDIMENT. **MIDDLE:** (LEFT TO RIGHT) COLIN WHITE, ZACH ZEHANI, PETER DOTRAY AND COLE SPEED IN THE LAB. **BOTTOM RIGHT:** 2016 MARINE GEOLOGY & GEOSCIENCES CLASS. **BOTTOM LEFT:** THE R/V MANTA RETURNING FROM A DAY OF SURVEYING.

Geo 660

TOP: THE GEO660 CLASS AT GRAND TETON NATIONAL PARK. **MIDDLE:** (LEFT TO RIGHT) DANIEL ORTEGA-ARROYO, JACQUELINE RAMBO, EMMA HEITMANN, MARK HELPER AND CHRISTIAN BLACK AT THE GHOST RANCH CAMPGROUND NEAR ABIQUIU, NEW MEXICO. **BOTTOM:** (BACK TO FRONT) APRIL TREVINO USING A JACOB'S STAFF. WITH CHLOE BELL, EMILY PEASE AND CAROLINE NAZWORTH.

In summer 2016, GEO 660 students explored geology from Texas to Montana. The class visited over 10 unique sites, including the Valles Caldera, Book Cliffs, Grand Teton National Park, Yellowstone National Park and a historical silver-zinc mining district in southwest Montana. Thirty-nine students enrolled in the first three-week session and 44 in the second. The class was directed by Distinguished Senior Lecturer Mark Helper, with assistance from instructors who spent a week or more with the students focusing on different aspects of geology. They were: David Mohrig, Christopher Zahm, Charles Kerans, Peter Flaig, Tip Meckel, Randall Marrett, Brian Horton, James Gardner and Whitney Behr.

"Through the beautiful scenery in our field areas and the company of 40 lifelong friends, 660 field course was the best six weeks of my life."

Zehao Xue, undergraduate

The 2016 hydrology camp brought students to Valles Caldera National Preserve in northern New Mexico and to Hornsby Bend in the Austin area to conduct field work, including drilling, pump tests, water quality monitoring and geophysical surveys. In addition to learning from Jackson School professors and researchers, students also benefited from professional assistance and mentoring offered by crews from Geoprojects International, a company owned by Jackson School alumnus Pat Goodson (B.A., 1984).

CLOCKWISE FROM TOP WITH NAMES LISTED FROM LEFT TO RIGHT: 1) ALIF MUSA, DYLAN HART, OLIVER NEWBERRY AND ELY NICHOLS. 2) GABE CABAÑAS AND DYLAN HART. 3) (BACKGROUND) GABE CABAÑAS, CHRISTIAN DOWDLE. (FRONT) OLIVER NEWBERRY, ALIF MUSA, ELY NICHOLS AND DYLAN HART. 4) EVAN CHANG-TUNG AND CHRISTIAN DOWDLE. 5) LUISA FLOREZ AND GABE CABAÑAS.

Hydrology

"My favorite part was doing water science while being up close and personal with nature. One day, in the middle of us taking total station measurements, we saw a mama elk protecting her baby from a four-coyote attack."

Christian Dowdle, undergraduate

CENTRAL CALIFORNIA: NASA;SAN ANDREAS FAULT: U.S. GEOLOGICAL SURVEY.

ROLAND BÜRGMANN

GEODESISTS REFINE PLATE TECTONIC TOOLS

By Barbra Rodriguez

Geodynamics experts have used GPS to detect horizontal movement of tectonic plates for decades. In an October 2015 talk at the Jackson School, Roland Bürgmann, director of the Active Tectonics Research Group at the University of California, Berkeley, revealed how an enhanced GPS network and related aerial observations have allowed vertical changes in crustal motion, including non-tectonic sources of deformation, to finally be investigated.

His talk, made possible by the Jackson School's Judd H. and Cynthia S. Oualline Centennial Lectureship in Geological Sciences, focused on a section of the San Andreas Fault running roughly parallel to and east of California's San Joaquin Valley. This heavily farmed valley is bounded by a mountainous coast range to the west and the Sierra Nevada mountains to the east. Thanks to the Plate Boundary Observatory project, Bürgmann noted, more than 1,000 GPS stations now exist in the actively deforming western coast of California. The sheer number of GPS stations capturing data as often as every second has allowed scientists to capture precise 3-D measurements of tectonic plate motion.

Bürgmann reviewed vertical deformation studies and what is known about the effect of removing large masses of water during uplift or subsidence of the Earth's crust near the San Andreas Fault. Bürgmann's group has collaborated with researchers from the University of Nevada, Reno, who were the first to indicate that vertical—not horizontal—deformation was occurring. In particular, the Reno researchers' study in 2012 suggested that the Sierra Nevada had undergone vertical uplift of 1 to 2 millimeters annually in recent years, with the mass loss of sediment from the Sierras due to erosion being among potential causes.

Another study that piqued Bürgmann's curiosity was about whether groundwater removal from the San Joaquin Valley for agricultural purposes could factor into this vertical uplift; that 2011 study led by University of California, Irvine, researchers used measurements from the GRACE (Gravity Recovery and Climate Experiment) satellite to indicate that the Central Valley had lost enough water between 2003 and 2007 to fill Lake Mead.

By combining GPS station data with that derived from InSAR (interferometric synthetic aperture radar), Bürgmann and colleagues studied water load impacts on vertical deformation throughout the Central Valley, Sierras and the coast range. InSAR can survey areas unreachable by GPS because it doesn't require installing land-based equipment. It instead maps deformation by using a satellite or aircraft radar system to detect reflected electromagnetic waves and the phase change of the return signal between flyovers.

The researchers detected general uplift of coastal and Sierra Nevada locations from measurements taken for three or more years, whereas Central Valley stations subsided as much as 3 centimeters annually.

THE SAN ANDREAS FAULT IN CARRIZO PLAIN, CALIFORNIA.

"That's as fast as the San Andreas Fault moves laterally," Bürgmann said, adding that seasonal patterns of deformation occurred.

For instance, although stations in the Central Valley generally subsided over time, some underwent uplift during the wet winter and early spring. The researchers reviewed data to decipher whether San Joaquin Valley water load changes were related to irrigation rather than shifting tectonic plates causing some areas to undergo crustal rebound and uplift. Hydrological processes turned out to underpin vertical deformation changes in general, he said.

"It's not the highest (Sierra) mountains that move up the fastest, but it's actually the low-lying areas next to the valley ... because they are closest to the unloading of the water."

He noted that for the Coast Range and Sierras overall, tectonic factors held sway.

Bürgmann also discussed early studies on large-scale water movements as a force behind earthquakes. Removing a water load equivalent to the mass of Lake Mead (with an overburden of about 1 kilopascal of pressure) likely does not register long term on larger faults, he said, because geologic forces produce much higher stress overall (up to hundreds of megapascals in pressure) and annual fault-loading rate (up to 50 kilopascals).

To see if water load changes or other factors influence smaller earthquakes, Bürgmann and colleagues considered a well-studied area around Parkfield, California. They reviewed 30 years of data on three different types of fault stresses (normal, shear and Coulomb) and other factors for 4,000-plus earthquakes of 2.5 magnitude or above. Based on data, seasonal changes in seismicity were identified that complicated underpinnings, with water load a likely factor in some cases, along with factors such as fault orientation.

"You really have to consider the individual orientation of faults to ultimately make out how they are being affected by these very small stress changes," he noted of this work in progress.

Given the many smaller earthquakes and their annual fault-loading rates, Bürgmann said that seasonal water load changes near some faults could "be enough to break the camel's back."

LEFT: CENTRAL CALIFORNIA AS VIEWED FROM SPACE.

PERMIAN DIORAMA: UNIVERSITY OF MICHIGAN MUSEUM OF NATURAL HISTORY. VOLCANO: U.S. GEOLOGICAL SURVEY.

RACHEL WOOD

GEOCHEMICAL CLUES UNEARTHED TO PALEOZOIC EXTINCTION

By Barbra Rodriguez

Death from greenhouse gases, a wallop from a meteorite or a big freeze? Rachel Wood, a carbonate geoscientist from the University of Edinburgh, is among the experts who now believe the largest extinction to hit Earth was an inside job, triggered by volcanic release of gases from within the Earth rather than glaciation or other causes. In April 2016, as part of the DeFord lecture series at the Jackson School, she outlined her understanding of the chemical players in this tragedy known as the "Great Dying" that occurred some 252 million years ago at the end of the Permian period.

"Somewhere between 90 and 95 percent of all species went extinct," Wood said. "It was really extremely catastrophic."

She described how the Siberian Traps, a hilly region that covers upwards of 123 million acres, have become recognized as the culprit of the extinction. In particular, the timing of ancient volcanic eruptions from this region correlates with two waves of die-offs that ended the Paleozoic era. Emphasizing the impact on marine life, Wood reviewed some of the major atmospheric and oceanic changes that likely resulted from volcanic eruptions.

"You really have to look at the whole, holistic Earth system to understand the response when you're dealing with a mass extinction," Wood said.

A key tool has been studying carbon and other chemicals as their different forms cycle between land, air and water. The Siberian volcanoes would have unlocked carbon from the Earth's mantle as dissolved carbon dioxide (CO_2) in molten magma that spewed from volcanic vents. Wood summarized how the ratio of different carbon isotopes found in Permian fossils and rocks revealed that the first extinction phase likely stemmed from atmospheric injection of organic carbon from magmatic CO_2. This greenhouse gas would have blanketed and warmed the atmosphere. In addition, the CO_2 probably spread to oceans, poisoning certain marine organisms during the first extinction phase. One theory suggests that brachiopods, sponges, crinoids and other creatures had slower metabolisms than other marine life and couldn't protect themselves against concentrated CO_2 in the water.

Additionally, the greenhouse gas-induced global warming likely altered ocean circulation patterns and reduced oceans' dissolved oxygen, potentially suffocating some marine species.

"There's no doubt that anoxia is a key player globally," Wood said of the early phase of the extinction.

Elevated atmospheric CO_2 likely also triggered a more widespread, second extinction phase, 60,000 or so years after the end of the first phase. Wood described how oceans initially could have maintained their acidity level because aqueous CO_2 (and the bicarbonate produced when it dissolves) can serve as an alkalinizing buffer. However, at some point in the million years or so that the Siberian Traps were volcanically active, the oceans' buffering capacity probably became overwhelmed by the hydrogen ions released during the break down of CO_2. Increased acidity could have directly or indirectly caused marine life such as bivalves and gastropods that had survived the earlier extinction to lose the ability to make shells and reproduce.

LAVA ERUPTS FROM FISSURES NEAR PU'U 'O'O, A VOLCANO IN HAWAII. ANCIENT ERUPTIONS IN THE SIBERIAN TRAPS LIKELY CONTRIBUTED TO THE PERMIAN EXTINCTION.

With that background, Wood covered her research into the geochemical details of this extinction. She has used borate isotope analyses of ancient brachiopod fossils samples that were collected from the Arabian Peninsula as a proxy for pH changes. That approach uncovered the surprising possibility that Permian oceans became alkalinized well before the first extinction phase. Quantitative models also suggest that the rate of atmospheric CO_2 release was relatively slow during much of the formation of the Siberian Traps.

The Arabian borate samples also support the theory that the marine pH plummeted 60,000 years after the first extinction phase. A rapid Siberian release of CO_2 has been suggested as causing that acidification—which lasted about 10,000 years—and the extinction of most remaining marine species.

"It's a really dramatic acidification event," Wood said.

Using the boron isotope excursion pattern to extrapolate backward, she and her colleagues suggest that atmospheric CO_2 levels had to rapidly climb three times above background to produce the pH drop and the second extinction phase in the Paleozoic.

She noted that understanding the impacts of the slow CO_2 release that started closing the curtain on this era, and the subsequent ocean acidification, could inform discussions about how modern increases in CO_2 may impact the environment.

"I leave it to you to decide how good an analog this is," Wood said. "Is this just an extraordinary event and more doom saying? Nonetheless, I think there are lessons here."

LEFT: A DIORAMA AT THE UNIVERSITY OF MICHIGAN'S MUSEUM OF NATURAL HISTORY SHOWS LIFE THAT THRIVED IN PERMIAN SEAS BEFORE THE EXTINCTION.

Tectonics Legend Leads Newfoundland Trip

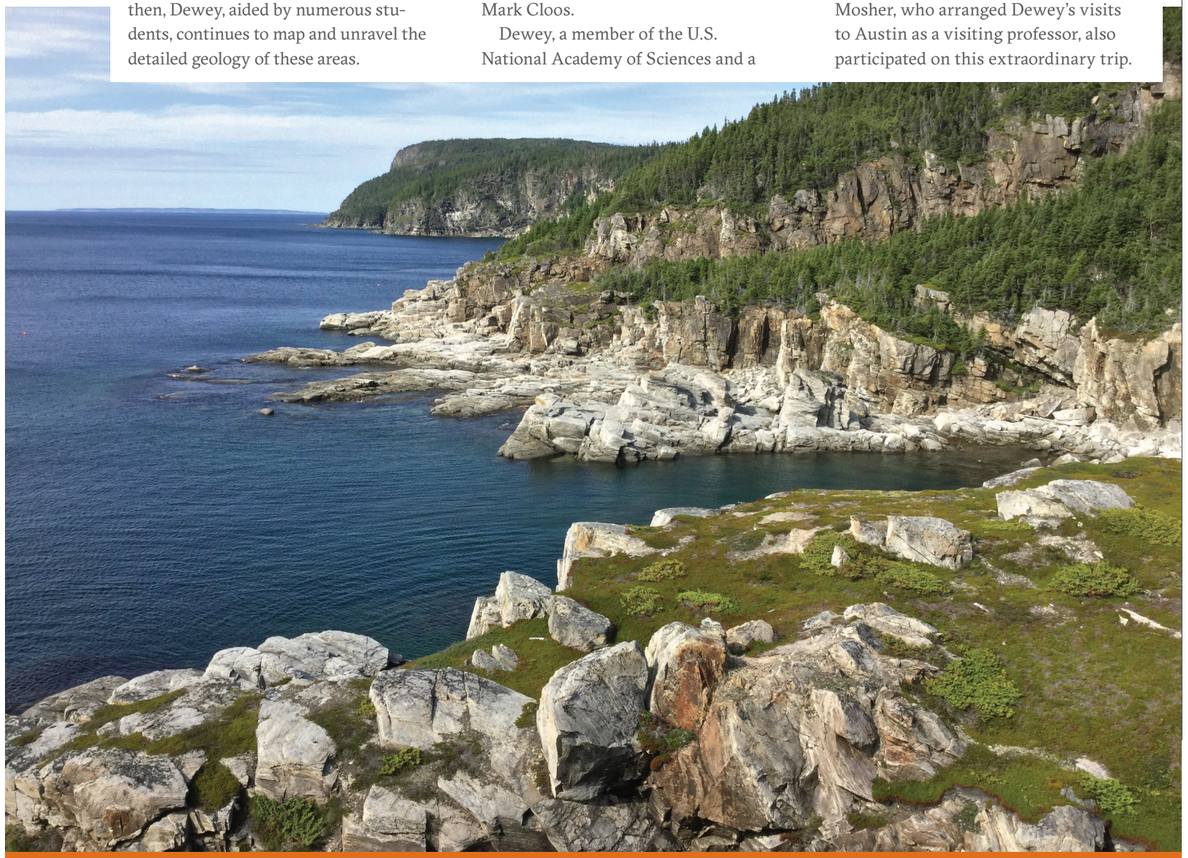
In July 2016, graduate students in the Tectonic Problems course travelled to western Newfoundland to study geology under the guidance of John Dewey, a Jackson School visiting professor emeritus from Oxford University. Dewey's field studies in Newfoundland and Ireland in the 1960s led to papers that laid the foundation to how plate tectonic movements explain the geology of mountain belts.

In 1970, Dewey and colleague John Bird changed the field of geology forever with a seminal paper titled "Mountain belts and the new global tectonics." Unraveling the geology of Newfoundland and the comparison to western Ireland played a pivotal role in their revelations about how our planet behaves. Since then, Dewey, aided by numerous students, continues to map and unravel the detailed geology of these areas.

The spring Tectonic Problems class, with the theme of "Ordovician Arc-Continent Collision and Ophiolite Obduction," spent the spring semester studying the geology and tectonic history of Newfoundland by reading papers by Dewey, his students and many others. The capstone of the class was the summer field trip, which was co-led by one of Dewey's former students, University of Houston Professor John Casey. The nine-day trip included visits to about 80 outcrops across the Taconic autochthon, Humber Arm allochthon and Notre Dame Bay subzone.

"It's not often that you get to visit the outcrops with the people whose study of them led to papers that changed the books," said Jackson School Professor Mark Cloos.

Dewey, a member of the U.S. National Academy of Sciences and a fellow of the Royal Society, has led three field trips for the Department of Geological Sciences. Two years ago he led a graduate student trip to western Ireland to see the area in which he did his own dissertation studies that led him to visit correlative terranes in Newfoundland. Last year, he took the undergraduate honors students to see the geology of northern England and Scotland, including Siccar Point and the Moine Thrust. On the Newfoundland trip, in addition to the students, Cloos and co-instructor Assistant Professor Whitney Behr, was Jackson School Associate Dean for Academic Affairs Rich Ketcham, UTIG Research Scientist Nick Hayman and Distinguished Senior Lecturer Mark Helper. Dean Sharon Mosher, who arranged Dewey's visits to Austin as a visiting professor, also participated on this extraordinary trip.



NEWFOUNDLAND: JACKSON SCHOOL.

LEFT: THE GROUP TOURING THE MING COPPER AND GOLD MINE. RIGHT: DEAN SHARON MOSHER AND ASSISTANT PROFESSOR WHITNEY BEHR. BOTTOM: JOHN DEWEY (RIGHT) AND JOHN CASEY DISCUSS A SAMPLE.

FOLLOWING ARE SOME REFLECTIONS FROM GRADUATE STUDENTS WHO WENT ON THE FIELD TRIP AND SAW FIRST-HAND THE GEOLOGY THAT WAS CREATED BY PLATE TECTONIC MOVEMENTS UNRAVELED BY DEWEY AND HIS COLLABORATORS:

"Given the complexity of 'the rock's' structures and lithologies, I find it remarkable that the theory of plate tectonics was formed (at least in part) by the work of Dewey and Casey on Newfoundland. That being said, we saw the remnants of the three major types of plate boundaries—from rifted margin sequences, to relict subduction complexes and major strike slip offsets. It seemed like a complex mess to tear apart compared to younger places in the world that have experienced less orogenic cycles and makes the accomplishments of these geologists even more impressive."

-Emily Cooperdock

"It was interesting to compare the geology of Western Ireland (the focus of the 2014 Tectonic Problems field trip) to what we saw in Newfoundland. The Clew Bay Line in Ireland separates Grenville basement, including the deformed Neoproterozoic Dalradian Supergroup, from the South Mayo Trough and the Clew Bay Complex, which represent the forearc basin and the accretionary complex formed during the Grampian orogeny. It is remarkable that with relatively little outcrop in Ireland, and minimal geochronologic data, Professor Dewey was able to correlate the units and realize that Ireland and Newfoundland were both part of the leading edge of Laurentia."

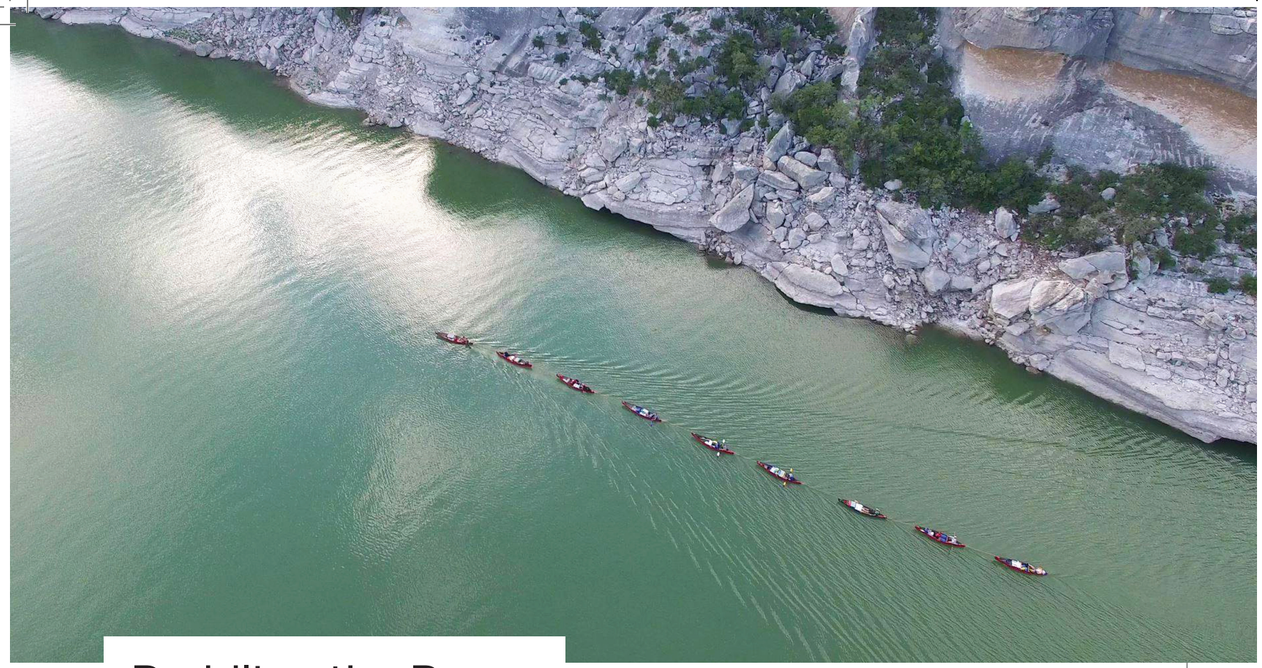
-Stephanie Wafforn

"Since developing an interest in structure and tectonics, I've dreamt of visiting a location as geologically complex, diverse and intriguing as Newfoundland. Having the opportunity to go to world-class outcrops with the two geologists, John Dewey and Jack Casey, that know the area and its history better than anyone in the world made the experience very beneficial to building my skills as an observational geologist. What was most striking in the first few days of this trip was how incredibly tight the tectonic story these two have developed for this region is, especially for Humber Arm Allochton, where units with similar lithologies seem to overlap to the untrained eye. It was something that didn't truly hit me until being out in the field, despite digesting the literature all throughout the spring."

-Travis Clow

"The stops compiled by Dewey and Casey provided a comprehensive overview of the field evidence used to reconstruct the regional accretion and ophiolite obduction history, and our boat tour of the ophiolite sequence, in addition to providing our only opportunity to view the metamorphic sole first-hand, excellently placed our roadside stops in context and provided an astounding sense of scale."

-Chelsea Lofland



Paddling the Pecos

The Carbonate and Evaporite Petrology class (GEO383M) typically visits localities like the Guadalupe Mountains and Paradox Basin—also called Death Valley—for its fall excursion. But in 2015, as in 2010, the class made the epic journey down the lower canyons of the Pecos more or less the only way it can be done: in canoes.

This trip included 14 graduate students, including three carbonate graduate students with previous experience on the river. Chris Zahm, a research associate from the Bureau of Economic Geology with extensive experience in the structural evolution of the area, was another trip participant. Professor Charles Kerans, the instructor and trip leader, began running trips with two other Texas alumni, Laura Zahm and Bill Fitchen, in 1995. Much has changed since 1995 in terms of our understanding of the region, but its wild river setting is still the most compelling and unforgettable component.

The main geologic message of the trip is the detailed view of a carbonate ramp to intrashelf basin profile at true scale, as witnessed day-in and day-out for six days. The distinct signature of eustatic and biotic drivers that produce the spectacular suite of rudist and associated skeletal reefs and carbonate sand complexes is certainly among the best examples in the world of such a system, and is known to be a major petroleum system throughout the Lower Cretaceous of Texas and the Aptian and Cenomanian of the Middle East. Short stops along the river are mixed with half-day projects at key localities to ensure that participants gain lasting geologic knowledge to go along with their bruises, blisters and visions of spectacular scenery.

The trip doubles as a crash-course in canoeing as well as Cretaceous geology, and after a 25-mile first day of paddling, most of the navigational issues were resolved (most). Days 2-5 involved a mixture of paddling and stops at some of the more spectacular side canyons. Along the way, brief stops to examine world-renowned rock-art sites mix with the scenery and geology to shape a truly unforgettable experience.

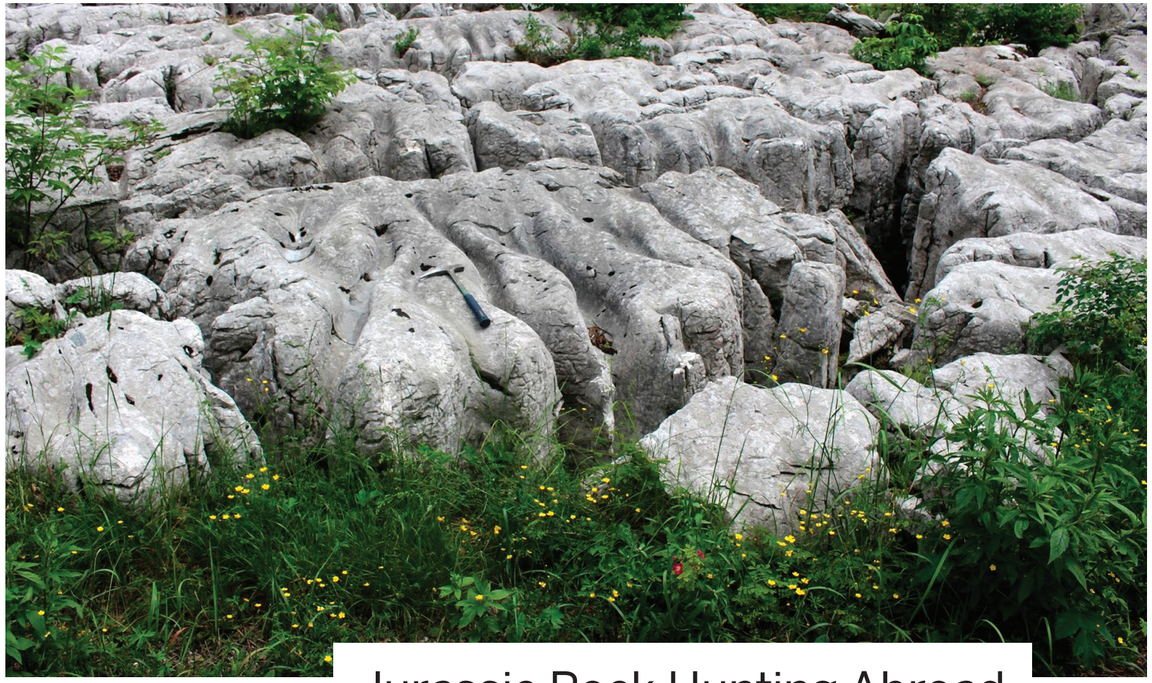
A real reckoning of a sort wraps the trip with a 10-mile paddle and tow out of the slack-water stretch of Lake Amistad finishing at the Pecos. But this type of effort is expected of Jackson School graduate students both during studies and in their lifestyles, so the Pecos experience becomes just another unforgettable piece of the educational experience.

By Charles Kerans, chair of the Department of Geological Sciences, Jackson School of Geosciences

TOP: OPEN-WATER PADDLE ON LAKE AMISTAD. MIDDLE: FRACTURE PATTERNS IN THE DEVILS RIVER CARBONATES. BOTTOM: GOING OVER THE DAY'S DATA COLLECTED AT HARKELL CANYON.

PADDLING THE PECOS: CHARLES KERANS. JURASSIC ROCK HUNTING: ROWAN MARTINDALE.

LEFT: A VIEW OF MOROCCO'S DADES VALLEY.
RIGHT: FOSSILIZED CORALS ON AN OUTCROP IN MOROCCO.



MIDDLE: KARST ROCK IN SLOVENIA.
BOTTOM: GRADUATE STUDENT NICK ETTINGER TAKING SAMPLES WITH A SLEDGEHAMMER.

Jurassic Rock Hunting Abroad

Rowan Martindale, an assistant professor in the Department of Geological Sciences, and graduate student Nick Ettinger traveled to Morocco and Slovenia to look for Early Jurassic rocks from the Toarcian Oceanic Anoxic Event, a period 183 million years ago when oxygen levels in the world's oceans were very low.

In Morocco, Martindale and collaborators hiked the High Atlas Mountains, which has one of the thickest records of shallow water carbonates from the Early Jurassic and some of the best reefs, looking at the sedimentological and biotic response to this event. In Slovenia, she and Ettinger collected samples for his master's thesis.

Slovenia is one of the few shallow water carbonate platforms that has a good record of the Toarcian Oceanic Anoxic Event. Ettinger is hoping to identify the Anoxic Event in Slovenia and combine sedimentology, paleontology and geochemistry to understand the environmental changes that occurred during it.

Carbonate Geology of the Bahamas

The challenging syllabus for the Jackson School's new GEO 193 Carbonate Geology of San Salvador, Bahamas, featured a unique prerequisite: open water scuba certification.

The goal of the class was to provide a holistic view of island evolution, including study of the Pleistocene "bedrock" of the island, the shallow marine environments of the surrounding shelf, shelf-edge reefs and the upper reaches of the slope apron, where enormous blocks that spalled off the reef front could be observed directly.

Professor Charles Kerans of the Department of Geological Sciences, Chris Zahm, a research associate at the Bureau of Economic Geology and Ph.D. student Andrea Nolting observed the reef wall and upper slope profiles along the margins of the Caicos Platform during their dives in 2015 and realized the importance of the steep reef wall profile and collapsed margins along the western and southern margins of the Caicos platform for understanding island evolution. They were not prepared, however, for the frequency and scale of collapse features observed by the class along the San Salvador margin during the 11 dives on the western wall that were part of class field work. An imperfect analogy to the observed spalling of reef blocks from the vertical shelf margin is the calving of icebergs observed on the front of active glacial ice shelves, except the carbonate blocks sink and form a steep talus slope.

To build on the understanding of Pleistocene evolution of San Salvador, the class dissected the well-studied Pleistocene stratigraphy of the 125,000-year-old Cockburn Town reef system using high-resolution UAV imagery and high-resolution sequence stratigraphic analysis. The group hopes to develop and soon submit an abstract to an upcoming meeting with all students and faculty involved.

There are amazing outcrops around the coast of the island, as well as dramatic evidence of the erosive power of recent Hurricane Joaquin that hit the island in October 2015. Uniform agreement between students and faculty was that the combination of land, shallow water and deep diving observations provided an unforgettable image of an evolving carbonate platform.

By Charles Kerans, chair of the Department of Geological Sciences, Jackson School of Geosciences

TOP: STUDYING CARBONATE GEOLOGY OFFSHORE OF SAN SALVADOR ISLAND. RIGHT: GEO 193 STUDYING EARLY HOLOCENE DUNES.

CARBONATE GEOLOGY OF THE BAHAMAS: CHARLES KERANS.

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TexNet

SITE EVALUATION AND MAP: BUREAU OF ECONOMIC GEOLOGY.

Getting to the bottom of what's causing quakes in Texas

BY ANTON CAPUTO

Alexandros Savvaidis had never been to Texas before starting his new position at the Bureau of Economic Geology. Since arriving in January 2016 though, the native Greek has become very familiar with the large expanse of land within the state's borders.

Savvaidis is leading the deployment of the TexNet seismic network, a job that has him and his colleagues crisscrossing the state, visiting and testing potential sites for the most comprehensive state-run network in the country.

TexNet, which will begin operating at the end of 2016, is the backbone of the state's far-reaching approach to gathering information about subsurface seismic activity throughout Texas and answering a difficult question plaguing many oil-producing areas across the country—how are some fluid disposal wells used by the industry causing low-level earthquakes?

Savvaidis, who is TexNet project manager, has made a career of operating similar seismic systems in Greece and other parts of Europe. He said that the opportunity to build a system nearly from scratch was too good to pass up. Laying the groundwork has been challenging given the size of the state, but he's confident the work will pay off soon.

"This has been a big issue for us. The state is big. The ranches are big," he said. "What is important from our side is that we work proactively in the state in order to provide the necessary information to protect the public and the industrial infrastructure."

At issue is how a small subset of wells commonly used to dispose of wastewater from hydraulic fracturing and water co-produced with oil and gas could be triggering faults. Mounting yet circumstantial evidence points to a link between disposing of fluids by injecting them deep into the ground and earthquakes, but comprehensive data is not available. The lack of data, coupled with the complexity of the science, makes definitive answers impossible at the current time.

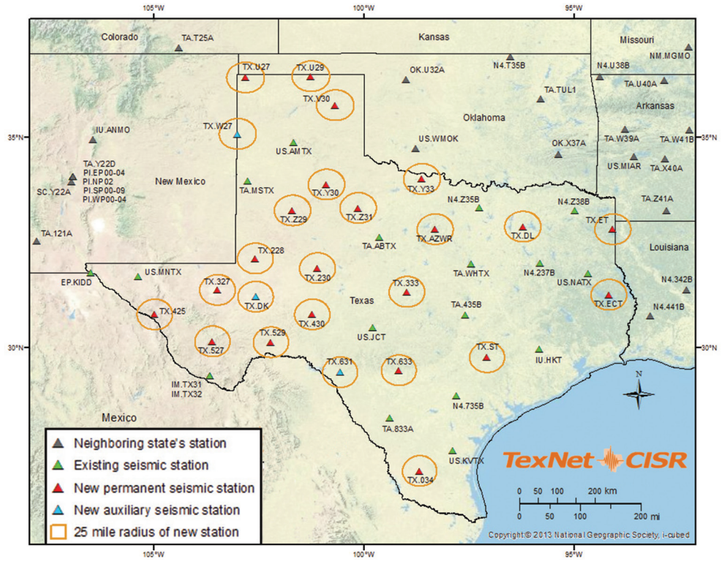
"Trying to understand what actually caused a fault to move is not simple science," said Scott Tinker, director of the Bureau of Economic Geology, who led the formation of TexNet with the state. "It involves the time of the event and the position both on a map and at depth. It also involves how the fault system is oriented in today's stress fields as well as local and regional tectonics. And it involves changes in the earth system from the disposed fluids."

The goal of TexNet is to cut through the speculation by collecting the sorely needed data straight from the source.

LONESTAR LEADERSHIP

Texas Gov. Greg Abbott and the legislature in June 2015 authorized $4.47 million for TexNet and related research—both initiatives led by the bureau, which also serves as the State Geologic Survey of Texas.

Since then, researchers have quietly gone about the business of building the system from the ground up—or down, with Savvaidis and others traveling the state to identify and survey potential sites and negotiate leases for the locations of the seismic sensing stations with landowners. A good spot for a seismometer is quiet and solid, Savvaidis said. Background noise and loose rock or soil can interfere with the sensors.

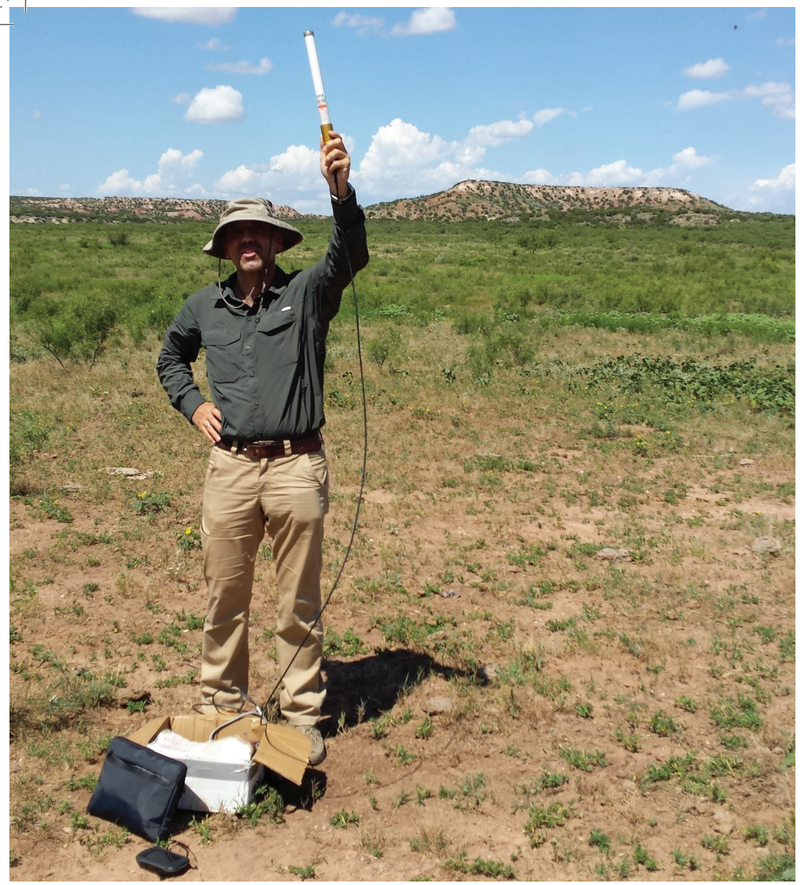


"We try to avoid unconsolidated formations," Savvaidis explained. "We try to find more stiff formations like the Cretaceous limestones we have in abundance here in the state of Texas. We can do this anywhere, but we would prefer to have stiff soil and rocks because usually the noise level is really low."

TexNet is being built around an ad-hoc system of seismometers already in place—17 seismic stations throughout the state run by the U.S. Geological Survey and Southern Methodist University. TexNet will add 22 more permanent stations and another 36 portable seismometers, each with sensitive accelerometers, in key areas around the state to test various scientific hypotheses.

Once in place, the stations will continuously monitor the sites for seismic activity, with data eventually being streamed live to the system's website where anyone can view it.

LEFT: THE BUREAU'S PETER HENNINGS (LEFT) AND BISSETT YOUNG DURING A SITE EVALUATION. **ABOVE:** A MAP OF PROPOSED TEXNET STATIONS.



THE BUREAU'S ALEXANDROS SAVVAIDIS DURING A SITE VISIT TO DETERMINE SUITABILITY FOR A SEISMIC MONITORING STATION.

"This is a vital topic that spans a huge base of stakeholders including the public, cities and municipalities, the petroleum industry and their need and desire for sustainable business practices, the state of Texas and the regulators, and then, of course, a broad base of academic specialties," said Peter Hennings, a research scientist at the bureau and a principal investigator in the bureau's Center for Integrated Seismicity Research.

Monitoring is only part of the equation. The state funding and directive that formed TexNet motivated the creation of the Center for Integrated Seismicity Research (CISR), a multidisciplinary research group that will work in parallel with TexNet to conduct fundamental research to better understand natural and induced earthquakes in Texas.

The role of TexNet is not to make policy decisions, explained Robie Vaughn, chair of the Technical Advisory Committee appointed by the governor to help guide the project, but to provide technical and scientific information to assist policy and decision makers.

"Our job is to focus on the science and provide the governor and the legislature with the data and the hard facts," Vaughn said. "I really believe Texas is leading by investing in a disciplined process to best understand the issue."

RESEARCH RENAISSANCE

Over the past several years, researchers in Texas and throughout the country have become increasingly interested in the question of whether oil and gas activity can cause earthquakes. That's because, according to the U.S. Geological Survey, the annual occurrence of earthquakes of magnitude 3 or larger has increased significantly within the central and eastern United States since about 2009. These earthquakes are typically large enough to be felt, but usually small enough not to cause damage, although in Oklahoma the quakes have generally been stronger than those in other parts of the country.

In Texas, it was a series of quakes in the Dallas-Fort Worth area beginning in 2008 that started scientists to begin to investigate the link, said Cliff Frohlich, a seismologist with the University of Texas Institute for Geophysics. Frohlich, who is part of TexNet and CISR, said that in the early years induced seismicity was a niche interest, with only a small group of scientists looking into the issue. But now seismicity research in Texas is in a "renaissance" of sorts when it comes to investigating earthquakes' potential link to human activity, he said.

"For most of my career, induced earthquakes were a minor sideline—a minor unfunded sideline," he said. "Now you go to a meeting and there will be four different sessions, and I'm one of 50 or 60 people speaking. When you have 50 people working on something, progress is being made."

The early research, Frohlich said, was complicated by a hodgepodge system of seismometers, a lack of data, and even undefined roles and responsibilities.

ALEXANDROS SAVVAIDIS: BUREAU OF ECONOMIC GEOLOGY.

"I used to say I was the world's leading authority on Texas earthquakes, but it's not a paid job." Frohlich quipped. "But with TexNet, a lot of these problems should improve."

INTERDISCIPLINARY APPROACH

The new data from TexNet is just part of the data that CISR is collecting. Another important resource comes from industry partners (currently 10 and counting). Data that companies have collected over the years is crucial to the effort, Hennings said, because often it is the best, and sometimes only, information available on subsurface Texas in a given location.

The industry-research collaboration also extends to CISR's principal investigators, who include oil and gas professionals, as well as researchers at universities across Texas.

Hennings joined the CISR research team after spending 25 years in the oil and gas industry where he was a research scientist and technical manager. He said he's never seen an effort as thorough as TexNet and CISR.

"In terms of subsurface geoscience application, I really don't know of another project that has this type of interdisciplinary breadth," Hennings said.

In addition to Hennings and Savvaidis, Ellen Rathje, a professor of civil engineering at The University of Texas Cockrell School of Engineering, is serving as co-principal investigator of CISR. At The University of Texas at Austin, the research collaboration spans the Bureau of Economic Geology, the Institute for Geophysics, the Department of Petroleum and Geosystems Engineering, the Department of Psychology and the Moody College of Communication.

TexNet also includes Southern Methodist University's North Texas Seismicity Study Group—which Hennings and Frohlich described as a pioneer and leader in the field—and the Texas A&M Department of Petroleum Engineering. CISR also includes the Stanford Center for Induced and Triggered Seismicity.

The research the consortium will undertake is designed to understand the subsurface processes that may influence seismicity. The work will include the study of earthquake sequences, triggering analysis, fault characteristics, fault sensitivity, fluid data and more. There will also be research on infrastructure vulnerabilities throughout the state and strategies for best communicating the issues to the public.

The first project, which is already underway, is "an integrated assessment of the seismicity potential of the Fort Worth Basin and how it might relate to oil and gas operations," according to CISR's website. Future focus areas include the greater Permian Basin, especially the Delaware Basin where unconventional oil development is expected to accelerate in the coming years. The Eagle Ford play area, the East Texas Basin and Haynesville play area and the Texas Panhandle are also areas that will be focused on in the future.

Ultimately, it may take years for TexNet to meet its goal of providing the kind of science that will help decision makers determine the best approaches for avoiding or responding to seismicity in Texas. The current schedule calls for the Fort Worth Basin assessment to be complete by the end of 2018 and the Permian Basis assessment by the end of 2020, with the Eagle Ford and Panhandle assessments to follow.

Tinker said that part of the challenge is keeping a realistic perspective of the problem while the work is being done; it's quite likely that some disposal wells have and are causing seismicity, he said, but there are nearly 8,000 such wells in Texas, and the vast majority have been used for years, if not decades, without issue.

"This is right at the heart of what I call the radical middle; where industry, government, academia and the public converge," Tinker said. "Texas wants to have oil and gas produced in its state and fluids disposed safely. It's good for commerce. It's good for the economy. And a healthy economy is good for environmental investment. Part of the challenge is making sure that all the things that are done right—the vast majority—aren't shut down in the process."

THE DRIVING GOALS AND THEMES OF CISR AND TEXNET ARE TO:

PRODUCE ACCURATE AND DETAILED SEISMICITY/GROUND-SHAKING DATA;

GAIN A MECHANISTIC UNDERSTANDING OF HOW FLUID PRESSURE TRIGGERS FAULTING AND SEISMICITY;

IMPROVE METHODS FOR MANAGING RISK OF SUBSURFACE FLUID INJECTION AND DISPOSAL;

PERFORM ASSESSMENTS OF THE SEISMOGENIC POTENTIAL OF SEDIMENTARY BASINS IN TEXAS;

IMPROVE ASSESSMENTS OF SEISMIC HAZARD TO INFRASTRUCTURE IN TEXAS; AND,

IMPROVE VEHICLES FOR COMMUNICATION OF DATA, KNOWLEDGE AND RISK TO ALL STAKEHOLDERS IN TEXAS.

Drilling into Dino Doomsday

BY MONICA KORTSHA

About 15 miles offshore of Progreso, a beach town near the Yucatán Peninsula's capitol city Mérida, a black and yellow boat called Myrtle stands still in the Gulf of Mexico, dark blue waves rolling beneath it.

While other boats float, Myrtle really does stand, supported by three stout legs that rest on the seafloor and act like giant kickstands to lift the vessel 40 feet above the water.

Usually the Myrtle is a delivery vessel for oil platforms, with the legs raising the boat right to the deck of the platform for easy cargo transfer. But for the past month, the Myrtle's legs have been used to suspend the boat above ground zero of one of the most violent events in Earth's history: the asteroid impact that caused the extinction of the dinosaurs 66 million years ago.

The impact site, called Chicxulub (chic-SOO-loob) after a nearby town, is invisible from the surface; millions-of-years-worth of rock and sediment fill the crater basin. Preserved in these rocks is a record of the impact and the worldwide extinction event that followed, as well as life's recovery. The rocks also hold physical evidence for how large impacts happen—how, in about five minute's time, a six-mile-wide asteroid can deform the Earth into a crater 124-miles wide and almost 1-mile deep.

LIFTBOAT MYRTLE; JACKSON SCHOOL.

THE LIFTBOAT MYRTLE RAISED ABOVE THE GULF'S WATERS ON THREE LEGS.

The Jackson School's Sean Gulick, a research professor at the University of Texas Institute for Geophysics (UTIG), is on a mission to retrieve the record from the apocalyptic impact. He and a team of scientists from around the world are doing it by drilling deep into the impact from the deck of the Myrtle and bringing up evidence one core sample at a time.

On May 10, 2016, they're currently at 823 meters—more than halfway to their 1,500 meter goal.

"It's rare that you can design a project where you're going to have a win, a real slam dunk by simply seeing what rocks are made of," Gulick said. "And this one is that way because it took so many years to build, so many (impact) models, so many ideas, that we've gotten to the point now where we have a truly testable set of ideas that can be answered with a single drill site."

Gulick is co-leading the mission with Joanna Morgan, a professor of geophysics at Imperial College London. The two first met in 2005 when conducting a marine seismic survey of the crater area, a project that helped lay the groundwork for the current drilling research. More than a decade after the survey, the International Ocean Discovery Program, a multicountry consortium for scientific drilling, approved Gulick and Morgan to lead IODP Expedition 364—a $10 million mission to recover rock from the impact site.

"The IODP is big science; it's our version of the Hubble Telescope or the Large Hadron collider. It's how we get samples that we could never ever get otherwise," said Chris Lowery, a micropaleontologist and postdoctoral researcher at UTIG who was aboard the Myrtle earlier in the mission. "It's so important for the community and science as a whole to have this program."

On board the Myrtle, life and science is made possible by a team of eight scientists from across geosciences disciplines, drill operators and ship crew. A series of handmade wooden crossroads signs, zip-tied to a thin metal support beam on the boat, show how far everyone has come. According to one sign shaped like an electric guitar and decorated with a doodle of the UT Tower, Austin, Texas, is 820 miles away.

That plank represents home for Gulick, as well as other Jackson School researchers that were on the Myrtle earlier in the mission. Gail Christeson, a geophysicist and UTIG senior research scientist; Steffen Saustrup, a UTIG geophysicist and research scientist associate; and Lowery all left at the start of May to make room for other scientists to come aboard.

But it's not just scientists who want to see the core. The governor of the Yucatán State, Rolando Zapata Bello, sent an envoy to the Myrtle to meet the researchers. And the mobile phone mogul, Carlos Slim Helú, the "Warren Buffet of Mexico," paid a visit to the boat with his grandchildren.

Since the expedition started in April, The media coverage has been a constant, too. Journalists are frequent guests on the Myrtle, with a record of 29 reporters coming aboard in a single day. Dozens of publications, including *Nature*, the *BBC*, and *The Washington Post*, have run articles on the mission, and for the first two-weeks of coring a documentary crew kept their cameras rolling.

"By a long way, this is the most newsworthy item we've ever done," said Dave Smith, an operations manager for IODP ESO who helps arrange scientific drilling missions around the world. "We're receiving more attention than any other project I've worked on."

From scientists to school kids, everyone is interested in the same question: After the asteroid hit 66 million years ago, what happened next?

TOP: REPORTERS INTERVIEW A RESEARCHER AROUND CHICXULUB CORE SAMPLES. BOTTOM: SEAN GULICK, A UTIG RESEARCH PROFESSOR, IS CO-CHIEF OF THE CORING MISSION.

REPORTERS: ECORD SCIENCE OPERATOR. DINOSAURS: SCIENCE PHOTO LIBRARY. GULICK: ANNA DONLAN FOR ALCALDE MAGAZINE.

AFTERMATH AND DISCOVERY

The Chicxulub asteroid hit what is now the Gulf of Mexico with a force of 100 million atomic bombs. What followed was a cascade of disasters that the scientists call "kill mechanisms"—a term that describes the different ways life was wiped out across the globe.

"It's expected that most of the kill mechanisms happened and most of them were important," Gulick said. "But the relative importance of these things needs to be figured out."

Still, researchers say the combined effect added up to nothing less than environmental apocalypse.

The Chicxulub impact instantly blew the asteroid apart, spewing a mixture of pulverized Earth rock and asteroid into the atmosphere, with some making it to outer space. The shockwave of the impact triggered earthquakes across the planet and birthed monstrous tsunamis that swept as far inland as where Illinois is today.

Anything within 1,000 square miles of the impact was killed almost instantly, obliterated by the ruptured Earth, burned away by the heat of the impact or swept away in the tsunami's waves. Worldwide, the ejecta that was blasted high into the atmosphere fell back to Earth as friction-heated fireballs that ignited wildfires and cooked wildlife alive by heating up parts of the atmosphere for minutes.

But most of the dying came days to months later. Dust kicked up from the impact likely lingered in the atmosphere for months, blocking sunlight and causing massive die-offs of plants and phytoplankton, the base of the food chain. The sulfurous carbonate composition of the Yucatán's rock likely exacerbated the killing by releasing a glut of sulfur and CO_2 into the atmosphere. The sulfur made acid rain, and the CO_2, when reabsorbed into the ocean, made carbonic acid. Both acidified the ocean, likely dissolving shells of marine organisms before they could fully develop.

THE CHICXULUB IMPACT KILLED OVER 75 PERCENT OF LIFE ON EARTH, INCLUDING ALL NON-AVIAN DINOSAURS.

When the killing was finally done, 75 percent of life on Earth was extinct, no animal weighing more than 55 pounds remained and the reign of the dinosaurs was over.

"It's the death of an era," Gulick said. "Dinosaurs and marine reptiles ruled the Earth as the top set of species for nearly 200 million years, they were absolutely kings of the ecosystems, and a lot of things evolved alongside them and with them to take advantage of that type of ecosystem—that all ends."

But the ashes of the old order provided fertile ground for mammals to begin their ascent as the new dominant lifeform on planet Earth.

"We end up with an entirely different system and in that system mammals evolved to be very important and ultimately led to humans," Gulick said. "And it wouldn't have happened without this cataclysmic event."

The extinction event is evident in the fossil record. However, what caused three-quarters of the world's species to go extinct was unknown until 1980, when a team of scientists found iridium—a mineral common in meteorites but rare on Earth—in the K-Pg boundary, the thin geological section found across that planet that marks the extinction event and separates the Cretaceous from the Paleogene.

The finding suggested that an extraterrestrial impact was responsible for creating the layer—a hypothesis that started a search for a crater.

Interestingly, signs of the Chicxulub crater were first detected two years before iridium was found in the K-Pg boundary during a gravity survey of the gulf by the Mexican oil company PEMEX. The ringed features on the data suggested that an area of the gulf had been shaped by a massive impact or a volcano, a finding that was presented at a Society of Exploration Geophysicists meeting in 1981.

The identity of the site as an impact crater was confirmed in the 1990s when scientists reexamined the PEMEX cores taken in the 1950s and found shocked quartz, a mineral that's present in only two places: nuclear bomb detonation sites and large impact craters.

"When we realized what this impact had done, suddenly everybody became interested," Morgan said. "The whole world started talking about impacts, both public and scientists."

The discovery spurred more research on the Chicxulub impact, which only strengthened the connection between

the impact and the extinction event. A paper published in *Nature* in 2010 and authored by 32 scientists—including Gulick, Christeson and Morgan—made the connection official by concluding that the Chicxulub impact was the best explanation for the mass extinction at the K-Pg boundary.

The cores being retrieved on the research mission are different from the PEMEX samples because they're continuous. The mining-grade drilling equipment collects uninterrupted cores all the way down, capturing each geological layer of the crater. The preliminary science conducted on board the Myrtle also allows for core properties that may change over time to be noted.

"The reason we're doing any science on board is some of these measurements are ephemeral measurements," Gulick said. "If we waited months to measure their physical properties, the drying out process could change them."

On the Myrtle, life and work revolves around pulling cores and analyzing them, 24 hours a day, seven days a week. To cover it all, scientists are split into two teams that are assigned 12-hour shifts.

When a core comes to the surface the science team springs into action to take measurements. Features that can be viewed through its plastic sheath are noted; samples chipped for microfossil analysis or DNA collection; a geophysical scan taken to record initial density, chemicals present, water content and other physical features that are likely to change as the core adjusts to being at the surface instead of hundreds of meters below the seafloor.

At the same time the core is being analyzed, other scientists are taking readings from inside the borehole. The acoustic imaging team, led by Johanna Lofi of the University of Montpellier in France, uses sound to create images of the rock surrounding the hole, revealing rock layers and cracks. And the vertical seismic profile team uses instruments dropped in the borehole and a sound source at the surface to record core depth and image surrounding rock layers.

Gulick, and until this week, Saustrup, control the sound source while University of Alberta researchers Doug Schmitt, a geophysics professor, and Chris Nixon, a graduate student, man the geophones that are dropped down the hole. To cut costs and save space aboard the Myrtle, Schmitt and Nixon only come aboard when it's time to take borehole readings. Otherwise, they're at a century-old villa in Mérida, complete with a courtyard pool and green coconut trees.

THE LIFTED LIFE

The reason the Myrtle is lifted above the water is to provide a stable environment for the drilling rig. Held high above the beating waves, there's nothing more than a slight sway on deck.

The position requires all who board the Myrtle to be plucked from a transport boat and raised up to the Myrtle's decks in a crane operated basket. On May 10, two scientists and a BBC photographer are among those taking the ride. The

TOP: DAVE SMITH, AN OPERATIONS MANAGER FOR THE IODP, HOLDS A DRILL BIT.
BOTTOM: MEMBERS OF THE RESEARCH TEAM TALKING ON THE DECK OF THE MYRTLE.

SCIENTISTS: JACKSON SCHOOL. DRILL BIT: ANNA DONLAN FOR ALCALDE MAGAZINE.

scientists are Mario Rebolledo-Vieyra, a geophysicist specializing in physical properties from the Unidad de Ciencias del Agua, a water research center in Mérida, and Axel Wittmann, an inorganic geochemist from Arizona State University.

The ride up gives a good view of the drilling rig, the stack of pipes used to guide the rig down the borehole and the six teal shipping containers that serve as scientific laboratories. The basket touches down near a grouping of scientists, easily identifiable in their red work suits and white hardhats.

Who's on board the Myrtle depends on the drilling stage. Costs and tight living arrangements don't allow for any more extra researchers than necessary. So last week the two micropaleontologists packed up to make room for Rebolledo-Vieyra and Wittmann, both experts in impact geoscience. They've been called aboard because the drill has passed into a new layer of the crater.

But they'll have to wait to see any new cores samples pulled up from the depths; the drill bit has dulled, so today it's being pulled up, pipe-by-pipe, so a new diamond-embedded bit can be fitted on the end.

The times when the drill operators are busy pulling the pipe up or pushing it back down, offer opportunities for other things. The researchers review data, hash out theories on the deck, file the daily reports on coring progress, update the IODP expedition blog and even enjoy some wildlife spotting. The boat is a good bird watching spot—though some of the sightings are a bit gruesome. The peregrine falcons that hang around the ship have a habit of dropping the disembodied heads of songbirds on deck.

The "Fish-Cam," a GoPro on a rope, lets the scientists look at wildlife swimming below the boat. Along with silvery fish and sharks, the footage captures a view of the drill rig, encased in a pipe, sticking out of the seafloor like a straw. A large starfish nearby seems none the wiser.

So the new arrivals don't have to wait to see the core, Gulick and Morgan are happy to show them a sample of what's been brought up so far. They carry out three cores from the reefer—a refrigerated shipping container where the cores are stored—and line them up on a holding stand in the walkway between the containers.

Each core is from a different section of the impact crater and looks surprisingly distinctive from one another.

The first core is a swirling grey rock made from sediments that filled the crater millions of years after impact, while the second core contains pink granite breccia, rock that was cracked by the impact or fell back into the crater after being blown apart, peeking out from grey sediment.

Gulick said researchers can use these cores to learn about the Earth after the impact. But he and Morgan are most interested in the Earth during the impact. So their treasure is the third core—a sample from the crater's peak ring, a circular mountain range that sprung up when rocks deep in the Earth's crust rebounded from the force of the impact.

Understanding how the peak ring forms can give clues not only about how the Chicxulub impact occurred, but also about large impacts on Earth and around the universe, Gulick said.

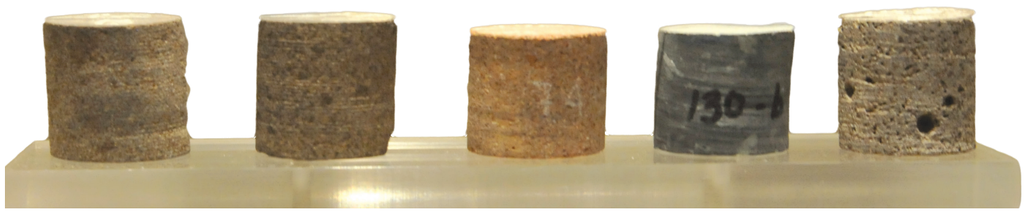
"Large impacts are the most important process of how the surface of planets are built," Gulick said. "Most don't have plate tectonics like Earth."

HITTING THE PEAK, REVEALING RECOVERY

A peak ring is the tell-tale mark of a large impact crater on a rocky surface. Although Earth is known to have been struck by three large impacts, Chicxulub is the only known crater to have its peak ring intact. All other large craters have been distorted by tectonic activity or have had their impact structures eroded away.

"The next closest peak ring after Chicxulub is on the moon," Lowery said.

According to models, the force of large impacts can make solid rock temporarily behave like fluid, with the



crater forming from rocks flowing apart and the peak ring recoiling up from the impact, like a drop of water bouncing up from a lake's surface when a stone is dropped into it.

"The rock appears to flow like a viscous fluid," Gulick said. "It's basically hit so hard that it fractures all the way down to the crystal scale. The fractures are causing little earthquakes, which cause more fractures, so as a medium it can move temporarily."

The core samples taken from the peak ring rocks offer direct evidence to compare to models, Gulick said.

"We can see the crater's morphology and we can see the shape, but there's all these competing theories on how you make that shape," Gulick said. "By drilling the peak ring, we're basically able to calibrate everybody's models and come up with an answer amongst the competing theories."

Another interesting feature from the peak ring core is a fibrous-looking, scarlet mineral creeping between the cracks of the peak ring rocks. It is a sign of hydrothermal activity, of hot water trapped in the peak ring rocks.

Hydrothermal areas on Earth are a literal hotbed for diverse microbial life called extremophiles that are adapted to live off the minerals associated with hydrothermal activity. The mineral is a good sign that life may have once inhabited pores in the peak ring rock, said Marco Coolen, a microbiologist from Curtin University in Australia.

Coolen is taking sterile samples from the peak ring cores. Once back on shore, he, along with astrobiologist Charles Cockell of the University of Edinburgh, will analyze the samples to see if they contain DNA or RNA from ancient life.

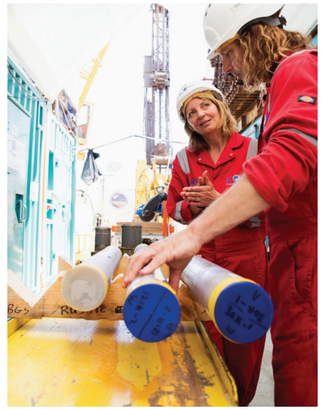
Any microbial evidence that shows up almost certainly came from Earth, Coolen said. The force of the impact would have destroyed any interstellar hitchhikers. But the new niches available after impact could have provided an array of ecosystems for peak ring life to inhabit.

In cores taken from above the peak ring, life is clearly visible. One thumbnail-sized sample of ground-up core can reveal thousands of microfossils, mostly shells from free-floating nannoplankton and foraminifera, or forams. Before the scientists hit the peak ring, they used different species of microfossils as landmarks to know where in the geologic record the drill was at.

"Fossils are the building blocks of geologic time," Lowery said. "So as a paleontologist, you're the first one who gets to look at (the core) and say 'what age is this?'"

Fossils, along with other data, served as a check on the 2005 seismic readings the team was using to predict what layers they were coring. The 10-year old data matched up perfectly with the recovered core except in one case, said Christeson, when a core taken at 618 meters revealed unexpected deposits of sandstone that puzzled the onboard scientists. Gulick thought the rocks could be from K-Pg boundary—a layer that the seismic data indicated was 30 feet deeper. But Christeson wasn't convinced.

A vertical seismic reading of the borehole, supported by microfossil and geological analysis, revealed that Gulick was right—a finding that revealed a depth conversion error in the seismic data and settled a bet between



TOP: CHICXULUB CORES DRILLED BY PEMEX ON DISPLAY IN THE GRAN MUSEO DEL MUNDO MAYA IN MÉRIDA, YUCATÁN. BOTTOM: MISSION CO-CHIEFS JOANNA MORGAN (BACK) AND SEAN GULICK DISCUSS CHICXULUB CORE SAMPLES.

CORE SAMPLES: JACKSON SCHOOL. MORGAN AND GULICK: ANNA DONLAN FOR ALCALDE MAGAZINE

Christeson and Gulick (his prize: a bottle of single-malt scotch).

Besides using microfossils as a geologic roadmap, they're useful measures of how life responded after impact and in what conditions, Lowery said.

"What makes these things so powerful is that they are so good at reconstructing what was going on in the oceans," he said. "And so, using different proxies associated with forams we can look at oxygen, we can look at salinity, we can look at productivity, and by reconstructing things like that we can make some larger inferences about the larger ocean ecosystem."

The fossil readings taken on the boat are important, but they're just the beginning. A month-long examination of the cores and associated data will happen in Bremen, Germany in the fall. Here, the Myrtle team will reunite and be joined by an onshore team of scientists who will cut the cores in two. One half of each core will be stored, and the other half studied by the researchers.

GOODBYE CHICXULUB

On May 13, the borehole has reached a depth of 859 meters. It's staying that way because the drill bit needs to be changed again.

Beau Marshall, the drill company manager, brought two diamond-studded drill bits on board this morning to do the job. But for Gulick, this is as deep as he's going.

Like other researchers before him, his time to leave the ship has come. Morgan will take full command of the research operations on board.

Back in Austin, Gulick's son is graduating from UT, as well as three Ph.D. students he advised. Less than a week later, he'll be back at sea leading the Jackson School's Marine Geology and Geophysics field course with Saustrup.

So, after a lunch of lasagna with the researchers, crew and drillers,

TOP: MISSION CO-CHIEF SEAN GULICK WAVES GOODBYE TO THE LIFTBOAT MYRTLE. BOTTOM: A MAKESHIFT CROSSROADS SIGN POINTS TO THE HOMETOWNS OF RESEARCHERS AND CREW WHO CAME TO THE MYRTLE FROM AROUND THE WORLD.

Gulick trades his white hardhat and red IODP work suit for blue jeans and a brimmed hat made of black leather. He boards the basket that took him on the Myrtle a month ago. It raises him above the lifted boat and softly places him on the deck of a transport boat called Linda waiting on the water below.

While Myrtle stood still, this boat is softly sloshed back and forth over the waves. He stands on deck and looks up at the Myrtle and turns to Claire Mellet, the expedition project manager, who is also leaving the ship today.

"What are we doing here? We belong up there!" he laughs.

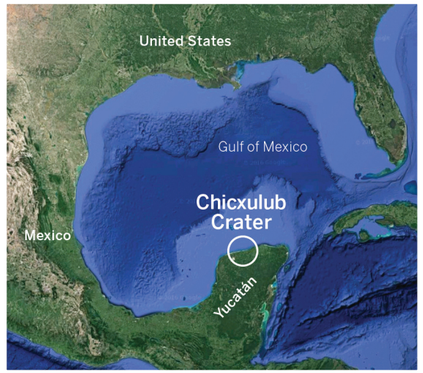
He waves goodbye to the Myrtle and the scientists who have lined up along the edge of the boat to see Gulick and Mellet off.

The Linda does a lap around the Myrtle, and then it's back to the docks of Progresso.

"I feel like I'm leaving in the middle of a chapter," Gulick said.

Although he's gone for now, he's hardly closing the book on Chicxulub. He'll join the others in Bremen, when the next leg of the research starts again.

The weeks of analysis in Bremen will help reveal the details of the destruction, and the great extinction that followed. And if DNA is found in hydrothermal minerals, the cores could show that life thrived in the peak ring on our world and may do so on worlds outside our own. If anything, the success of the drilling project shows that after the destruction of the Chicxulub impact, life came back. And it came back curious.



LEFT: THE CHICXULUB CRATER IS LOCATED IN MODERN DAY MEXICO. PART OF THE CRATER IS OFFSHORE AND PART IS ON LAND. **RIGHT:** CENOTE BOLONCHOOJOL. **BOTTOM:** RESEARCHERS ON THE CHICXULUB CORING MISSION.

Impact Creates Ring of Hidden Oases

The onshore rim of the Chicxulub crater is surrounded by a ring of water-filled caverns called cenotes.

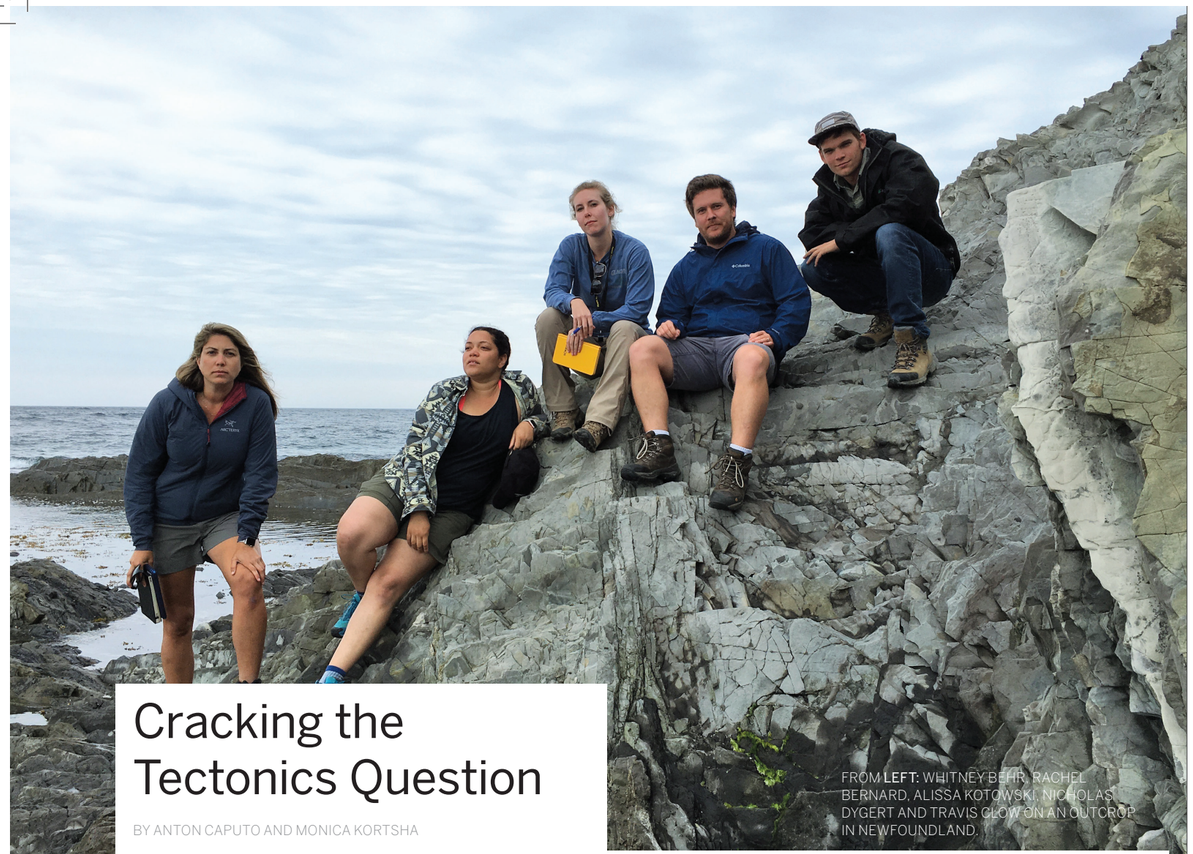
The cenote pools can be hundreds of feet deep, with some being completely exposed from the surface and others being visible only through a small hole in the ground. Nearly a thousand cenotes form a "ring" around the land portion of the Chicxulub crater.

The Chicxulub impact directly influenced the formation of the cenotes by creating fractures in the carbonate rock that radiate from around the rim of the crater. Over time, groundwater entered into some of the fractures and eroded away the surrounding rock, creating underground caverns. A cenote is born when a surface opening forms above the cavern—often by tree roots breaking through the ground to dip into the pool of water below.

The ancient Maya considered cenotes symbolic passageways to the underworld and used certain ones as sites for human sacrifice. The bottom of the sacred cenote (called "Chen Ku" by the Maya) at the ruins of Chichen Itza is covered with a 14-foot-thick layer of blue pigment, remnants of paint that coated people and valuables that were thrown into the cenote as sacrifices to the rain god Chaak.

Today, cenotes are popular swimming holes in the Yucatán. The cool, clear water offers an underground escape from the hot and humid climate at the surface.

CENOTE: ANNA DONLAN FOR ALCALDE MAGAZINE. GROUP: JACKSON SCHOOL. MAP: JACKSON SCHOOL/GOOGLE MAPS.



FROM **LEFT:** WHITNEY BEHR, RACHEL BERNARD, ALISSA KOTOWSKI, NICHOLAS DYGERT AND TRAVIS CLOW ON AN OUTCROP IN NEWFOUNDLAND.

NEWFOUNDLAND: RACHEL BERNARD. CLOW AND GOLD: TRAVIS CLOW. XENOLITH: RACHEL BERNARD.

Cracking the Tectonics Question

BY ANTON CAPUTO AND MONICA KORTSHA

Plate tectonics is the dominant geological process on Earth, explaining phenomena as diverse as mountain building and megathrust earthquakes, to the distribution of fossils and living organisms across continents.

But fundamental questions remain about how plate boundaries form and persist over geologic time. These questions are the driving force behind Assistant Professor Whitney Behr's research.

"Although I'm interested in tectonic history, much of my research focuses more on tectonic process and specifically on how the rock record can tell us about the physics of our planet," said Behr, a structural geologist who describes her work as tectonophysics. "I mainly focus on the lithosphere because, unfortunately, those are the only rocks we have. I want to know what the rocks tell us about the forces behind plate tectonic activity, over a range of time and length scales, from the large-scale processes that drive the plates over millions of years to the micromechanics of individual earthquakes that are near instantaneous in time."

Behr leads one of the most diverse and energetic research groups in the Department of Geological Sciences, heading an array of projects that use a range of field, analytical and experimental techniques to study plate behavior at both active and ancient plate margins. The work attracts graduate students interested in studying tectonics questions from a variety of perspectives, as well as undergraduate students who are making their first forays into Earth science research guided by Behr's mentorship. Behr is making a concerted effort on the mentorship front, launching a new program to help ensure that students from underserved minority areas aren't lost in the shuffle when they study geosciences at The University of Texas at Austin. It's a project that hits home with her.

"I'm a first generation college student and an ethnic minority (half-Cuban), so my interest in this type of mentorship is modeled after something I had as an undergrad, which ultimately inspired me to finish college and go on to graduate school," Behr said. "I remember how confused and lost I was going into college as to what I was even supposed to be doing."

With tectonics being a uniting thread, the research projects of Behr's students span from the Earth's upper crust to the upper mantle. Among them, Behr's teams are working to: quantify incision rates in the Rio Grande River Gorge in northern New Mexico and relate them to climatic and tectonic forcings; understand the present-day rheology of the lithospheric mantle and the nature of the lithosphere-asthenosphere boundary by studying xenoliths erupted from young volcanoes; and determine how the San Andreas Fault has behaved over the past 1,000 to 100,000 years through mapping tectonic geomorphic features in the field and dating their formation ages using surface exposure geochronology.

"The nature of the projects my students and I work on are always quite different, because some are focused on earthquake hazard and some are focused on understanding longer-term deformation patterns," Behr said. "I really like the problem solving aspects of Earth sciences, and I like to bridge different scales and interact with different types of geoscientists. I'm very comfortable with learning new techniques that will help me answer any burning tectonics-related question, especially since this provides me an opportunity to collaborate with other researchers and technical experts."

SURFACE SIGNS

The San Andreas Fault is arguably the most well-known tectonic feature in North America. Ph.D. student Peter Gold is studying its history with cosmogenic surface exposure and pedogenic carbonate geochronology along with lidar-based surface analyses. He is using these techniques to quantify fault displacement rates along several strands of the southern San Andreas fault system in Southern California and Baja California, Mexico.

"These types of measurements, which require analysis of high-resolution topographic data, detailed field mapping, physically demanding rock and soil sampling and weeks of complex wet chemistry, are important for understanding strain partitioning in complex fault systems and for determining the relative contribution of a particular fault to seismic hazard," said Gold, who is working with master's student J.J. Munoz on the projects.

Gold first met Behr at the Southern California Earthquake Center annual meeting and joined her group in 2012 on the active tectonics side of the research. He said an important strength of her program is how researchers collect and process their own samples from beginning to end.

"None of us are doing one of these projects using someone else's samples to interpret processes at a field area we have never been to," Gold said. "I think that's a really important strength of Whitney's program. Field observations are so important for providing context, and collection and processing one's own samples is critical for interpreting ages or rates from the measurements."

Master's student Travis Clow is also using cosmogenic dating. He's applying the technique to study the evolution of the Rio Grande River over the past 500,000 years to determine whether climate, tectonics or local drainage integration is behind the river's rapid incision in parts of New Mexico. The research takes place in the Rio Grande del Norte National Monument near the river's confluence with the Red River in northern New Mexico. It involves dating rocks that are deposited on old river terraces, and calculating an average incision rate for the area by comparing the age of the rocks with the distance of the terraces from the modern water line.

"We've observed these terraces, mapped them, sampled them and then we do geochronology to get the actual dates of creation of these terraces," said Clow, who is doing the geochronology portion of the research at the Jackson School in Professor Daniel Stockli's helium lab.

TOP: GRADUATE STUDENTS TRAVIS CLOW (LEFT) AND PETER GOLD COLLECTING SAMPLES FROM A BASALT BOULDER FOR COSMOGENIC SURFACE EXPOSURE DATING. BOTTOM: PH.D. STUDENT RACHEL BERNARD HOLDS A XENOLITH WITH GREEN OLIVINE GRAINS.

Clow first met Behr as an undergraduate in her graduate-level microstructural geology class where he became enraptured with microstructures and geomorphology. He said he didn't initially anticipate incorporating geochemistry into his thesis work, but that visiting the river on a field trip with Behr, Gold and Jackson School Distinguished Senior Lecturer Mark Helper piqued his interest.

"I fell in love with the field area, and it was something new to me," Clow said. "Just talking to (everyone) about what's going on there and being able to actually go out there made me realize this is something I wanted to pursue, and I've found that I like it a lot."

So far, the research has helped reveal a connection between changes in incision rates and periods of past climate change—a finding that might indicate that climate, rather than tectonic forces, is primarily controlling how the river is carving the land.

"Much of the area is bounded by fault zones that have active slip occurring on them, and there's regional uplift, but the problem with our area is those rates are just way too slow for how quickly it's incising," Clow said.

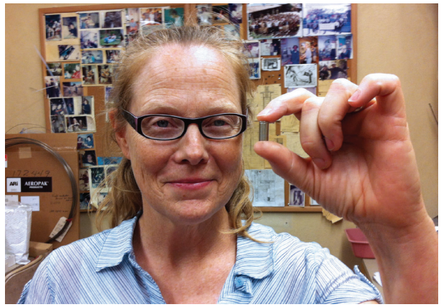


PLATE BOUNDARY RESEARCH IN THE LAB AND FIELD

Like Clow, Ph.D. student Pamela Speciale first met Behr as an undergraduate student.

"I was very impressed with the diversity of her interests in all aspects of geological sciences, so I decided to volunteer to work with her kind of on the side my year off between undergrad and grad school," Speciale said.

While Clow's work led him to focus on surface phenomena, Speciale's research concerns dynamic recrystallization, an important phenomena that contributes to strain localization in the upper mantle, and involves the competition between grain growth, fostered by the hot mantle environment, and grain shrinkage caused by deformation at the plate boundaries.

Speciale's goal is to develop a grain-growth law by observing how olivine—the most common mineral in the mantle—behaves when subjected to pressures and temperatures equivalent to what's found in the deep lithosphere.

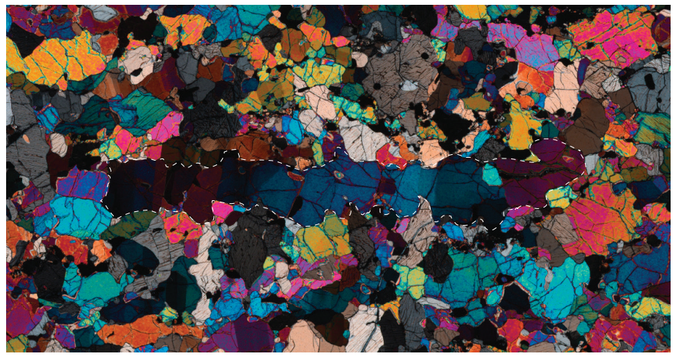
Her experiments show that when cylinders of olivine are deformed under these controlled conditions, the olivine starts to recrystallize and shrink. When the stress is removed, the recrystallized grains begin to grow. Speciale said that collecting data on how conditions change olivine crystals will be key to developing a law that can improve models of grain-size evolution in deforming mantle rocks.

"These models depend on grain-size evolution, so by investigating the effects of deformation on grain growth I can provide detailed mechanical and microstructural data on how grain size evolves," Speciale said. "If I can distinguish the conditions under which grain growth counteracts grain-size reduction, and the driving forces for growth, then others can include those parameters in models of large-scale mantle dynamics for Earth and other planetary mantles."

Ph.D. student Rachel Bernard is also interested in strain localization in the mantle. Instead of recreating it, she seeks out evidence of strain by studying samples of mantle rocks brought up by volcanic eruptions.

These rocks, called xenoliths, are pulled from magma chamber walls during basaltic eruptions that produce lava flows at the surface. Because eruptions are rapid, and the volcanoes Bernard studies in the Mojave Desert are geologically young (less than 3 million years old), the rocks offer a snapshot of the mantle forces that shaped them without the interference that comes from long-term residence in the crust or at the surface where mantle minerals readily degrade.

"We can look at young xenoliths and infer what the mantle is doing at depth over recent timescales," said Bernard,



LEFT: PH.D. STUDENT PAMELA SPECIALE HOLDING AN EXPERIMENTAL SAMPLE.
ABOVE: A PERIDOTITE XENOLITH THIN SECTION UNDER POLARIZED LIGHT. THE WHITE DASHES OUTLINE A LARGE, STRETCHED GRAIN.

SPECIALE: PAMELA SPECIALE; GRAINS: RACHEL BERNARD. DISH HILL: RACHEL BERNARD.

DISH HILL, A CINDER CONE VOLCANO IN THE MOJAVE DESERT, ERUPTED MANY OF THE XENOLITH SAMPLES THAT RACHEL BERNARD IS RESEARCHING.

who has an engineering background but came to the Jackson School after meeting Behr at an AGU conference.

Bernard's samples are snapshots of strain localization on the large scale. The alignment of the grains across different samples into distinct fabrics gives clues into the forces that shape mantle flow over time for a certain area.

The xenoliths collected by Bernard come from the Eastern California Shear Zone near the San Andreas Fault, the plate boundary between the North American Plate and the Pacific Plate that hosts large earthquakes but whose relationship to the upper mantle is not yet understood. Researching such a tectonically active region can give clues into how strain is currently distributed in the lithosphere, Bernard said.

To track strain localization across the region, she spent the summer at the Smithsonian Institution analyzing xenoliths from different sites in Arizona and Nevada.

"One of the ways to figure out how strain localizes is to look at xenoliths from different regions but similar depths," Bernard said.

Bernard's work on xenoliths is part of a larger initiative in Behr's research group to examine crustal and mantle rocks from several plate boundaries across Western North America: from Baja California, Mexico, to Alaska; as well as within the Mediterranean region, including the Cycladic Islands in Greece and the Andalusia region of southern Spain. Working in different regions allows researchers to examine plate boundary formation in a variety of tectonic environments.

"We need to look at a range of different rock types to see how they behave," Behr said. "If the mantle in one area is dominantly olivine, it will have one kind of rheological behavior or flow, while if it has pyroxene mixed with olivine, it could behave totally differently. The same goes for major plate boundaries dominated by crustal rock types, such as at several subduction plate boundaries, where crustal minerals such as quartz, feldspar, amphibole or mica are more fundamental to both long- and short-term plate boundary mechanics."

MENTORING THE NEXT GENERATION

The mystery of plate tectonic boundaries throughout the lithosphere remains one of the biggest questions in geodynamics. Understanding the process inspires Behr's research group, but it also can make for intimidating material, particularly to undergraduate students who come from environments not as grounded in the rigors of science in middle and high school.

Behr, who can personally relate to the challenges those students face, would like to change the equation through a new mentoring program she's creating aimed at underserved minority populations.

"I think some people could use a little extra mentoring because this is such a big place," she said.

In February 2016, Behr received a National Science Foundation CAREER grant, one of the foundation's most prestigious awards in support of junior faculty. The award will enable Behr to couple high-level geologic research with mentorship for students from underserved communities. It's one among many high profile awards she received this past year (see page 35). On the research side, the project is focused on investigating the rheological properties and evolution of the subduction interface using exhumed rocks. Field sites include the Chugach accretionary complex in Alaska, the Condrey Mountain Window in northern California and southern Oregon's Klamath Mountains and the Cycladic Blueschist Unit in Greece's Syros Island.

Behr will be looking for prospective students to join the program, named JSGCatalyst (JSGC), this academic year. She envisions students joining the JSGC program in their sophomore year and staying through their senior year. Behr believes that the new program, which is patterned after one that she went through as a student at California State University Northridge, could work well with programs like GeoFORCE, an outreach program of the Jackson School of Geosciences aimed at high school students from disadvantaged areas of the state in inner-city Houston and rural Southwest Texas.

"I'd like to try to catch some of these students earlier because I felt like I was caught earlier and that's why I finished college and went on to grad school," she said. "My hope is that with a little bit of extra effort early on, we can encourage some of these students to continue their education into the upper tiers of academia where diversity is currently lacking."

With Behr at the helm, the research will continue to study processes—and build student skills—on the small and large scale.

UNLOCKING THE POTENTIAL OF METHANE HYDRATE

BY ANTON CAPUTO

Buried deep beneath the world's oceans and Arctic permafrost is a mysterious substance that holds the promise of an enormous amount of energy. Created under high pressure and low temperatures when methane molecules are trapped in a cage-like lattice of water molecules, methane hydrate is an incredibly energy-dense substance found in abundance in many parts of the world. Deposits can be several hundred meters thick, and, when returned to surface pressure and temperature, 1 cubic meter can produce 164 cubic meters of natural gas.

Despite its potential as an energy resource, little is known about how methane hydrate forms or behaves in its natural state. These questions need to be answered to understand the environmental implications and technical and logistical challenges of someday trying to produce this energy. Compounding the challenges, methane hydrate is also tremendously difficult to study because it is unstable at surface pressure and temperature.

To help unravel the mysteries surrounding methane hydrate, the U.S. Department of Energy (DOE) has turned to a team of researchers led by the Jackson School of Geosciences. The team is currently in the beginning stages of one of the most ambitious research projects in the history of The University of Texas at Austin—a six-year, $80 million project to drill core samples of methane hydrate from beneath the floor of the Gulf of Mexico and bring them to the surface for scientific study.

The project is being led by the Jackson School's Peter Flemings, the John A. and Katherine G. Jackson Chair in Energy and Mineral Resources in the Department of Geological Sciences. It includes researchers from The Ohio State University, Columbia University's Lamont-Doherty Earth Observatory, the Consortium for Ocean Leadership and the U.S. Geological Survey. The majority of the funding is from the U.S. Department of Energy, with the balance provided by the research institutions involved in the project. Industry is providing significant data.

If all goes as planned, crews will be drilling core samples in 2017 from a leased rig, and again in 2019, potentially using the JOIDES Resolution, the ocean drilling research vessel of the International Ocean Discovery Program. Teams of scientists will perform tests on the samples in 2020 at a specialized lab being built at the Jackson School.

Peter Flemings is leading the DOE-supported methane hydrate project.

FLEMINGS: JACKSON SCHOOL; DRILLING PIPES: PETER FLEMINGS.

THE JACKSON SCHOOL NEWSLETTER SPOKE WITH FLEMINGS, THE PRINCIPAL INVESTIGATOR, ABOUT THE PROJECT.

Q: Methane hydrate is an intriguing substance that is sometimes referred to as "fire in ice" because it seems like ice, yet you can light it on fire. Is it ice?

A: No. It looks like ice, but it's not. When hydrates melt they separate into gas and water. And that's very different than ice melting where all you have is water.

Q: What exactly are you preparing to do?

A: At the heart of the proposal is the desire to drill methane hydrates in the marine setting and recover actual core from the methane hydrate reservoir. It's fairly common in the energy industry to core when you drill a well. The difference here is that methane hydrate is stable at high pressure and low temperature at the bottom of the ocean, so if you don't have a way to bring it to the surface under pressure it will just bubble away.

Q: How will you accomplish that?

A: What we need to do is take that core at depth and slide it inside a pressurized container that seals before we bring it to the surface. This technology is called pressure coring. We are continuing to test and modify the tool that has been developed for this. The tool, which is very complicated and probably 90 feet long, goes inside the drilling assembly. The objective of that tool is to core and take that core and put it inside a metal enclosure that is sealed under pressure and then lift that pressurized core up to the surface. Then, when you get the core on the deck, you have to transfer it from the pressurized coring container to a pressurized analysis facility.

This tool has been used in India, South Korea and China. Based on those experiences, we are making a series of modifications to make it drill better and to improve the ability to recover full core and preserve that core under pressure.

Q: In December 2015, your team conducted land-based coring tests with the pressurized coring tool. How did those tests go?

A: The purpose of that was to test the tool and to get UT up to speed on the technology and how to deploy it. In fact, when I wrote the proposal, even after they funded us, they said, 'by the way, this tool needs some modifications to work more effectively, and you're going to need to fix it.' So we've got work to do.

For the field test, we went out to an experimental rig owned by Schlumberger. We spent two weeks drilling down into the Eagle Ford formation and did a series of coring tests.

Q: Were they successful?

A: We actually have two types of coring tools that are slightly different technologically, and we tested both those tools. One of those tools performed significantly better than the other tool, and it was not the tool that anyone predicted ahead of schedule. So we've got two tools we are modifying now. We'll take two tools to sea on this test.

Q: So you're testing the tool at sea? When does that happen?

A: The marine test is a 20-day experiment that will drill and core into a hydrate-bearing horizon in May 2017. We're contracting with a Gulf of Mexico industrial company. Our drilling requirements are not that deep. We're

SCHLUMBERGER'S CAMERON TEST DRILLING FACILITY.

going up to 1,000 meters. It's almost a $10 million program. This is a huge test, and it is only a part of our entire drilling program, which may be the single biggest contract UT has received.

Q: Where exactly will you be taking the cores?

A: If you go to the bottom of the ocean out in deep water—thousands of meters of water depth—it's a couple of degrees Celsius and the pressure is high. As you go down, the pressure increases but the temperature also increases. So there's only this specific layer that contains methane hydrate. It can range in thickness, but we are looking somewhere within the first 1,000 meters below the seafloor. It's only above that depth that hydrates are present, and it seems like hydrates are more present near the bottom of that depth.

In geology we often talk about shales (or mudrock) and sands. The type of deposit we're looking for is hydrates that are locked inside the sand beds. That's important because historically there has been work done on methane hydrates in shales.

As in traditional petroleum geology, where we produce oil and gas out of sands because they are permeable so the fluids flow, the thought is that if we can find sands full of hydrate, those have the potential to be the most economically viable.

Q: What will you do with the cores once you have them?

A: The other really cool part of this is that we are creating a facility in the Jackson School—in the basement—called the pressure core center. This is a long-term thing. This is going to be a facility where we will store these pressurized cores and also have the ability to analyze them.

Once you've got these pressurized cores, you have to transfer them under pressure to do anything you want to do. So in the pressure coring center there will be this device where you will be able to take these pressure cores, cut a little sample, and then slide it into an experimental device that is under pressure and maybe do a CAT scan, a flow experiment or maybe perform a Raman spectroscopy. The thing always has to stay under pressure, so it's actually significantly complicated technology.

We'll store everything here and we'll have a whole experimental facility at UT, but we'll also serve as a library. We'll provide samples for other people and institutions to study.

Q: Are these type of facilities common?

A: No. This will be one of the very few laboratories in the country to do this type of work.

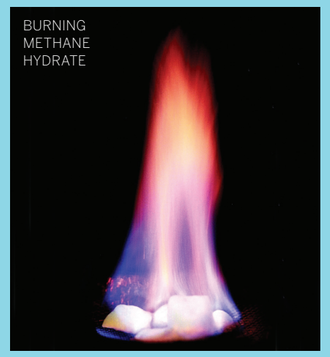
Q: You've talked before about environmental concerns with methane hydrate, particularly the potential for the methane to affect the climate as permafrost melts. Will the research you are conducting help improve scientific understanding of such issues?

A: The question is: will climate fluctuation destabilize the methane hydrate? The scenario is: if we have a little bit of global warming, that could destabilize the methane under the permafrost, the methane then bubbles up into the atmosphere and that accelerates the global warming. That's a big question right now—are methane hydrates destabilizing and contributing significant amounts of methane to the atmosphere?

The focus of the study is not related to the climate issue. But to flip it around, I would say that the understanding you get about methane hydrates, about how they form, about their habits, their concentrations, I think that's going to be hugely helpful to these issues. I just don't think there's any doubt about that.

Q: The estimates of how much energy could be contained in methane hydrates seem almost unbelievable. How much is there?

A: The numbers over the years have varied incredibly. The most recent numbers just for the Gulf of Mexico are on the order of 700 trillion cubic feet



(TCF). We're talking hundreds of years of supply at current gas consumption rates and that's just the Gulf of Mexico.

Furthermore, methane hydrates may contribute to long-term energy security within the United States and abroad. Many key global economies lack clean and secure energy supplies but have potentially enormous hydrate resources.

Q: Why go through all this expense and trouble?

A: There's all kinds of people who study hydrates for different reasons, but the DOE's focus here is as an energy resource 30 to 50 years out. Methane hydrate has an incredible energy density, so if you could produce it, it is a significant resource.

Q: Is that likely to happen anytime soon, particularly with gas and oil prices as low as they are?

A: I think this is going to be really hard. It's thousands of feet down. It's going to be expensive. I find this a challenge to envision how we would make this economically viable, especially now with low gas and oil prices. But have you ever held a piece of gas shale? When I hold that in my hand and look at it, I say how the heck are you ever going to produce (energy from) that? But right now, that's why oil and gas prices are so low. The DOE has the same vision for methane hydrate. They say we plan to do the first order technical exploration to see if this could come online 30 years from now.

METHANE HYDRATE: JACKSON SCHOOL. CORING TEST: PETER FLEMINGS. DYLAN MEYER: JACKSON SCHOOL.

ABOVE: DYLAN MEYER. LEFT: (LEFT TO RIGHT) MAHDI HEIDARI, KEVIN MEAZELL, KRIS DARNELL, BAIYUAN GAO, TESSA GREEN AND CARLA THOMAS AT THE LAND-BASED CORING TEST IN DECEMBER 2015.

PEELING BACK THE LAYERS OF WHAT WE KNOW

BY ANTON CAPUTO

Among the great challenges of studying methane hydrate is that scientists aren't sure how it forms and don't yet have the tools to study it in the natural environment.

Jackson School Ph.D. student Dylan Meyer has spent the past two years trying to work around this problem by creating methane hydrate in an experimental lab in the basement of the Cockrell School's Petroleum and Geosystem Engineering building.

Meyer is one of the many students working on the methane hydrate project spearheaded by Professor Peter Flemings. He uses a unique method that he believes—and hopes—mimics the forces that form methane hydrate in nature.

"We're really trying to get a first order understanding—to peel back the layers on what we actually know," Meyer said. "The idea being that if we can form hydrates under controlled conditions, we can get an idea what's happening with them in the field by using this as an analogue."

Subsurface methane is formed either by the breakdown of organisms that died over millions of years and have been buried under the seafloor or by microorganisms that produce methane as a byproduct of consuming organic matter in low-oxygen environments.

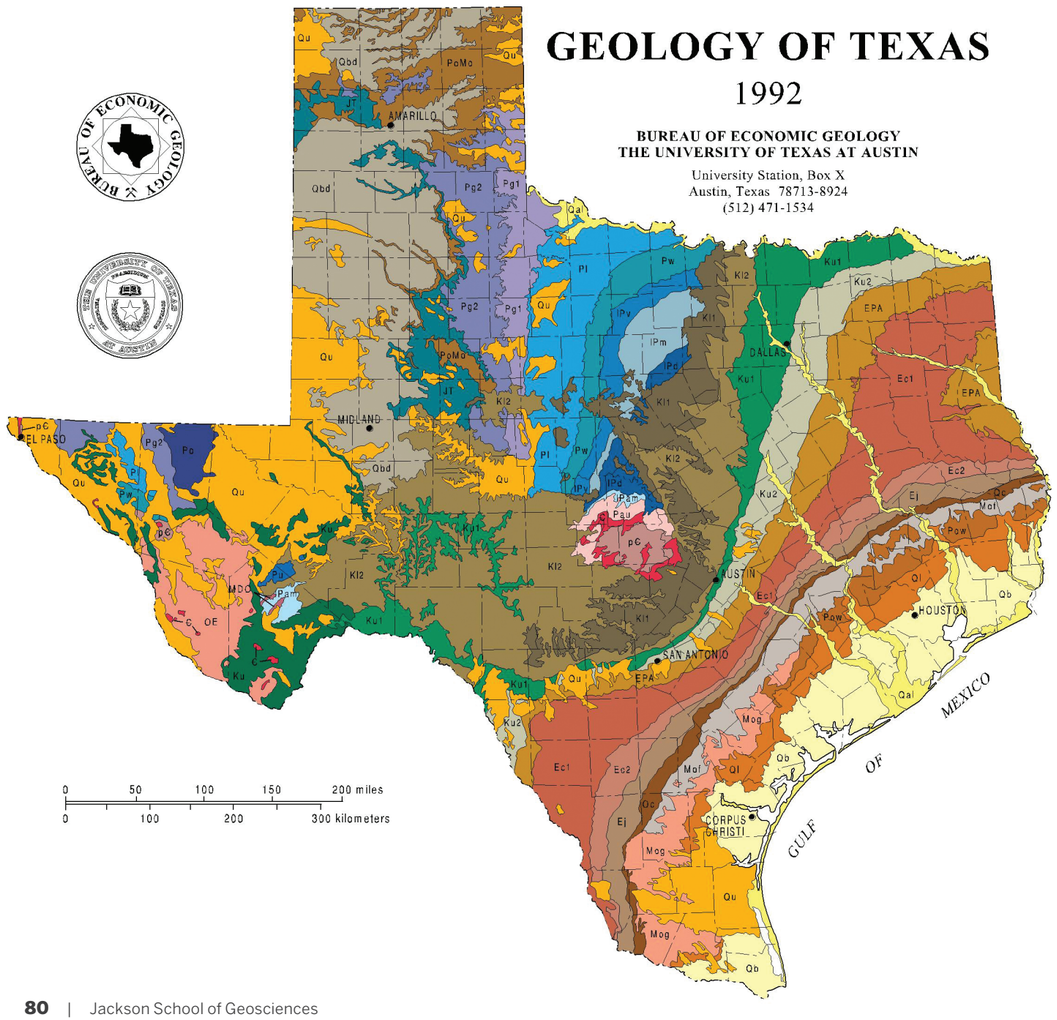
How that methane is turned into a hydrate is an open question, but Meyer said there are likely a number of processes at work, depending on where in the world it forms. The way Meyer makes methane hydrate in the lab is meant to mirror Flemings' theory of how the hydrates form in the dipping sand layers found in certain regions of the Gulf of Mexico—areas that Flemings' team plans to take pressurized core samples from in the coming years.

The process of making the hydrates involves injecting pressurized methane into a cold, brine-saturated sand sample. Meyer then varies the flow rates and clay content and analyzes the hydrate formation response using several techniques, including computed tomography (CT) scanning.

"This allows us to take cross-sectional images of the sample and investigate the transient formation of hydrate," he said. "Improving our understanding of how hydrates are formed at this scale will have implications for natural hydrate formation."

MAPPING TEXAS THEN AND NOW

FROM ITS HUMBLE ORIGINS AS LITTLE MORE THAN A VISUAL GUIDE TO SURFACE ROCK FORMATIONS, THE GEOLOGIC MAP HAS EVOLVED INTO A RICH, MULTILAYERED TOOL USED BY A VARIETY OF DISCIPLINES. IN TEXAS, THE JACKSON SCHOOL OF GEOSCIENCES BUREAU OF ECONOMIC GEOLOGY HAS BEEN CENTRAL TO THAT EVOLUTION FOR OVER A CENTURY. BY JOHN HOLDEN



TEXAS MAP: BUREAU OF ECONOMIC GEOLOGY. BRITAIN MAP: WIKIMEDIA COMMONS. POWDERHORN RANCH AND AUSTIN OUTCROP: TORTOISE: SCOTT CAMBRIN.

WHEN WILLIAM SMITH PRESENTED THE VERY FIRST GEOLOGIC MAP OF BRITAIN TO THE WORLD 200 YEARS AGO, BOTH THE CREATOR AND HIS PIONEERING MASTERPIECE WERE IGNORED BY THE BRITISH SCIENTIFIC ESTABLISHMENT OF THE TIME.

Recognition for the "Father of English Geology" eventually came later in life, but not before his map had been widely plagiarized, and he had endured several years of financial hardship.

While Smith may not have initially received the credit he deserved, he would likely take comfort knowing just how far things have come since his map was published in 1815. By the 20th century, his revolutionary approach to mapping—showing three-dimensional representations of geologic strata on a two-dimensional map—had been adopted by aspiring geologists worldwide, including those mapping the landscape in Texas.

Geologic mapping has been one of the principle duties at the Bureau of Economic Geology since its establishment in 1909. As the state geological survey, the bureau has been officially responsible for mapping the Lone Star landscape for more than a century.

"Back then geologists would have gone out on foot or horseback and simply recorded the surface rocks they saw on a given plot of land," said Edward Collins, bureau research scientist associate and resident geologic mapping expert.

In its early days much of the bureau's research was tied up in exploration for minerals deemed economically valuable—hence the "economic" part of the bureau's moniker.

"In those days, geologic mapping was commissioned by those in search of natural resources such as coal, copper and building materials like limestone," Collins explained.

Fast forward 100 years and the functions and applications of the geologic maps being produced have grown to include data prized in a variety of scientific disciplines.

"Given our dual role as the state geological survey as well as an independent multidisciplinary research institute, it's no surprise that geologic mapping at the bureau has extended beyond the original recording of geographical rock formations," said Michael Young, bureau associate director for environmental systems and senior research scientist. "While every state survey has its own mapping program, few, if any, have as wide a reach as ours here at The University of Texas."

The geologic map of the 21st century is first and foremost a visual illustration of the distribution of geologic features, but it has a myriad of other applications depending on who is using it.

In Texas, applications vary depending on location. In the Central Plains, maps are informing planning and management of land. In coastal environments, they're helping to monitor change in coastal depositional environments, respond to erosion and assess the suitability of resource development activities, including managing future plans for development of energy and industrial mineral resources, and commercial and recreational interests.

WILLIAM SMITH'S 1815 GEOLOGICAL MAP OF BRITAIN.

In this context, map applications are often critical to supporting the continued growth of the Texas economy. But geologic mapping in Texas is not motivated purely by commercial imperatives.

Ongoing projects developed as part of the combined state and federal STATEMAP Program are used to monitor natural depositional and erosion processes as well as human activities known to impact water quality. This includes making geologic maps of the Texas Gulf Coast Corridor. In addition, boundaries of wetland environments, shoreline changes and the littoral sediment budget can also be assessed. Equipped with this kind of information, maps can be used to help resource management decisions, support coastal research and inform conservation projects that protect threatened wetland environments.

How the geologic map has evolved from paper format to the multilayered tool it is today—used by engineers, realtors, surveyors, scientists, city planners, conservationists, tourists and others—relates in no small part to recent technological advances.

"Almost everything is now done on computers," Collins said. "Field research is still required, but these days, students and researchers bring tablets with GPS capability, and other mapping-related programs."

In particular, the modern geologic map owes much of its sophistication to advances in aerial photography and satellite imagery technology. Lidar—a laser-based light system used to determine topography—has been enthusiastically adopted by the geologic mapping community at the bureau.

"The high resolution measurements and accuracy of the topography become the foundation for many other geologic features," Young said. "We can then map rock types, geological features, vegetation, on top of the topography, helping us identify relationships that before were more difficult to see."

Geologic mapping at the bureau has even extended to include measuring temperature variations within river systems in order to understand where ideal habitat conditions favorable to fish and other species are likely to be found.

This kind of research is but one example demonstrating how geologic mapping plays a central role in conservation efforts.

There's no telling what other novel uses might be found for the geologic map of the future. Yet the map itself will always retain core features that have been a constant since the days of Smith.

"The applications may have widened, but the basic functions have not," Young said. "Each standard map will still have the same geologic illustrations detailing sediment or rock units at the surface, but now there's all this additional metadata that's available."

THE BUREAU'S JEFFREY PAINE, A SENIOR RESEARCH SCIENTIST, TAKING GEOPHYSICAL MEASUREMENTS AND MAKING FIELD OBSERVATIONS AT POWDERHORN RANCH.

ON THE GROUND: GEOLOGIC MAPPING IN ACTION

Ecosystem Mapping at Powderhorn Ranch

In 2014, history was made when $37.7 million was raised for the purchase of the 17,351-acre Powderhorn Ranch in Calhoun County, the largest amount ever paid for a conservation land purchase in the state's history.

Located on the Gulf Coast, the ranch is one of the biggest tracts of unspoiled coastal prairie land left in Texas and was paid for through a partnership between the Texas Parks and Wildlife Foundation, The Nature Conservancy and The Conservation Fund. It will eventually become a state park and wildlife management area managed by the Texas Parks and Wildlife Department.

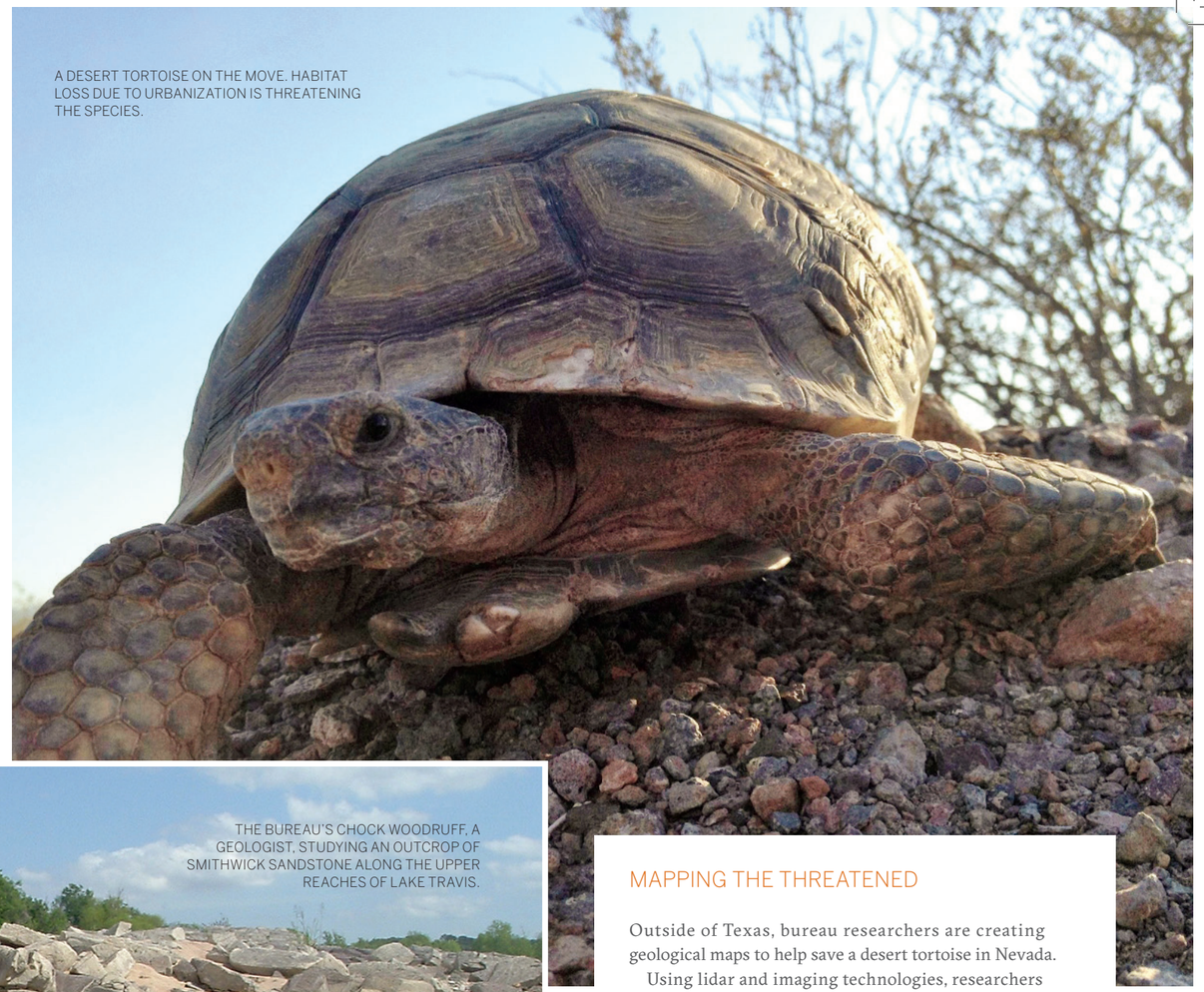
After making the substantial investment, the state turned to the bureau to map the property and produce a print and digital geoenvironmental atlas of the management area to assist planners, managers and conservationists.

Through initiatives funded by the Texas General Land Office and the U.S. Geological Survey, bureau researchers are studying ecosystems that include bay frontage, tallgrass prairie, fresh and saltwater wetlands, as well as live oak woodlands established on the Ingleside barrier-strandplain, an ancient barrier system formed along the Texas coast during the last Pleistocene interglacial period about 100,000 years ago.

Projects include an airborne lidar survey to create a high-resolution topographic model of the area and an aerial hyperspectral survey to help determine habitat distribution.

"We're also taking ground and borehole geophysical measurements and acquiring soil samples to determine paleoenvironments and ages of the shallow strata," said Jeffrey Paine, senior research scientist at the bureau.

PAINE: BUREAU OF ECONOMIC GEOLOGY. WOODRUFF: BUREAU OF ECONOMIC GEOLOGY. TORTOISE: SCOTT CAMERIN.



A DESERT TORTOISE ON THE MOVE. HABITAT LOSS DUE TO URBANIZATION IS THREATENING THE SPECIES.

RURAL & URBAN MAPPING

Powderhorn Ranch is not the bureau's only project on the coast.

"It ties into what we're doing across the Middle Texas Gulf of Mexico Coastal Plain," said Edward Collins, a research scientist associate at the bureau.

Another one of those projects is mapping in environmentally sensitive areas adjacent to Matagorda and Lavaca bays.

New maps of these areas will help assess coastal erosion and permit activities related to resource development, Collins said. They'll also assist in evaluating historical changes of coastal depositional environments.

Away from the coastal wetlands and near the state's capitol, the bureau is assisting with urban development plans by creating geologic maps of areas west of Austin within the Central Texas transportation/population corridor, areas that have experienced major population increases and significant suburban development in recent years.

Geologic maps are being produced to help address needs for planning and managing groundwater, surface water, land use and construction projects. So far, researchers have been busy mapping in the upper Lake Travis area as far south as Wimberley, including Mansfield Dam and Dripping Springs. However, this project is far from complete, and plans are in place to chart regions further west in the coming years.

THE BUREAU'S CHOCK WOODRUFF, A GEOLOGIST, STUDYING AN OUTCROP OF SMITHWICK SANDSTONE ALONG THE UPPER REACHES OF LAKE TRAVIS.

MAPPING THE THREATENED

Outside of Texas, bureau researchers are creating geological maps to help save a desert tortoise in Nevada.

Using lidar and imaging technologies, researchers are assessing potential habitats in Eldorado Valley, south of Las Vegas, Nevada, for *Gopherus agassizii*, a threatened species of desert tortoise found in the Southwest.

The assessments include measuring vegetation, diversity in plant canopies and landscape characteristics.

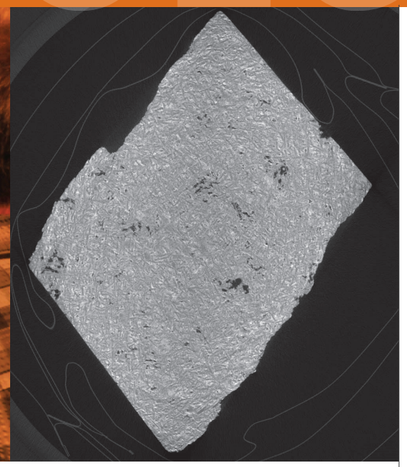
This is not the only project where the bureau has used its mapping expertise to assist in species conservation. In the recent past, the bureau has undertook studies in Texas, including mapping habitats for the endangered earless lizard, the western chicken turtle and the fresh-water mussels found in several Texas rivers.

Michael Young, a senior research scientist and associate director for environmental systems at the bureau, said that techniques being used in Nevada could help in future Texas conservation projects.

"The technique we're attempting to use—which is a combination of remote sensing and on-the-ground mapping—could be very helpful in Texas, particularly on our military bases where many are also dealing with the conservation of species on the threatened or endangered list," Young said.

LOOKING INSIDE 2016

The Jackson School's world famous CT lab gives us a peek into some of the world's most precious artifacts



LEFT: ARTIST ERIKA BLUMENFELD (LEFT) AND RESEARCH SCIENTIST MATT COLBERT EXAMINE A CT SCAN. RIGHT: A CT SCAN OF APOLLO LUNAR SAMPLE 12038-7, WHICH WAS COLLECTED FROM THE MOON DURING THE APOLLO 12 MISSION.

CT LAB: JACKSON SCHOOL. MOONROCK: NASA. SKELETON: JASON KUFFER. KAPPLEMAN AND KETCHAM: UT AUSTIN.

Rocks from Space

The CT lab provides a look inside Apollo moon rocks and more

BY MONICA KORTSHA

In June 2016 the Jackson School hosted visitors from other worlds.

Since coming to Earth with astronauts on the Apollo missions or being plucked by scientists from the Antarctic ice, the visitors—moon rocks and meteorites from Mars, the moon and asteroids—have become some of the most studied samples in NASA's collection.

This summer a select few were brought to the Jackson School's High-Resolution X-ray Computed Tomography Facility, or UTCT, to capture a perspective that no one has seen before: a view from the inside.

NASA's plan is to combine the interior view from CT with high-resolution precision photography to create a 3-D virtual model useful to scientists and space aficionados alike, said Erika Blumenfeld, a visual artist and conservation scientist who is designing the model for NASA.

"Combining these two datasets into a 3-D virtual model—where you can zoom in to see details at 60 microns or greater, rotate it around and really get a sense of the rock—will provide an incredible amount of information," Blumenfeld said. "Additionally, we can make lower resolution versions for NASA apps and include the evolving story of the rock's formation, so kids and adults alike can begin to explore what scientists have learned from these special rocks from space."

The lab's scientific CT scanners work like a high-powered clinical CAT scan. Because the samples imaged by the lab are not living, they can be safely scanned with high-energy X-rays that clearly bring features as small as 10 microns (less than the width of a human hair) into view, depending on the size and density of the sample.

The Johnson Space Center in Houston is in the process of buying its own CT scanner to image its thousands of samples. For the first batch of rocks, a collection of 27 specimens, they're learning the ropes from the experts at the Jackson School.

"These guys have been running the facility for 20 years, so we're collaborating with the best in the nation here," said Cindy Evans, Johnson Space Center astromaterials curation chief.

The Jackson School's lab will scan more batches from Johnson Space Center in the future.

UTCT Lab Director Richard Ketcham, a professor and Jackson School Associate Dean for Academic Affairs, has made a name for the lab in scanning and analyzing a wide range of geological specimens, from fossils to crystalline rocks, and also a few meteorites over the years. Romy Hanna, a Ph.D. student at the Jackson School advised by Ketcham, has been helping to further the use of scanning on space rocks. Her own research on carbonaceous chondrites—primitive meteorites

Continued on page 86

Solving a 3.2-million-year-old mystery

BY ANTON CAPUTO AND RACHEL GRIESS

University of Texas researchers closed one of the coldest of cold cases in August 2016 when they revealed that Lucy, the world's most famous fossil of a human ancestor, likely died after falling from a tree.

The research, published in *Nature*, was made possible because eight years ago the celebrated fossil took a detour from a U.S. museum tour to the Jackson School's High-Resolution X-ray Computed Tomography Facility (UTCT).

Over 10 days at the lab in 2008, UT Austin anthropology and geological sciences Professor John Kappelman and geological sciences Professor Richard Ketcham carefully scanned every piece of Lucy's 40-percent-complete skeleton to create a digital archive of more than 35,000 CT slices.

Ketcham, who is also the lab's director and Jackson School Associate Dean for Academic Affairs, said researchers jumped at the chance to study Lucy, a 3.2-million-year-old specimen of *Australopithecus afarensis* that is among the oldest, most complete skeletons of any adult, erect-walking human ancestor.

The crew prepared to work day and night and bought a safe to keep the priceless fossil secure—a safe they wouldn't use again until June 2016, when it housed meteorites and Apollo moon rocks from NASA.

The lab's equipment is designed to scan through solid rock at a higher resolution than medical CT. This made the lab one of the few places in the world capable of scanning something as precious as Lucy.

"We were the first industrial CT scanner in a science department in the world when we got our scanner in 1997, and we were recognized as the premier place to have this kind of work done," Ketcham said. "There's only one Lucy, and you want to study her as much as possible. CT is nondestructive, so you can see what is inside, the internal details and arrangement of the internal bones."

The discovery of the cause of Lucy's death would come years after the scanning when, studying Lucy and her scans, Kappelman noticed something unusual: The end of the right

Continued on page 87

LEFT: LUCY'S SKELETON. RIGHT: PROFESSORS JOHN KAPPELMAN (LEFT) AND RICHARD KETCHAM EXAMINE CASTS OF LUCY WHILE SCANNING THE ORIGINAL FOSSIL.

Continued from page 84

made of leftover material from the formation of the solar system—has helped increase UTCT's repertoire and deepened its involvement with meteorites.

By assisting NASA in scanning its samples, Hanna hopes to showcase the value of CT and further strengthen the bonds between the lab and the planetary geology community.

"CT is interesting in the meteorite world because it hasn't been used very much," Hanna said. "We have this amazing technique that can document the interior of these really rare objects ... so it's very desirable that we be more involved in the meteorite community and scan more samples."

The CT scanning project is a new direction for NASA. But collaborations with the Jackson School go back to the space program's Apollo days, with Department of Geological Sciences Professor Bill Muehlberger teaching field geology to astronauts and helping define the scientific objectives for the Apollo 16 and 17 missions. Some of the rocks the lab will be scanning include samples brought back from those very missions. However, "Big Muley"—a nearly 26-pound find from Apollo 16 named in Muehlberger's honor—wasn't among the samples. As the largest rock ever recovered from the moon, it's too big to scan in the lab's instrument.

At their home at the Johnson Space Center, the space rocks are secured in nitrogen-gas-filled cabinets within a vault. During their two weeks at UTCT the rocks were kept in the more modest accommodation of a blue Patagonia duffle bag locked in a safe, with each sample sealed inside a silvery opaque "travel case" made up of three nitrogen-filled bags nested inside each other.

The bags blur the rocks' features from the outside, but disappear completely in CT images that reveal the individual mineral grains that comprise the celestial material.

Some of the specimens are originally from Vesta, the second-largest and brightest object in the asteroid belt. Others are carbonaceous chondrites, Hanna's expertise. From the moon, there are breccias—rocks broken and fused together by the force of an impact like an asteroid—basalts from lunar lava flows, as well as crumbly rocks from the old and cratered highlands.

"Because these samples were chunks on the surface of the moon, they've been smashed by multiple impacts and become really friable, crumbly," Evans said. "So one of the things that we'll be able to do because of the CT scans is have critical data about the samples without having to handle them as much."

All the rocks are scientifically important. But a handful of samples were selected primarily for their celebrity.

Parts of Lunar basalt 70017, nicknamed the "Children of the World Rock," served as a goodwill gesture toward humanity when, in 1973, President Richard Nixon had small chunks of the moonrock mounted on plaques and distributed to all countries in the world and to all 50 United States.

And in 1996 the Martian meteorite Allan Hills 84001 made headlines—and sparked controversy—when NASA announced the rock could hold evidence for life on Mars in the form of microscopic features that looked like fossilized bacteria. The actual identity of the structures remains an open question.

By the end of its collaboration with the Jackson School, NASA plans to scan at least 60 rocks. The CT scans of the first 27 samples will soon provide wider access to rare materials that only a handful of scientists and astronauts have been able to examine up close—and a first look at what's inside.

Evans said she's excited to open up the opportunity to examine rocks from the moon, Mars and other worlds to more people.

"It's challenging for individual students or investigators to get permission to come into the lab, and suit up and interact with the sample, and it's more challenging to be able to provide that opportunity to a larger number of people for understandable reasons," she said. "With the 3-D models, we'll be able to share samples with people anywhere."

MARS METEORITE: NASA. ROMY HANNA: JACKSON SCHOOL. BONE IN CT SCANNER: UT AUSTIN. LUCY RECONSTRUCTION: JASON KUFFER.

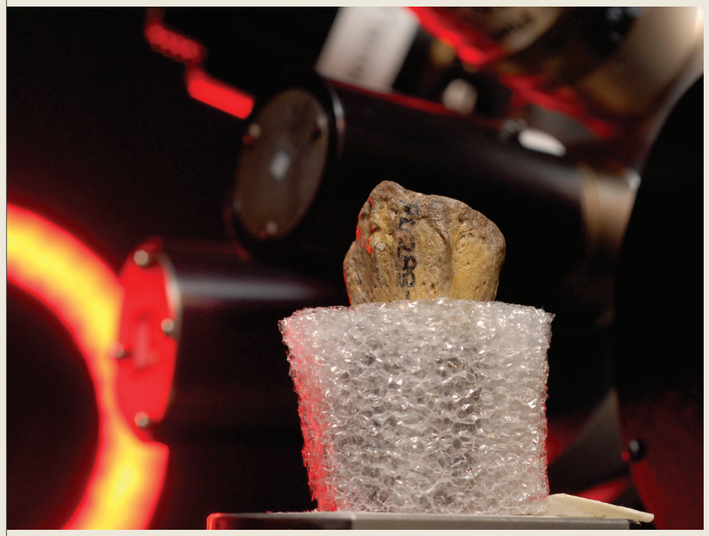
LEFT: PH.D. STUDENT ROMY HANNA WITH A ROCK SAMPLE IN THE UTCT LAB. BOTTOM: AN ELECTRON MICROSCOPE SCAN OF ALH 84001, A METEORITE FROM MARS WITH FEATURES THAT WERE FIRST INTERPRETED AS FOSSILIZED BACTERIA.

Continued from page 85

humerus was fractured in a manner not normally seen in fossils, with the round head of the joint collapsed and driven into the shaft, while preserving a series of sharp, clean breaks with tiny bone fragments and slivers still in place.

"This compressive fracture results when the hand hits the ground during a fall, impacting the elements of the shoulder against one another to create a unique signature on the humerus," said Kappelman, who consulted Dr. Stephen Pearce, an orthopedic surgeon at Austin Bone and Joint Clinic.

Kappelman showed him a modern human-scale, 3-D printed model of Lucy and asked how he would diagnose the break.



Pearce confirmed: The injury was consistent with a four-part proximal humerus fracture, caused by a fall from considerable height when the conscious victim stretched out an arm in an attempt to break the fall.

Kappelman observed similar but less severe fractures at the left shoulder and other compressive fractures throughout Lucy's skeleton including a pilon fracture of the right ankle, a fractured left knee and pelvis, and even more subtle evidence such as a fractured first rib—"a hallmark of severe trauma." These marks were all consistent with fractures caused by a fall. Without any evidence of healing, Kappelman concluded the breaks occurred perimortem, or near the time of death.

A question remained: How could Lucy have achieved the height necessary to produce such a high velocity fall and forceful impact? Kappelman argued that because of her small size—about 3 feet 6 inches and 60 pounds—Lucy probably foraged and sought nightly refuge in trees.

When the findings were announced, news of the research flooded major science and news outlets worldwide. But the theory of her death is not without controversy.

That's because Lucy has been at the center of a vigorous debate about whether this ancient species spent time in the trees in addition to walking on the ground since her discovery in the Afar region of Ethiopia in 1974 by Arizona State University anthropologist Donald Johanson and graduate student Tom Gray.

Thanks to the UTCT and the Ethiopian National Museum, anyone can evaluate the hypothesis for themselves. The researchers have provided access to 3-D files of Lucy's shoulder and knee for the public to download and print on a 3-D printer.

"We are hoping that releasing these files helps lead to a transformation in the culture of how data like this are handled," Ketcham said. "For over 30 years, Lucy was kept in a vault in Ethiopia and few were allowed to see and study her, and any new measurements were treated essentially as trade secrets to be guarded. We want everyone to be able to check what we did, and see if they can come up with anything better, or notice something new."

TOP: A PART OF LUCY'S RIGHT DISTAL RADIUS (ARM BONE) IN THE CT SCANNER. BOTTOM: A REALISTIC RECONSTRUCTION OF LUCY FROM A HOUSTON MUSEUM OF NATURAL SCIENCE EXHIBIT.

3-D FILES AND OTHER SCHOLASTIC MATERIALS ARE AVAILABLE ON ELUCY.ORG.

GULF BASIN DATA

CURRENT EVENTS SPARK NEW LIFE FOR DECADES-OLD RESEARCH

BY MONICA KORTSHA

GULF: ROBERT S. DONOVAN, BOAT: GROUP PHOTO: GBDS PROGRAM.

In 1972 The University of Texas Institute for Geophysics (UTIG) began acquiring and processing seismic data in the Gulf of Mexico to better understand its geology. The surveys were the definition of basic research, with scientific cruises crisscrossing between U.S., Mexican and Cuban waters throughout the '70s and early '80s simply to learn about the tectonic history of the Gulf of Mexico.

The data wasn't of much use to oil and gas companies at the time—they weren't yet drilling into the deep water of the gulf's basin that the surveys covered. The seismic surveys continued until winter 1982, when the Mexican government, bolstered by the United Nations Convention on the Law of the Sea, stopped allowing foreign research exploration on its side of the gulf.

But after 40 years, the vintage dataset has taken on value besides the academic. After being reprocessed and sold by the seismic services company ION Geophysical, the data has brought more than $4.77 million in royalty payments to The University of Texas at Austin where it has been reinvested into UTIG research grants and used to create the Richard T. Buffler Post-Doctoral Fellowship, a position that supports research in basin-scale depositional systems, such as the Gulf of Mexico.

"Scientists and staff members at UTIG will see the benefits of this partnership every year moving forward," said UTIG Director Terry Quinn. "It's truly a win-win scenario."

The amazing returns on the data come from serendipitous timing. Towards the end of the reprocessing and interpretation, in summer 2014, Mexico announced that it would be lifting a 77-year ban against foreign gas exploration and drilling on its side of the gulf. The reprocessed UTIG dataset—dubbed YucatanSPAN by ION—was the only commercial dataset to include data from Mexican waters.

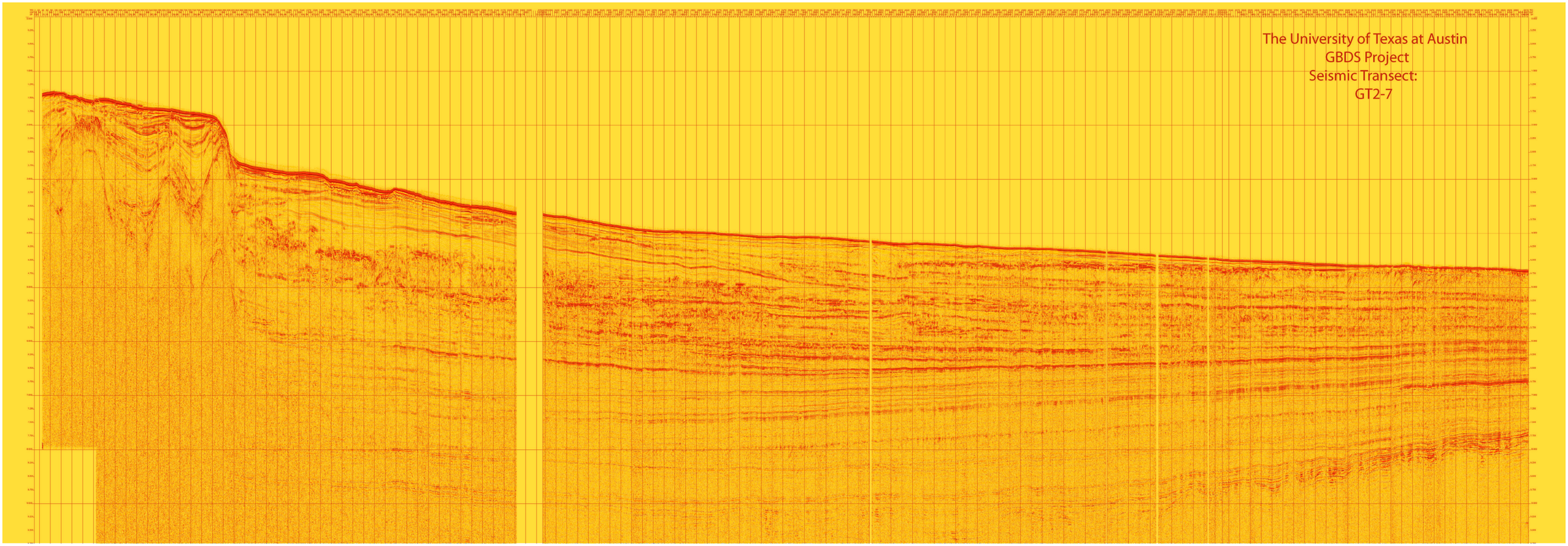
"If you wanted data immediately when those waters opened, ION was there with YucatanSPAN," said Andrew Hartwig, a geophysicist at ION who earned his B.S. from the Jackson School in 2009 and began the reprocessing effort as a master's project at the University of Houston in 2011.

The story of the dataset shows that it's not enough to rely on new data—old data can be key to driving new discoveries. But to be applied, it needs to be remembered, not stored out of sight and ignored.

Professor Emeritus William Galloway said uniting data, old and new, from onshore and offshore sources was what he and Richard Buffler, a retired UTIG researcher, had in mind when they formed UTIG's Gulf Basin Depositional Synthesis (GBDS) program in 1995. The program keeps and builds on old gulf data by collecting information from researchers and industry partners in the oil and gas industry.

"The more you know about what is landward, where the sediment came from, the better you can understand, or make predictions about what's out in the frontier, the basin," Galloway said. "All the pieces come together if you do good work and create periodic reports and updated maps that are useful."

LEFT: THE GULF OF MEXICO.
TOP: (LEFT TO RIGHT) GBDS DIRECTOR JOHN W. SNEDDEN; RICHARD T. BUFFLER POSTDOCTORAL FELLOW CHRIS LOWERY, FORMER UTIG RESEARCH SCIENTIST RICHARD T. BUFFLER, GBDS PROJECT MANAGER PATRICIA E. GANEY-CURRY AND UTIG PROFESSOR EMERITUS WILLIAM GALLOWAY.
BOTTOM: THE R/V IDA GREEN AND THE R/V FRED H. MOORE, UTIG'S SEISMIC RESEARCH VESSELS IN THE '70S AND '80S.



TOP: A SAMPLE OF THE ORIGINAL SEISMIC DATA COLORED ORANGE. BOTTOM: A SAMPLE OF THE REPROCESSED SEISMIC DATA.

Researchers and graduate students involved in the project use data from the GBDS to reveal the depositional history and processes that shaped the gulf, while industry partners, which include national and international companies, apply the data to finding oil and gas deposits. With UTIG integrating decades of data into interactive maps, industry partners are able to skip digging through records and look at results, Galloway said, describing the pitch the GBDS team gave to prospective industry partners when first seeking funding for the research.

The GBDS program has been more successful than anyone ever imagined—transforming from what was planned to be a three-year project to a program in its 21st year, and having its supporting partners grow from 15 to 32. GBDS Program Director John Snedden said the project's focus on basic science is the reason for its success.

"We do fundamental science. That's our first objective," said Snedden, who is also a UTIG senior research scientist. "And what you find is that companies generally tell you that the best decision making is based on good science, so you have to do the science first."

The program also benefits students, who receive training on industry tools as they work on GBDS projects, said GBDS Program Manager Patricia Ganey-Curry. She's been a part of UTIG since 1978 and even longer if you count her time driving the institute's research vessel around the gulf while studying at the Texas A&M Maritime Academy.

"Meeting everyone on board and the excitement of being out at sea brought me here," said Ganey-Curry, who joined the institute right after graduating college.

For over 35 years, Ganey-Curry's job at GBDS has involved maintaining digital data and acquisition records. It's a duty that involves overseeing students who input new information and format old data so it is accessible and not forgotten on reels of microfilm or the pages of old binders. In 2007, one of the student workers was Hartwig, then a second-year geophysics undergraduate.

DATA: GBDS PROGRAM.

"As an undergrad I didn't know how long or how detailed the project was. I was just doing very basic intern, part-time work," Hartwig said. "It wasn't until after I graduated and started at ION Geophysical that I started seeing this GBDS dataset, this regional Gulf of Mexico data, being used in the industry, and then it all kind of clicked one day—I was working on this project that oil companies and service companies like ION are really utilizing for frontier exploration."

He decided to reprocess the GBDS data taken in Mexican waters for a master's thesis project at the University of Houston, where he enrolled in 2011 while working at ION. The data wasn't being directly used by clients, but Hartwig sensed that it had potential, despite skepticism from others.

"People have been waiting for Mexico to open up for 20 years, it's never going to open up," a co-worker told him.

"Well, maybe it will," Hartwig replied, "maybe it will someday and this will give us an advantage."

He then contacted Ganey-Curry and got to work.

Hartwig was granted permission to reprocess GT3 54 and 55, two sets of data that make a single seismic line taken in 1979 that stretches more than 600 miles from one side of the gulf to the other.

Running nearly 40-year-old seismic data through state-of-the-art processing technology improved the resolution immensely, Hartwig said. The reprocessed data revealed new deposition layers from five million years ago in the Miocene era all the way back to the basement structures that formed the very bottom of the gulf over 100 million years ago in the Jurassic. Ganey-Curry's familiarity with the original seismic data helped answer analysis questions that were outside the ability of new technology. For example, she identified an odd reading in the seismic data as an artifact made by swapping out the tapes on which the original data was recorded.

"By no means was it a one man show," Hartwig said. "I was just building on the work of others at the GBDS and my mentors around the office."

Hartwig's thesis work was proof of concept. But rumblings about Mexico finally opening its border led ION to take an interest in reprocessing UTIG's entire seismic dataset. After negotiating a royalty fee, The University of Texas at Austin agreed.

The announcement that Mexico would be opening for outside exploration came months later, and YucatanSPAN was sold to companies around the world eager to see what could be waiting in an offshore area that had been closed before deep-sea drilling had matured.

"It felt really good, personally, to be a part of something that had a lot of value once those Mexican waters opened up," Hartwig said.

The millions brought to the university made the dataset the second-highest-grossing royalty from 2014-2015, while the opening of Mexico has gained the program new industry partners and continued to keep students who contribute to the program in high demand, said Ganey-Curry.

"The last five undergraduates in the program are each where they want to be. Four in graduate school, one in industry," she said.

Rosie Fryer is one of those undergraduates. She earned her bachelor's in spring 2016, has a summer internship at Hilcorp Energy Company and starts graduate school at the Colorado School of Mines in the fall.

"A lot of people who were interviewing me last year were interested in how I was an active student in research, especially in a sedimentology/stratigraphy focused group with Dr. John Snedden and Dr. Galloway—those are two huge names in petroleum geoscience," Fryer said. "So it was a great connection for me. A lot of people could easily recognize I was a part of something that was big."

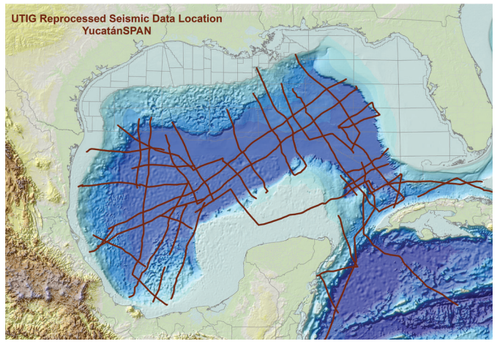
Though large oil and gas companies are now starting to take their own seismic readings in Mexican waters, the data from the 1970s campaign may have more to give. According to Ganey-Curry, UTIG has given ION permission to reprocess the entirety of its Caribbean data, which includes readings taken off the coast of Cuba.

"We have the same type contract where if they sell the data we get a royalty after the derivatives of the sales," she said.

Like Mexico, Cuba has been off limits to private drilling for decades. But with travel restrictions loosening and American leaders, including President Obama and Texas Gov. Greg Abbott, visiting, there's talk that its waters, too, may soon be opening up.

The dataset's renewed value shows that UTIG's mission to learn about the history of the Earth can have unexpected benefits. That's because geological data has long-lasting usefulness, Galloway said.

"In most sciences it's really fair to say that, other than historical reasons, you don't need to read the literature that's more than 10 years old because the new stuff replaces it. But geology, in that sense, is different," Galloway said. "As long as data was collected by a good observer and preserved, it can be just as valuable now, and even more valuable than it was when it was collected, and that seismic data is an example. The raw data may have been cycled and used as acquired, done some useful things ... but you can come back to it and learn whole new things."



TOP: ANDREW HARTWIG WITH SEISMIC DATA. HE BEGAN THE REPROCESSING EFFORT AS A MASTER'S THESIS PROJECT. MIDDLE: RICHARD BUFFLER CIRCA 1977-78 ON THE R/V IDA GREEN PEERING OVER A NAUTICAL CHART OF THE GULF OF MEXICO OFFSHORE LOUISIANA DURING A SEISMIC ACQUISITION CRUISE. BOTTOM: SEISMIC LINES ACQUIRED BY UTIG RESEARCH CRUISES ON THE GULF OF MEXICO. RIGHT: PATRICIA GANEY-CURRY ON THE DECK OF THE R/V IDA GREEN, A UTIG SEISMIC RESEARCH VESSEL, IN JANUARY 1977.

HARTWIG: ANDREW HARTWIG. BUFFLER WITH MAP: PATRICIA GANEY-CURRY. SEISMIC LINES: GBDS PROGRAM. GANEY-CURRY ON R/V IDA GREEN: TRENT HAINES.

In Recognition of Donors

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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.

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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.

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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.

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David Arctur
Jan & Tom* Barrow
Vada & Walt Boyle
Barbara & Philip Braithwaite
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L.T. Barrow Founders Circle

The L.T. Barrow Founders Circle recognizes friends and alumni who have given cumulative gifts of $100,000 or more. 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

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Holland Exploration Inc.

Mr. David L. Kirchner, B.S. '73
Basin & Range Hydrogeologists, Inc.

Mr. James T. Langham
Langham McKay & Company

Mr. Thomas B. Layman, M.A. '87
Parsley Energy

Dr. Susan A. Longacre, Ph.D. '68
ChevronTexaco Fellow, Emeritus

Mr. Richard Lunam
ConocoPhillips

Mr. David T. Martineau, M.S. '97
Martineau Petroleum, Inc.

Mr. Otaviano de Cruz Pessoa Neto,
Petroleo Brasileiro S. A. Petrobras

Mr. Forrest W. Pace, Jr., B.S. '85
Talisman Energy

Dr. Donald L. Paul
University of Southern California

Mr. Wagner Peres, Ph.D. '90
HRT, America, Retired

Ms. Deborah Pfeiffer, M.A. '88
BHP Billiton Petroleum

Dr. David I. Rainey

Mr. Walter J. Scherr III
Valence Operating Company

Mr. Don B. Sheffield, B.S. '58
Hahn and Clay

Mr. Daniel L. Smith, B.S. '58
Sandalwood Oil & Gas, Inc.

Mr. Richard K. Stoneburner, B.S. '76
Pine Brook Partners

Mr. Bryan C. Wagner, B.A. '84
Wagner Oil Company

Mr. John E. Watson, B.A. '72

Dr. Charles R. Williamson, Ph.D. '78

Ms. Cindy A. Yeilding
BP America

EX-OFFICIO

Dr. Gregory L. Fenves
The University of Texas at Austin

Dr. Sharon Mosher
Geology Foundation
Jackson School of Geosciences
The University of Texas at Austin

Mrs. Belle German
Geology Foundation
Jackson School of Geosciences
The University of Texas at Austin

ALUMNI NOTES

1950s

Walter V. Boyle (B.S. '54, M.A. '55) writes, "Vada and I continued our world travels with a three-week Crystal Cruise to Argentina, Uruguay, the Falkland Islands, Antarctica and Chile. Then in June, another Crystal Cruise back to the Hawaiian Islands. I stay active attending computer investment club seminars, Houston Geological Society meetings, men's church group sessions, and working in the yard and garden. In June, Vada finished her two-year term as president of the North Harris County American Association of University Women and continues to serve as a member of the Board of Directors of Houston Symphony League. We continue to enjoy attending the Jackson School of Geosciences luncheons and dinners in Austin and visiting with old classmates and the JSG staff. I also enjoy frequently visiting and talking with Will Green, Burgess Stengl, Bill Holland, and Jimmie Russell. Finally, we wish continued success to Dean Sharon Mosher and her staff for another great year leading the Jackson School of Geosciences into the 21st Century."

Philip Braithwaite (M.A. '58) shares, "Barbara and I continue to enjoy a quiet retirement in Dallas, Texas. I spend my time gardening and attending talks on geology at D.C.S. and UTD. I have swapped trap shooting for sailing. Barbara spends most of her time reading biographical and historical stories. We both have fond memories of Austin and wish the Jackson School every success in the future."

Dean Callender (B.S. '56) says, "Keep the faith. Oil will soon move higher."

Jack Cleveland Cartwright (B.S. '51, M.A. '55) writes, "In July 1951, after completing the required Summer Field Camp at Brady, I reported to Monahans, Texas, to join Stanolind Oil and Gas Company's Seismic crew No. 10. Thus, sixty-five years ago I began my career in the oil business. During 1953 thru 1954 I did return to Austin and obtained an M.A. and my future wife (Barbara Wells) who was working in the Geology Library. After returning to Midland in February 1955, I transferred into the Geology Department and began my career as a geologist. In 1966, I left the major oil company and then worked for a smaller company, an independent oil company and was in a successful three-man partnership for seven years. From 1979 until retirement in 2005, I worked as an individual turning deals and then became primarily an investor. That is a very brief synopsis of my professional life. I must give credit to the university for the fine education that made all of that possible. My life has been blessed by my wife of 61 years, and three wonderful daughters and their husbands that have to present yielded a family that includes nine grandchildren, 13 great-grandchildren, and a great-great-grandson. I feel like I have been a truly blessed man. My best regards to all of the early fifties geology grads that are still around."

Wayne D. Miller (M.A. '57) shares, "I am continuing to consult for a few local independent oil companies but at a slower pace. The lower oil price and my higher age have both had an affect on how much time I spend working. I still enjoy coming to my office and spend time each morning having coffee with a group of retired geologists and solving all our problems. The family is doing fine, and I am enjoying time with the grand- and great-grandchildren. Best regards to everyone."

Jimmie Norton Russell (B.S. '52, M.A. '54) says, "'Never regret growing old, it's a privilege denied to many.' As pointed out to me in the Army, and later in professions, you will have SOME buddies, and a FEW friends. It was SUPER visiting with those still contactable. Some other very pleasant pluses, but also a significant negative, were major items of my year. I was feted again by the Jackson School. 'They are betting on the come!' as a crap shooter would say. After 52 years, I have been reconnected with the young Argentine geologist that assisted me in conducting stratigraphic studies in Patagonia. A mutual colleague now residing in Houston, but in Patagonia then, facilitated exchanging emails with Carlos Perot. Carlos, from Buenos Aires, had just received his geologic diploma from a well-known Argentine university. Carlos was very pleased to be doing field work rather than logging cuttings. Carlos Perot is consulting in Peru and other countries. In a recent email, he informed me that he had learned a lot from me. We had some lengthy discussions, mostly "scientific," pertaining to our work. However, he also entertained me by relating the exploits of earlier geologists exploring the area. Especially el Viejo Greaber and his supply train of 20 mules, 19 carrying barrels of "cerveza!" Carlos is not proficient in English. Fortunately, the excellent Spanish program and its instructors I had at UT, helped me immensely. It gave me an excellent base that I later honed in Venezuela. Our studies were conducted on the outcrops around the string of lakes along the foothills of the Andes. We commenced in the south at Lago Argentino. Floating therein were small icebergs calving from the ice-field glaciers. Standing alongside, and touching one-such, we found that it had polished the igneous bedrock as smooth and shiny as a modern-day granite countertop. Also floating were large chunks of white pumice from an erupted Chilean volcano. That eruption had disrupted the tourism, especially at San Carlos de Barilochi, and the adjacent spectacular Lago Nahuel Huapi. To the north of Lago Argentino, near Lago Viedma, very large fossilized bones littered the ground. They had been eroded from the adjacent

cliffs of tuffs called "Las tobas mamiferous"—tuffs with mammalian fossils. I have had other gratifying experiences with learning/teaching. David was one of my students during my time teaching students with special needs in the Round Rock (Texas) ISD. He frequently was very "low," thus he needed lots of encouraging. Although I have not seen him since retiring, we both have moved forward. Periodically we speak by phone. No longer mostly monosyllabic statements, now his speaking is very indicative of his maturing. This is also evidenced by his pursuit of higher levels of education. I see his mother now and again where she works at Home Depot. (Yes, I am a DIY, but a very limited one now!) Wendy stated, "David loves you!" Also, I was helping another student with whom I had good rapport. I wanted him to understand some problem-solving strategies. Next, he was to learn how to utilize them with problems he was having trouble with. Calmly, I said, "Jacob, the main thing I want you to learn from this is to think." He looked at me and stated, calmly but firmly, "Thats hard!" Another reconnection of a different type was bittersweet. Waiting at Home Depot for paint, we spoke with a priest who was also waiting. Father John, of Saint Joseph's in South Austin, had grown up near Saint Mary Cathedral in central Austin. There he knew Father Whely. Father Whely was very educated, distinguished, and charismatic. We had great rapport with Father Whely; he oversaw the reaffirmation of our matrimonial vows. Sadly for us, Father Whely was relocated to New Orleans. He has long-since passed away. For myself, successful strategies have been perseverance and "keep your cool." Interestingly, several teachers have agreed with me that, even though they might be able to successfully "strategize" with students, they have difficulty with "transference" to adults! Although I have had lower back/leg problems for some time, these now significantly interfere with mobility, etc." Jimmie can be reached at ritalrussell@gmail.com.

Floyd F. Sabins (B.S. '52) writes, "The prolonged slump in oil and mineral prices has impacted exploration projects for my company Remote Sensing Enterprises, Inc. This slump is as serious as any I have experienced in my 60+ years in exploration. Eventually, however, supply and demand will balance out. I am reminded of the following old yarns from West Texas during the previous slump: In Midland a beat-up pickup truck had a bumper sticker, "Lord give me one more oil boom and I promise not to piss this one away." A wildcatter in Odessa was asked about the oil business. He replied "The oil bidness is pickin up. Last week the bank picked up my airplane; this week they picked up my Cadillac." I do continue enjoying the semi-retired life. In 2015, I had three good fly-fishing trips to Montana, Alaska, and Mexico."

Theodore E. Stanzel (B.S. '56) shares, "Since the last newsletter in 2015, Wanda and I have lived a relatively stress free life, in and around Schulenburg with visits to Houston. Last October 2015, we cruised the eastern Atlantic Ocean from Boston around Prince Edward Island, Newfoundland and the St. Lawrence River to Quebec. We are in the process of leaving for Prague in late August and Passau to board the MS Amadeus Silver for a trip on the Danube River to Vienna, Melk, Austria, Bratislavia, Budapest, Romania, Bulgaria, Sophia and to the Black Sea."

Leslie P. White (B.S. '56) says, "Among my cherished campus memories is my involvement with the student geological society, then called The University of Texas Geological Society. In April, 60 years later, I visited the Student Center to support the Undergraduate Geological Society's Geoweek. It was an inspirational visit, heavy with nostalgia. Dianne and I continue to enjoy watching the grandkids grow and, not so much, watching Austin grow."

LeRoy Woollett (M.A. '51) writes, "I had 13 years at Gulf Oil and then 23 with AETNA Insurance. I am retired and living at The Abbey at Westminster Plaza. Having a good time."

1960s

Thomas K. Bjorklund (M.A. '62) writes, "I continue as a Research Scientist and oil and gas consultant at UH. My current goal is to better understand a piece of the climate change story. You can download a draft of my first foray into predicting the future from my webpage, www.geosc.uh.edu/people/faculty/tom-bjorklund, an evolving commentary entitled 'The Goldilocks Climate Doctrine—An analysis of the Mean Global Temperature Anomaly in 2031.' Critical feedback would be welcomed!"

Charles A. (Chuck) Caughey (B.S. '69, M.A. '73) shares, "My first year of retirement flew by, with a move at last to a 1-story patio home nearby, staying active on AAPG Committees (Imperial Barrel Award and Publication Pipeline), and more time for aviation, family and friends." Chuck can be contacted by email at Pak_Chuck@SBCGlobal.net.

Frederik E. Dekker (M.A. '66) says, "We have been applying for exploration licenses in North Africa and southern Europe, and hope to be in position to start serious exploration when the industry recovers." He can be reached at fdekker@wt.net.

Robert H. Fakundiny (M.A. '67, Ph.D. '70) writes, "My mapping in the Adirondack Mountains strongly suggests that the concept of repeated regional shearing events during the Grenville is demonstrated. The monterous (.6km3), 13,000 year-old landslide south of Syracuse presents mudslide hazards to the residents at its base. I hope to have both studies in some sort of publication in 2016. We are well but lament the loss of old UT colleagues."

J. Phil Jones (B.S. '64) shares, "Still enjoying retirement. I'm currently rehabilitating from a leaky heart valve surgery. The surgery was June 9, and I am mending quite well. We still have lots of kids and grandkids living within 1/4 mile of our place. They are amazing to watch. I'm hopeful that the energy business will once again be hiring geologists. Oklahoma City area energy involves lots of Scoop and Stack exploration and multi-well drilling. My hopes and prayers this fall is for explorationist, just graduating or layed off in the downturn of 2015-16, to find new and exciting employers. Wishing for you all the very best." He can be reached at philj1@cox.net.

Jereld E. McQueen (B.S. '61) says, "I am grateful for the basic foundation that the School of Geosciences provided for my career in the petroleum industry."

Tom S. Patty (M.A. '68) writes, "This year is number 4 after retirement from Wiss Janney Elstner Associates Inc. after 30 years doing concrete petrography and aggregate studies. I continue as an affiliated consultant for WJE and provide backup work when needed at the Tom S. Patty Petrographic Laboratory in the Austin Office. In addition, I continue to provide geologic consultation for local central Texas companies that need assistance in locating sand, gravel and crushed stone for the construction industry. The highlight of my fossil collecting for this year occurred during a recent quarry examination in San Saba County with the finding of a large Texas sized straight chain cephalopod Suborder Nautiloides: RAYONNOCERAS, as per the Non-Vertebrate Paleontology Laboratory (JSG). I gifted the specimen to the lab for their collection. My wife JoAnn has been able to go on some of my field studies, and kids and grandkids are all well and live nearby. I was able to attend the 50th Anniversary of the "Tower Shooting Event." I was on campus that day working on my graduate degree and watched the whole thing go down from the old geology building library."

Rubin Amos Schultz, Jr. (B.S. '61) says, "Still enjoying retirement. Spent some time in June visiting Nancy's relatives in Provo and Park City, Utah. Enjoyed the mountains and cool air. Grandkids are growing up fast. Another one graduated from high school this spring, and is on her way to college this fall. Nancy and I are still in Corpus Christi and would love to see any of my classmates, so if you are in Corpus Christi give me a call."

William Feathergail Wilson (B.S. '60, M.A. '62) shares, "Geology may be one of the few professions that a person can still be working at when they are 81-years old. Actively working on the Carrizo paleoenvironments of deposition on the Gulf Coastal Plain through the use samples and geophysical logs as the unit relates to groundwater. Thank you, Dr. Folk." Feather can be reached at featherg@hctc.net.

1970s

Michael Amdurer (M.A. '78) currently resides in Lakewood, CO and can be reached at mamdurer@aol.com.

Sara S. Avant (B.S. '78) currently resides in The Woodlands, Texas and can be contacted at savant@utexas.edu.

Royce P. Carr (B.S. '76) writes, "Deborah and I have moved to the lake but we still live in Mount Pleasant, Texas. I continue to work in West Texas in the Delaware and Midland Basins. I also work in the Eagle Ford-Eaglebine Trends."

Patricia Wood Dickerson (B.A. '70, Ph.D. '95) says, "Late fall afforded fine field sessions in Big Bend. One was to examine the oldest known rocks in the Solitario—a facet of simulating collaborations on the ancient bones of southern N. America. A return to my dissertation area came as a master's committee member for an eager Sul Ross University student who's now working there. Here at UT, I've enjoyed being on the senior thesis committee for a young scholar whose project concerns the age and origin of old, deeply buried metamorphic rocks in SW Texas. This year began in Patagonia, after celebrating the Eve dancing tango in Buenos Aires. Sailing in the wake of HMS Beagle, our Smithsonian group went ashore to sites that FitzRoy and Darwin had charted. At Cape Horn, Poseidon and Aeolus smiled—we could land the Zodiaks and ascend the promontory. I just returned from a Smithsonian trip to Machu Picchu and the Galapagos—climbed above the central archaeological complex to savor

first light on the monumental granite walls...awe-inspiring! Migrating from a high spot to a hotspot, we then consorted with giant tortoises, land and marine iguanas, flamingos and finches in another of Darwin's haunts. As I write this, there's just enough time to launder my socks before returning to Iceland with another SI group. Meanwhile, our latest Marathon research is basking in the light of print. Ongoing GeoRef work with favorite folks at AGI and UT is edifying and enjoyable. Musical accompaniment to all this flows from volunteering for Austin Classical Guitar and dancing Argentine tango and blues."

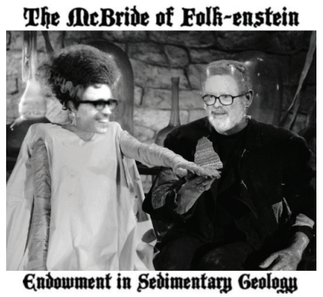
Larry French (M.A. '79) is with the Texas Water Development Board in Austin.

Jerry Gips (B.S. '70) shares, "I retired from Macquarie Capital (USA) in January 2014. Bette and I moved full time to our house in the country outside of Fayetteville, Texas. My neighbor wants to age date the terraces along the Colorado River between La Grange and Columbus. It appears from the literature that the previous work is upstream or downstream of this area. Guess I will be doing some field work again." Jerry can be reached at jerrygips@aol.com.

Charles G. Groat (Ph.D. '70) continues as President and CEO of The Water Institute of the Gulf, an independent, not-for-profit coastal, delta, and water systems applied research and technical services organization based in Baton Rouge, Louisiana. The Institute has many projects supporting the Louisiana Coastal Master Plan for coastal restoration and protection, but is also active internationally. Retirement is planned for mid 2017.

Charles W. Kreitler (M.A. '72, Ph.D. '74) says, "Recently won the lottery. I'm so filthy rich I don't know what to do with it all. For those of us in grad school back in the early 70s, let me know if you have some grand ideas for adventure." Charlie can be reached at ckreitler@lbg-guyton.com.

Robert A. Levich (M.A. '73) writes, "Retirement means that every day is a Saturday. I'm now 75 years of age, but still remain active professionally. Stella and I spent the past year entirely in Las Vegas and were unable to visit our second home on the Coast of Ghana for a variety of reasons. We do hope to return to West Africa in 2017. All our old friends are welcome to come over and enjoy the beauty of the West African Coast and the Gulf of Guinea. In February, I co-authored a paper on the history of Nuclear Waste Disposal in the U.S. with John Stuckless (USGS Emeritus): Stuckless, J.S. and Levich, R.A., 2016, The Road to Yucca Mountain—Evolution of Nuclear Waste Disposal in the United States, in Geological Society of America (GSA)—Association of Environmental & Engineering Geologists (AEG), Environmental & Engineering Geoscience, Vol. 22, No. 1, p. 1-25. This paper goes along with our two previously published GSA Memoirs: Stuckless, J.S. and Levich, R.A., editors, 2007, The Geology and Climatology of Yucca Mountain and Vicinity, Southern Nevada and California, Geological Society of America, Memoir 199, 205 p. and Stuckless, J.S. ed., 2012, Hydrology and Geochemistry of Yucca Mountain and Vicinity, Southern Nevada and California, Geological Society of America, Memoir 209, 393 p. The recent article is available as a pdf to anyone who requests it via email directly from me. The two GSA Memoirs are not available as pdfs, however, they may be purchased very inexpensively directly from the GSA Bookstore." Robert can be reached at cpgeologist@gmail.com.



Sandra J. Lindquist (M.A. '76) shares, "I remember most of my teachers from over the years, but the UT Austin experiences 40 years ago were among the finest with respect to 1) efficient delivery of quality, pertinent information and 2) an effective and (usually) pleasurable learning environment! No worries about political correctness or over-sensitivities back then. No "safe zones" from the faculty or ourselves, either. Now having made my independent living from geology, it was time for special payback to Dr. Earle McBride certainly for humiliating me unmercifully at an anything-but-leisurely game of badminton (only foolish enough to submit once) and to Dr. Robert Folk for trying to tattoo me with his "Folk You" stamp (more than once). Hence, activation of the 2015 JSG "McBride of Folk-enstein" endowment. Please consider it if you also appreciate these professors and might be looking for a place to park some cash in perpetuity for UT. The endowment is intended to recognize and honor "the keen intellects, superior teaching styles, exceptional rock-investigative skills, and geologic-knowledge contributions" of these two now-emeritus professors. A major intent is to prevent loss of invaluable, practical human observational skills 1) as technology continues to be more computerized and "remote" in nature and 2) as attention spans continue to contract and people become more self-centered, impatient, and removed from natural-world reality. Put down your smart phone, and give your thumbs a rest. Pick up a rock to caress and examine instead! "McB of F" distributions will provide graduate student funding for original sedimentary geology or petrology research and application—specifically including substantial, direct and "hands-on," micro and macro examination of sedimentary rocks—and/or funding for supplies or equipment to support continuation of related research by students or faculty. The methodical and direct examination and calibration approaches that Drs. McBride and Folk championed provide stable foundations for interpretation and conclusion—in all aspects of life. (I've also benefitted from using such skills in the medical and legal arenas when necessary!)"

George Allen Livesay (B.S. '79) currently resides in San Antonio, Texas, and can be contacted at georgelivesay@fastmail.fm.

James Irwin Lyons (B.A. '71, M.A. '75, Ph.D. '16) writes, "Well after a long pause, I have fulfilled my lifelong ambition of obtaining my Ph.D. at the age of 68 and my third degree from The University of Texas. Rather than obtaining it to teach, I have completed the dissertation as the first step to getting decades of geologic studies for the mineral industry in Mexico published. My teaching ambitions have been fulfilled by teaching short courses in the mining industry and for the Society of Economic Geology. I am continuing to consult in the mineral industry. James can be reached at jilyons@utexas.edu.

Kenneth E. Nemeth (M.A. '76) shares, "After just over 40 years in the O&G business and 18+ years at Schlumberger, I used the expedited departure to retire from Schlumberger. I have had a very interesting career. I will try to do a few things for HGS and AAPG but otherwise look forward to a few months of contemplation. I can be found on LinkedIn."

John William Preston (B.S. '70) says, "Well, my last year in the saddle, and I'm afraid of retirement. Been working since I was 11 and will be 70 before the end of this year, but since I don't pasture, pool, or tennis maybe can finally figure out something to make money out at my old family farm near Poteet. Hope everyone is hanging on somewhat during this down cycle."

M. Gary Thompson (B.S. '75, M.A. '77) writes, "Still retired. Survived a home remodel project last year. Other than that, we are keeping busy helping to take care of the family ranch in South Texas and the family "farm" west of Brenham."

1980s

Jim Anderson (Ph.D. '85) writes, "Deb has retired from teaching Biology and Environmental Science. We now have twin grandchildren, age 2.5. I am still at ExxonMobil and enjoying work."

Carol Swenumson Baker (B.S. '84) says, "Rodney retired in April. I'm still working but having fun too."

Fred Herbert (B.S. '83) and Teresa Harkrader Becker (B.S. '82) share, "Fred and I are still enjoying our house on the lake in Marble Falls. Fred retired from Shell in March so we've got a couple of nice trips planned. I'm playing pickleball at the YMCA twice a week, taking oil painting lessons and volunteering with Alzheimer's patients on Fridays. Fred is getting caught up on yardwork and enjoying more time to spend on investing. We would love to hear from any of our classmates!"

Cary L. Betz (B.S. '82) is with the Water Availability Division of the TCEQ in Austin.

Julie Bonner (B.S. '83) shares, "After spending the last 18 years of my career working for Chevron as a drilling engineer and multilateral well expert, the most recent 4 years working offshore Angola projects from Houston as a Drilling and Completions Team Lead, I had the opportunity to take early retirement and am thoroughly enjoying not having to get up at 3:30 a.m. anymore! I'm pondering what I want to be when I grow up, which will govern where I decide to live. For the time being, I'm staying put and may consider doing some part time consulting...or not. I'll get some overseas travel in seeing friends and will add a few countries to my current list of 49, but it's getting hard to travel safely these days to some of the countries still on my bucket list, so it may be time to explore my own backyard and see the parts of the U.S. I haven't been to yet. Some of my former geo classmates, like Mike Stowbridge, may remember that 17 years ago, I was in a near fatal car wreck that broke my neck for the second time in the same place (yes, I broke it once before), and I gave some advice in this newsletter to the effect of enjoy life, because you never know when you may get hit by a big ol' truck. I still have the same advice. Oh, and don't die at your desk! If at all possible, retire before you get too old to enjoy it!"

Theresa Brown (M.A. '89) recently returned from a conference in Singapore. Theresa is the technical lead for the National Infrastructure Simulation and Analysis Center work at Sandia and says, "I'm still working some in complex adaptive systems modeling and risk analysis. I keep waffling on early retirement, but seriously considering it in the next year or two."

Jenny Chapman (M.A. '84) is with the Desert Research Institute (DRI) working mostly on DOE groundwater issues and managing DRI's contract with the DOE Nevada Field Office. She says, "I have participated in some interesting projects recently regarding water quality issues with hydrofracturing and water supply in California, so it has been nice to mix things up. My husband has actually just retired, our daughter has married, and my son is finishing a math degree at UNLV. So life marches on."

Tom Connally (M.A. '81) writes, "Another interesting year on the retirement field trip. Highlights include a visit with Al Scott along with fellow Geo alumni George Stanton and Frank Cornish. Dr. Scott remembered us well, and we spent a pleasant lunch chatting about the oil business, geology and old times. We still live part of the year in Tuscany and welcome all visitors. Low lights included finishing up repairs to the Italian house from the '13

earthquake. Never knew aftershocks could continue for 2 years! Yikes. I used to think I wanted to experience an earthquake in person, but when your bed and house are shaking under you while you (try to) sleep it isn't fun at all. Glad that's over with. Travels included excursions to Sardinia, Corsica, Lakes Garda & Como in Italy, and north Spain. I am amazed at all the great research the department is doing covered in the Newsletter. Students today have amazing opportunities compared to the 70s and 80s but then all geology is interesting. So glad I studied at the Jackson before it was called that. I miss Profs. Scott, Young, Muehlberger, Barker et al. I owe you guys for my professional success, THANKS!" Tom can be reached at connalrad@yahoo.com.

Fred Crawford (B.S. '83) says, "An eventful year for me! Hiked 650 miles of the Appalachian Trail... left a gridlocked Austin for the Great Smoky Mountains... bought a 13 acre farm to raise chickens, vegetables and fruit... retirement is wonderful!" Fred can be reached at crawford.fred@gmail.com.

Laura De La Garza (B.S. '83) is an environmental consultant with Laura De La Garza Services in San Antonio.

Andrew Donnelly (M.A. '88) says, "I am a full-time Mr. Mom to two teenagers (at least it feels full time), mostly serving as a Dad Taxi and consulting with Daniel B. Stephens & Associates in Austin, mostly doing water supply work. I have also taken a number of trips with my family, with the Boy Scouts, and with my parents (my dad is one of the world's leading authorities on dragonflies and at 83 still travels all over the world with my mom collecting insects. In November, we go to Paraguay for three weeks to stomp around the jungle collecting)."

Kent England (B.S. '82) writes, "Retired from Marathon Oil in March of 2015—a great time to retire! Splitting my time between Houston (mostly) and Colorado. Staying very busy with travel, golf and family activities. Love to hear from old classmates." Kent can be reached at kengland4@comast.net.

Cynthia Lee Fong (B.S. '88) shares, "Last child graduated high school as a valedictorian and off to a gap year before college. Loving living in Hawaii and my new middle school line—Wood Workshop and STEAM Explorations."

Charles A. Goebel (B.S. '80) says, "Business has been a little rocky but we're very lean, so we're ok. Lots of good people out of work, including geologists. Gave a talk on the Margham Field Discovery, Dubai to FW Sipes in the spring—now that was exploration! Youngest 'child' (heir) will graduate UT in Dec. Her big brother and sister are both UT Austin grads, and doing very well. Pops is proud! (P.S. I am Chief Geologist for Banner Resources, LLC and also CEO of Santa Rita Energy, LLC.)"

Guy Groomer (B.S. '83) currently resides in Loveland, CO and can be reached at gromerg@gmail.com.

Franz Hiebert (M.A. '88, Ph.D. '94) is now Principal at Zephyr Environmental Corporation.

Janie Hopkins (M.A. '82) is Manager of the Groundwater Monitoring program at the Texas Water Development Board.

Les Jeske (B.S. '84) resides in Tyler, Texas, and can be reached at ljeske@solutientgeosciences.com.

Mark Kasmarek (B.S. '82) is with the USGS in Houston.

Richard Alan Kolb (M.A. '81) shares, "Son Travis graduated from Texas State University with a degree in geography in May 2016. Made the trip to his graduation in San Marcos and to see first-hand Austin's horrendous traffic; seems like I-35 hasn't changed at all since I moved from Austin in 1982. Daughter Jennifer (born in Austin while I was in grad school) starts this fall at UT to pursue an M.S. in social work after working for three years at a non profit in Austin. I am the chair of the North Carolina Board for the Licensing of Geologists and continue to work as an environmental geologist for a small consulting firm in Cary. I make periodic trips to Austin to visit my kids and sample the many new microbreweries in Austin and the Hill Country."

John LaFave (M.A. '87) is the Program Manager, Ground Water Assessment Program at the Montana Bureau of Mines and Geology in Butte. John reports that "our oldest son and his wife made us grandparents with the arrival of their son last June. We still have two at home, one in college, and the others are all making their way—though not a scientist in the bunch! Butte is as lovely as ever, the Berkeley Pit is still pH = 2.5 and rising (the water level that is...), snow pack was decent so fishing should be good—and hopefully will keep the summer forest fires away. We're very involved (as is Texas) with getting the national ground water monitoring network off the ground. That's been an interesting process, we're hoping that there will be some long-term funding to support a long-term network..."

Tom (M.A. '87) and Rosie (B.S. '85) Layman share, "This photo was taken in July 2016 at Siccar Point on the east coast of Scotland at the world famous Hutton Unconformity. We had the pleasure of being guided by our youngest son Calvin who had just finished geology field camp in Scotland. What a joy to see such beautiful a country and great geology and best of all to share our passion for geology with our son!" They relocated to Austin in the summer of 2014 and love being back in the city and being involved with the JSG.

David Eugene Lemke (B.S. '82) says, "My ability to dodge bullets ended this past May, and I'm moving my retirement plans up by a year or two. Sandie and I are going to slowly transition ourselves from Houston to northern New Mexico (Pecos), where we've been visiting since field camp days in 1981. You'll be able to find me on a stream teaching fly fishing or just fishing, on a mountain trail hiking, or in a brewery somewhere enjoying a fine New Mexican beer." He can be reached at dlemke@flyfishsantafe.com.

Bruno Maldonado (B.S. '82) writes, "I am not quite 60 yet and not ready to retire. I still have the passion to continue applying the knowledge that was passed on to me by this great geoscience school. I have been preparing for this downturn for some time and am able to weather this storm. Fortunately, I've landed a few consulting contracts (overseas) and have met some great geoscientist way beyond retirement still applying their geoscience knowledge. As for the family, Bruno D., petroleum engineer with Cantera Energy, is still extracting oil and gas in South Texas. Armando, electrical engineer, is at Dow Chemical after finishing up his Masters in EE. Patricia is still working at Cy-Fair ISD and has put up with me 38 years. I am loving the time I spend with my two granddaughters and one grandson." Bruno can be reached at bxm.brunom@gmail.com.

Jude McMurry (M.A. '82) says, "Retired for several years now from the Center for Nuclear Waste Regulatory Analyses (Southwest Research Institute). Now I'm field-testing the proverb, "Nature does not hurry, yet everything is accomplished"—so far, so good. Also blessed with a smart, funny, amazing daughter who is doing a graduate degree in... go figure... geochemistry, at Colorado School of Mines."

David Charles Noe (M.A. '84) writes, "I retired in May 2015 after 24 years with the Colorado Geological Survey, having served as the Chief Engineering Geologist and manager of Colorado's STATEMAP geological mapping program. Upon retirement, I moved to Paonia (pop. 1,500), a coal mining, arts and organic farming community at the western edge of the Rocky Mountains in central Colorado. There, I participate in community events, give public geology talks, and play my trombone in several different bands. Do I love what I do? Yes!! Do I miss working? No!! I am grateful to the UT Geology Department, and especially the recently deceased Professor Alan J. Scott, for preparing me for what has turned out to be a fine career in geology." Dave can be reached at dcnoe@hotmail.com.

Richard E. Paige (M.A. '88) shares, "Next year will be 20 with Suemaur E&P! Am now Chief Project Geologist for the company. After a career spent working onshore Gulf Coast, I have recently begun playing the Pennsylvanian cyclothems of Kansas. Have made three field discoveries—hoping I can keep the momentum going. Sarah retired from her position as Director of Animal Husbandry at the Texas State Aquarium five years ago, and is now enjoying her online craft business. Lately she's wondering when I'll retire, as am I... A shout-out to all my 'CADS' and 'Rock Doctors' friends!"

Joseph E. Patterson (M.A. '83) shares, "I'm currently on an expatriate assignment with ExxonMobil as a secondee to ZADCO (Zakum Development Co., a joint venture with the Abu Dhabi National Oil Co.). I've been here since Dec. 2015 and should be here for another 2.5 years +/- (depending on the Oil Gods). Winters are beautiful and mild; summers less so. If you're in Abu Dhabi, give me a call on my home/office phone or office email. We'll show you around!" Joe can be reached at joe.e.patterson@exxonmobil.com.

Deborah Pfeiffer (M.A. '88) is Vice President of Geoscience Operations at BHP Billiton in Houston.

John Morris Pope (B.S. '86) says, "Continuing my career with Travelers Insurance with the light at the end of the tunnel in sight! Kids are all grown up and attending college, two are at the University of Houston and one is at Texas State in San Marcos. If all goes well I will be the proud parent of another Geologist, an Electrical

Engineer and a Veterinarian! Fingers crossed!" John can be contacted at jpope@travelers.com.

Luke Brian Primrose (B.S. '83) shares, "I have always liked rocks. At 4 years of age the family went to Big Bend National Park where I piled up rocks to take home. Dad said, 'leave them here and we will pick them up on the way back'—right. A few years later I find cool calcareous concretions along Clear Creek in Brazoria County where I grew up. As a young teen, I hit the jackpot when I found a whole cut bank full of bivalve steinkerns near Vanderpool (Edwards Fm?) in Bandera County. I still have several in my collection. Speaking of collection, it is anchored by the tremendous hauls I made on two trips with the late Dr. Edward Jonas to Mexico as part of the SGS, some specimens are better than I've seen in some museums. I will always cherish the times with Dr. J. I have always liked rocks. Now I live on one. A big one. Bioko Island Equatorial Guinea to be more precise. A conglomeration of three shield volcanoes, part of the Cameroonian Volcanic Line. Bioko is dominated by Mt. Pico Basile at just over 9,000 ft. (see picture). About 60 miles off my back porch is Mt. Cameroon, the anchor of the Line around here. It is a massive stratovolcano, the 4th highest in Africa at over 13,250 ft. Unlike Pico, Mt. Cameroon is still active from time to time. Frustratingly, it behaves like Denali—only a few days a year is it clear enough to see all of it, but on those days it is impressive even from that distance.

But all that does not pay the bills. But the Miocene and Pliocene fans and turbidites do. That is why I live on this rock. After a stint with the global E&P arm of Enron, I came back to Marathon and am here working the business and planning chores for our operations which include gas/condensate production and the downstream methanol and LNG plants in which Marathon has interests. My wife Debbie is here too and doing well as are our offspring (4 of them, all educated with 2 being Teasips, 1 UH Cougar and 1 UF Gator) and 5 grandkids with the 6th coming before the end of August. When this gig is done, I suppose we will retire somewhere on the water in Brazoria or Galveston County as bay fishing is my passion, and we spend much of our R&R on the water now. Hello to all from yesteryear—now, how do I get 75kg of rocks on my checked bags...?" Luke can be contacted at lukeprimrosesf@gmail.com or lbprimrose@marathonoil.com.

Jerry Schwarzbach, MD (B.A. '83) writes, "Still playing doctor in Tyler. Enjoying flying & raising cattle. Even have a token Longhorn."

Stephen Speer (M.A. '83) shares, "Still hanging in there in the SC Lowcountry... and really enjoying it. Health is good but the bod is wearing out, me thinks. I'm now the proud owner of a new-fangled titanium left knee and it's been a year getting it up to speed, but it now works well enough that I'm back to ruining the day for some of the younger (and older) tennis players out here. Our five grandsons have been down here to beat me up several times, and our oldest daughter Sarah just informed us that they are adopting a newborn special needs girl from Armenia...she continues to amaze us, and little Maria will have the blessing of having four older brothers to watch over her like hawks. Howdy to all of the Dirty Dozen and others of that gen... pray all of you are doing well and surviving life with aplomb. Cheers! (Attached picture is of my departure from UT headed out on an all-night drive to the oil patch of Artesia, NM for my first job at Yates Petroleum on Aug. 1, 1983. Sending me off are fellow A.J. Scott Dirty Dozen members (left to right) Dave Noe, me, Joe Patterson. 33 years ago...can you tell it's the early '80s?? Joe looks like he ate a bad burrito...). The world's a far lesser place with the passing of one of the finest mentors I have had the pleasure of experiencing in my entire life. Dr. Alan J. Scott was a dynamic inspiration, both professionally and personally, in so many ways to not only me, but all of the graduate students whom he advised back in the early 80s heyday at the end of his teaching stint for the UT Department of Geological Sciences. My prayers and thoughts are with his family, both immediate and worldwide, because he certainly created himself a wonderful family of friends and admirers everywhere throughout his distinguished teaching career. A truly great man and friend. I'm impressed Al...favorably! Adios and Godspeed, mi amigo!!!"

Burgess Stengl (B.S. '85) says, "I am starting my 15th year in the solid waste industry and still live in the Houston area. Our son Kyle will have graduated Klein Oak High School by the time the Newsletter is published, and he should be settled in at UT San Antonio as an Engineering undergraduate (couldn't talk him in to geology). We now are blessed with four grandchildren, ages 11 years to 1 year, with two in Houston, and two in the thriving metropolis of Hutto, Texas. Hello to Walt Boyle, Jimmy Russell, Will Green, and also to the Class of 1985!"

Vance Tillman (B.S. '85) is currently CFO at Tideland Signal Corporation and can be reached at vance.tillman@tidelandsignal.com.

Carla Matherne Tucker (B.S. '86, M.A. '90) teaches at Lamar University and will be leading a field trip to Iceland later this year.

Mark C. Walker (B.A. '81) shares, "With the help and guidance of dedicated legislators, staff, and mental health organizations, we developed and passed in the 2015 Legislature Texas Senate Bill 1624, which requires, for the first time, Texas universities to include in their orientation program a section on mental health awareness and suicide prevention. Under the leadership of UT's Dr. Chris Brownson, program materials have already been developed and distributed to Texas universities. With this new law, we hope to provide a positive message and awareness training to over 150,000 students every year. See the article entitled University Leads Statewide Task Force to Create Suicide Prevention Video at news.utexas.edu."

William Barry Wethington (B.S. '85) says, "Hello to the class of 1985. We had a great field camp. Many good memories! I parted with BP in 2014 after 26 years of working around the globe. I tried retirement for a few months but realized I am not very good at doing nothing. I am currently working for Aramco in Saudi Arabia for one last adventure. My wife, Kerri, still puts up with me after 31 years. Our three kids are doing well. My youngest graduated from UT (Jackson School of Geology) and is now completing his masters in Geology at OU."

Matt Wickham (B.S.'85, M.A. '91) is principal hydrogeologist with Pastor, Behling & Wheeler, LLC (PBW) and manages their Victoria, Texas, office. Matt says, "I have many exciting projects (and some not so exciting). I have learned a heck of a lot about the behavior of arsenic in alkaline groundwater environments."

Jefferson Williams (B.A. '88) is weathering the Oil downturn (acousticpulse.com) and continuing research in GeoMythology (DeadSeaQuake.info). "I started a new business (StoriesFromTheEarth.com) and live in Los Angeles with my daughter Gladys (age 10). I visit Austin at least once per year to visit my mother and can be reached at Jefferson.Williams@gmail.com."

1990s

Keg Alexander (M.A. '90) traveled to southern Tanzania to work on a geothermal resource assessment.

Donald Andrew Bowen (B.S. '91) writes, "After working as a consulting geologist/hydrologist, I earned an M.B.A. and began working for technology companies. I am now seeking water development/water marketing positions at for profits or nonprofits. In my free time I volunteer and try to get my head wrapped around the idea that I'll be 50 this fall. I hope everyone is well."

Bruce Darling (Ph.D. '97) and his wife Diane traveled to Ecuador and the Galapagos Islands for 17 days in November and December 2015. Bruce says, "We spent eight days traveling around the islands under the guidance of Mountain Travel Sobek. We saw points of interest on Baltra, Santa Cruz, Isabela, Fernandina and Santiago islands. There were early morning and midafternoon hikes each day, with time for snorkeling between hikes. There was little downtime between the time we boarded smaller boats each day at 7:20 a.m. and the time we returned to the yacht at 6:30 p.m. I shot more than 2,500 photos of wildlife, plant life, and volcanoes etc. during the trip. One of my favorite sites was Darwin Lake, located on Isla Isabela. Darwin and members of HMS Beagle visited this location in 1835, while in search of fresh water. They were disappointed. It is a saline lake, located in a cinder cone on the flanks of the much larger Darwin Volcano. I was very pleased to have walked through many areas that Darwin visited when he spent five weeks in the Galapagos. I have been to the Masai Mara National Reserve and the Galapagos National Park. I look forward to seeing Tierra del Fuego soon!"

James Farmer (B.S. '94) is currently geoscience advisor for Halliburton/Landmark and can be reached at james.farmer@halliburton.com.

Douglas Gale (B.S. '97) joined JP Morgan's Dallas Energy Group in summer of 2016.

Christi Weissmantel Gell (B.S. '96) now works at Drillinginfo in Houston. She notes that, "our headquarters are in Austin, so I get to come back pretty regularly and hit some of my old stomping grounds. Kiddos are 5 & 6 year old and growing like weeds."

Keith Ging (B.S. '93) is senior hydrologist at the LCRA.

Mark Gordon (Ph.D. '90) writes, "I Started working at PGS last fall. I am interpreting seismic data for input into depth migration. I have been traveling more than in past jobs, but it has been interesting. Ceci and I went back to Alaska last year and enjoyed some early snow. We saw much more wildlife this time."

Kim Gordon (B.S. '99) is with INTERA in Austin.

Barry Hibbs (Ph.D. '93) received the outstanding professor award at California State University, Los Angeles.

Eugene Kim (Ph.D. '98) recently joined (March 2016) Millennium Management as an Oil & Gas Strategist and can be reached at eugene.kim@mlp.com. He was previously with Shell Trading as a LT Fundamental Supply Analyst.

Roger Lee (Ph.D. '96) has been with Sims & Associates now for 8 years in Austin.

Barbara Lorenzo-Rigney (B.S. '99) is with INTERA in Austin.

Barb Mahler (M.A. '91, Ph.D. '97) is with the USGS and part of the team that just published: Source, variability, and transformation of nitrate in a regional karst aquifer: Edwards aquifer, central Texas: Science of The Total Environment, v. 568, pp. 457–469.

Jim Mayer (Ph.D. '95) is department chair at the University of West Georgia in Carrollton, Georgia.

Daniel McConnell (B.S. '95) shares, "I am currently looking at seabed mining and gas hydrate projects globally for Fugro. I also help position the company for deepwater geochemistry surveys in the Asia Pacific region together with UT's own Jamshid "Jim" Gharib. So, plenty of travel for me. I am happy that UT won research funds for gas hydrate drilling in the Gulf of Mexico. I have a bit of history with the discovery and confirmation of the locations that UT intends to core as part of the Gulf in the US Dept of Energy Gas Hydrate Research program. I am glad that I have been able to make a contribution. Hook 'em! The family is doing well. Beth (UT M.A. Social Work) expects to reenter the workforce now that Molly has graduated high school. My daughter Cara will be finishing her B.A. in Geography from UT this year. Molly just enrolled at Southwestern in Georgetown." Dan can be reached at dmcconnell@fugro.com.

MaryLynn Musgrove (M.A. '93, Ph.D. '00) is with the USGS and part of the team that recently published: Source, variability, and transformation of nitrate in a regional karst aquifer: Edwards aquifer, central Texas: Science of The Total Environment, v. 568, pp. 457–469.

Edward Ray Newby (B.S. '91) currently resides in Austin, TX, and can be reached at ray.newby@glo.texas.gov.

Kevin Pasternak (B.S. '95) is a senior hydrogeologist/project manager with AECOM in Austin. He recently attended from the Battelle 10th International Conference on Remediation of Chlorinated and Recalcitrant Compounds that was held in Palm Springs, CA, and presented a poster entitled "Remediating DNAPL from Fractured Bedrock to Prevent Off-Site Migration to a Neighboring Creek."

Sachin Shah (B.S. '98) is currently Chief, Hydrologic Studies and Research, at the U.S. Geologic Survey – Gulf Coast Program and can be reached at sdshah@usgs.gov.

Jacqueline Avvakoumides van Lier (B.S. '97) is Marketing Coordinator at Dale Carnegie Training of Central & Eastern North Carolina.

Jennifer Wilson (B.S. '95, M.S. '01) is with the USGS and just published: Occurrence and concentrations of selected trace elements and halogenated organic compounds in stream sediments and potential sources of polychlorinated biphenyls, Leon Creek, San Antonio, Texas, 2012–14: U.S. Geological Survey Scientific Investigations Report 2016–5039.

Brad Wolaver (B.S. '95, Ph.D. '08) announces the arrival of John David Wolaver ("Jack"), 8 lbs 6 oz. Mom (Abby) and Jack are doing great.

2000s

Mishal Al-Johar (B.S. '07, M.S. '10) was in Dubai and Saudi Arabia over Christmas. He notes, "They have started using treated wastewater for irrigation but in those cases even if they are using wastewater, it might still not be a good idea to use it for landscaping! Dubai is also still trying to use cloud seeding to increase precipitation by geoengineering and claim to have had success this spring with increased storms. However, they have limited stormwater management infrastructure." He adds that they are still complaining about the rain in Portland.

Tyler Arrington (B.S. '08) has been a staff geologist for seven years at InControl Technologies. He says, "We specialize in groundwater and soil remediation and treatment using various techniques from low flow to in-situ injections using natural oxidizers or specialized microorganisms depending on the exceeding constituents of concern. I pursued my Fundamentals of Geology and passed last December, and plan to take the P.G. this fall in October. My family also had a boy this January, and we hope he will be another future Longhorn Alumnus."

Trevor Budge (Ph.D. '08) is with INTERA in Richland, Washington. Trevor and Camy recently returned to Austin for a short visit.

Johnathan Bumgarner (B.S. '02, M.S. '05) started as the director of the USGS New Mexico Water Science Center on February 8, 2016.

Kelly Iacono Daniel (B.S. '04) was promoted to senior project manager with Kleinfelder in Austin, Texas. She currently resides in Pflugerville with her husband and two daughters.

Ronald Dildine (B.S. '03) is Environmental Remediation Program Owner at Flint Hills Resources in Corpus Christi, TX. He says, "my wife Tara and 3-year-old son Jack are greatly looking forward to becoming beach bums in our spare time." He is also a new member of the Corpus Christi Geological Society and the local Society of Mining Engineers.

Patrick Fortson (B.S. '04) has been with Weston Solutions in Austin for five years now and is still enjoying it. Patrick is designing and conducting remedial investigations of soil, groundwater, sediment, and surface water to investigation heavy metals (from lead shot and bullets) and PAHs (from clay targets) contamination. He says, "It is certainly interesting and a challenge learning the CERCLA process. On the personal side, I have been married almost three years now and have an 11-month-old daughter, so that has been a lot of fun."

Beatriz Garcia-Fresca (M.S. '04, Ph.D. '09) returns to Texas. After a couple of years in Norway working with Statoil, Beatriz and family relocated to Houston in 2014. This month they relocated again to Austin, and she continues to work on Statoil's unconventionals R&D and is about to go on a month-long camping & road trip adventure across the U.S. southwest. Bea says, "Looking forward to seeing y'all around!!"

Peggy Hairston (B.S. '05) is a project engineer with Bullock, Bennett & Associates, LLC (BBA) Engineering and Geoscience in Bertram, Texas.

Sally Holl (M.S. '04) is now professor at Austin Community College.

Adrian Lindley (M.S. '05) is with Parsons in Austin.

Ben Linhoff (M.S. '08) just received his Ph.D. at Woods Hole/MIT.

Lauren Greene Martin (B.S. '07) shares, "Charlie Greene Martin was born this past March! The whole family is doing great, big brother Graham has learned how to say, "Hook 'Em Horns!" and Lauren is working part time at Apache in the reservoir modeling team." Lauren can be reached at lauren.greene.martin@gmail.com.

Stephanie Mills (B.S. '09) currently resides in Cibolo, TX, and can be reached at stephanie.elizabeth.mills@gmail.com.

Ryan Parks (B.S. '02) is practicing law in Houston with Lafitte Parks, PLLC, and has been specializing in energy & environmental insurance work.

Suzanne Pierce (Ph.D. '06) is the Newsletter Editor for the International Association of Hydrogeologists United States National Chapter.

Roman Pineda (B.S. '00) is a professional geologist at KFW Engineers & Surveying in San Antonio.

Dennis Ruez, Jr. (Ph.D. '07) writes, "I continue to serve as chair of the Department of Environmental Studies at the University of Illinois at Springfield. Ditto my position as research associate with the Illinois State Museum. This fall I am also becoming the chair of the UIS Department of Biology. I continue to serve at the University of Illinois System level in various capacities."

Marel Sanchez (M.S. '01) says, "I am pleased to announce that I have come with a team to open a consulting firm called Actus Veritas Geoscience, for petroleum asset evaluation. We are pretty positive to address changes needed in oil industry and keep our geoscience experience able to help to address G&G studies to any consulting. Actus Veritas is an integrated team of geologists, geophysicists and engineers specialized in technical and economics evaluations of oil and gas opportunities, business development and compliance. Applying a multidisciplinary collaborative approach and best practices to small and full cycle opportunity evaluation projects optimizing your workflows and delivering value to stakeholders." Marel can be reached at marel.sanchez@actusveritas.com, and her website is actusveritas.com.

Sunday Shepherd (M.S. '00) shares, "16 years and counting with Chevron... My husband Ryan and I have three amazing kids, one of whom is a budding earth scientist! I am returning to Houston to lead the DW GOM regional team after a few great years in Singapore exploring the Asia Pacific region. I look forward to getting back into the Jackson School community. All the best!" Sunday can be contacted at suns@chevron.com.

Sunny Simpkins (B.S. '00) is an engineering geologist in Portland, OR.

Jon Snatic (B.S. '02, M.S. '13) took a position with Halliburton in Lafayette, Louisiana, two years ago.

Dan Stine (B.S.'04) is a senior occupational safety specialist with UT's Office of Environmental Health and Safety.

Cynthia Valle (B.S. '07) is still with the U.S. National Park Service and has recently moved from Arizona to Idaho.

Diego Jose Van Berkel (M.S. '06) currently lives and works in Columbia. He can be reached at dvan@pacific.energy.

Tom Wiles (M.S. '07) reports, " I have been working for a private oil & gas firm, GeoSouthern Energy, here (in Houston) for three years now after spending six years in Denver with Encana. I find the work interesting and find my knowledge of hydrogeology to be illuminating."

Louis G. Zachos (Ph.D. '08) received tenure and promotion to associate professor, Department of Geology & Geological Engineering, University of Mississippi in May 2016.

2010s

Margaret "Maggie" Behnke (B.S. '12) continues to enjoy travelling around the state, country, and the world with her husband. She also got her third hole-in-one this past January. She also is very excited that she has now taken a job with Weston Solutions in their Austin office. She only has about 1-1.5 years left until she gets her P.G. License. Maggie can be reached at Maggie.Behnke@WestonSolutions.com.

Todd Burack (B.S. '15) shares, "August 2016 will mark my one-year anniversary at Aon where I provide risk management expertise for accounts in the renewable energy, transmission / distribution, and utilities sectors. The foundation provided by the Jackson School has prepared me for the ever-changing risk landscape that is characteristic to the power and energy space."

Marcus A. Chroback (B.S. '10) says, "I am a geologist with EOG Resources in San Antonio, Texas. I am currently serving as the San Antonio director of the Jackson School's FAN's Alumni Board. Always looking forward to visiting campus again!" Marcus can be reached at marcus_chroback@eogresources.com.

Luke Decker (M.S. '14) married Elvira Aguilera Alonso in Houston, TX on May 13, 2016.

Rania Eldam (B.S. '13) is the author of "MD and Finn Go Camping!" MD and Finn is an attempt to promote STEM (science, technology, engineering, and math) in a fun and engaging children's book series. Rania shares, "I am an author by nature, a scientist by nurture. Teachers were telling me by the time I was 9 years old that writing would be in my future: from the fake news articles I wrote, to the 13-page long fiction assignments. My imagination had a mind of its own, and with that heavy load, I travelled to New York City at 18 years old to pursue a degree in screen and television writing. It wasn't until I had transferred to the film program at The University of Texas at Austin a year later, that I stumbled into the limestone-pocked building with floors covered in dust and Chacos. I was taking Age of Dinosaurs, because why not, and suddenly, laid out before me in a span of 4.5 billion years, was the greatest story I could have ever hoped to tell. It didn't take long for the paperwork to go through and I became an official geology student in the Jackson School, but I kept telling myself that I wasn't giving up on my dream—I had just found another, more career-stable, one. A few years later, I began working on the pre-MD and Finn project, placating my nagging subconscious that I should still be writing creatively, and initially developed the plot of a cute little children's book with an animated fox (Finn) that ran around experimenting and blowing things up in his little white lab coat and safety goggles. His best friend, MD would come along and sort of keep him out of trouble, helping him learn how to properly do science. After brainstorming some of the first book, I realized that although I may empathize with the little fox who, despite his good intentions, just keeps breaking things in the lab, I was creating another story with similar features to most of the other children's books and television shows out there: a male (human/animal) main character, and a female sidekick that was the "motherly" figure who took care of him. I acknowledged that this was not the message that I wanted to continue to portray, and instead focused on a female protagonist who drives all of the questions and experiments that occur on their adventures. It was incredibly important to me that young girls see someone just like them being an adventurer and critical thinker. Similarly, it was essential for them to see that there are adventures in everyday life—even something as small as watching the stars at night. Every scientific question that I've ever had has been an adventure to me—a question which I am itching to solve, and I felt compelled to instill that same sense of curiosity within every child. Even through this realization, though, the practicality of creating the book itself was still just a little dream that I kept pushing off into my future—never really taking it seriously. I'm not sure why I started talking about that dream a little more in the fall of 2015, but I did, and one conversation led to another, where every person I would chat with about it kept asking me the same thing: why aren't you doing it? I was the master of excuses: time, money, feasibility, but what it really came down to was that I was terrified of failing at something that I felt incredibly passionate about. I didn't want to throw my dream into the tumultuous criticisms of the world, ready to be hacked apart, designated as useless dribble. However, after hearing my friends, colleagues, and mentors, repeatedly ask me that question, I finally had to face that fear and acknowledge that if I wanted to create an adventurous character who was ready to try anything and risk failure to learn new things, then I needed to emulate that bravery. It started one little bit at a time. I asked friends if anyone knew an artist that might be willing to work on the project, and in that way, I found an amazing illustrator/graphic designer who has done brilliant work. I learned all about the intricacies of self-publishing, and established an LLC to begin the process, becoming a business owner while finishing the last semester of my MSc. I realized how much money it was going to take to develop, so I made a successful Kickstarter campaign. Everything just sort of seemingly kept working out, so I kept moving forward. Now, I somehow have 10 boxes of copies of "MD and Finn Go Camping!" sitting in my garage that are slowly getting lighter every day, with every new purchase. It's truly been a dream come true. So Kristen (the illustrator) and I have already begun working on book number two, "MD and Finn, Solar Power!"

Audrey Eljuri (B.S. '14) is with TRC Environmental in Austin.

Kyle Gabb (M.S. '16) currently resides in Webster, TX and can be reached at Kcgabb@gmail.com.

Chelsea Halley (M.S. '16) is a geologist in the remediation division of AECOM in Austin.

Jenna Kromann (M.S. '15) is with GSI, Inc. in Austin.

Daniel Le (B.S. '14) is with GSI, Inc. in Austin.

Lorena Roque Martinez (B.S. '16) is now Karst Educator- Geoscientist in the Park at Buffalo National River in Arkansas.

Scott Moorhead (M.A. '12) is working with the Ben Barnes Group, LP in Austin. He says, "I am spending more time on Central Texas land issues including conservation with Texas Land Conservancy, whose board I joined last year. Also working hard to meet many of the professionals in the space from legal, geo, hydro, planning, non-profit disciplines. Trying to become engaged in contributing an informed and sober opinion about water-energy-transportation loops and how it all fits together. More importantly, proud father of two lovely children, 3 and 1 years old."

Frank L. Morgan (B.S. '11) is working as an exploration geologist in Devon Energy's New Ventures group in Oklahoma City.

Kimberly Dawn Myers (Ph.D. '15) writes, "After graduating in May 2015, I began an NSF funded postdoctoral fellowship, working in both the Department of Geology and Geophysics at Texas A&M University and the Lamont-Doherty Earth Observatory at Columbia University until June 2017. My work focuses on the Barberton Greenstone Belt in South Africa and Bangladesh, and I am looking at the distribution of arsenic in 3.2 billion-year-old sedimentary rocks. In late July I traveled to South Africa to conduct my first field season." Kimberly can be contacted at myers.kd@gmail.com.

Brandon Okafor (B.S. '12, M.S. '14) is now a hydrogeologist with AECOM in Houston.

Ashley Elizabeth (Quinn) Payne (B.S. '10) is currently a postdoctoral research fellow at the University of Michigan and can be reached at aepayne@umich.edu.

Audrey Pfeil (B.S. '13) is working with Harden & Associates in Austin.

James Pinkard (B.S. '12) is with INTERA in Austin.

Benjamin Porter (B.S. '15) currently resides in Houston, TX and can be reached at bbporter1@gmail.com.

Enrique Reyes (B.S. '16) writes, "Hi everyone! After graduation, I was accepted into and joined Teach For America and was placed in my hometown of San Antonio. I will be teaching science at Sam Houston High School, the same high school I graduated from in 2011. I love education, so as modest as this is, teaching is a dream come true. I had an awesome experience as a summer school teacher in Houston, and can't wait for my classroom in San Antonio at Sam Houston high school." Enrique can be reached at rique.reyes@gmail.com or enrique.reyes.16@tfacorps.org.

Ian Rogers (B.S. '13) has been working with the USGS as a hydrologic technician in beautiful Puerto Rico for almost two years now.

Audrey Sawyer (Ph.D. '11) is at The Ohio State University and has been chosen as the GSA Hydrogeology Division's 2016 Kohout Early Career Award recipient.

Diana Schlotter (B.S. '12) and Nabiel Eldam were married on October 27, 2015. "We are happy to be included

amongst the multiple Jackson School husbands and wives."

Samuel Shrull (B.S. '16) will be pursuing a M.S. in Geology at LSU in the fall of 2016.

Anna Eliza Svartman Dias (Ph.D. '15) currently resides in Rio de Janeiro and can be reached at annasvartman@gmail.com.

Nolan Townsend (B.S. '13) is with Pastor, Behling & Wheeler, LLC (PBW) in Round Rock, TX.

Michael Tso (B.S. '12) is now a Ph.D. student in environmental science at Lancaster University in the United Kingdom, after graduating from the University of Arizona with a M.S. in Hydrology. Michael is now married to Elizabeth, and the wedding was in Tucson last December.

Kelsi Ustipak (M.S. '15) says, "Following graduation from the Jackson School in December 2015, I moved to Houston to begin a career in reservoir geoscience consulting with Badley Ashton America. I trained as a borehole image interpretation specialist, focusing on Miocene age deepwater deposits in the Gulf of Mexico."

Nathan van Oort (B.S. '13) is a hydrologist with the Texas Water Development Board.

Kristopher Voorhees (B.S. '14, M.S. '16) graduated in 2016 with a Master's in Geology studying under Dr. Charles Kerans and the RCRL group. He says, "I traveled throughout SE Asia (Thailand and Japan) for a month the following June. Then I moved to Houston and began working with Apache Corporation and beat traffic by riding my bike to work every day." Kris can be reached at kris.voorhees@utexas.edu.

Maureen LeVoir Walton (Ph.D. '16) shares, "I recently graduated from UT with a Ph.D. after working with Sean Gulick at the Institute for Geophysics, and started a Mendenhall postdoc at the U.S. Geological Survey in Santa Cruz, California. I'll be working with the Marine Geohazards team on offshore hazards related to the San Andreas strike-slip system for the next two years."

Andrew Yanke (M.S. '16) writes, "After graduating recently from UT Austin, I'm looking forward to whatever stories that all of us recent alumni will make! I'll be beginning my career with Statoil in Houston, Texas, this fall 2016 after having spent my summer in San Antonio, TX. I was born and raised in Colorado, but I am excited to continue venturing in the path of a newfound Texan. I might even give into getting my first pair of cowboy boots...we'll see. Cheers!" Andrew can be reached at ayanke@utexas.edu. Photo is (left to right) me, Dr. Kyle Spikes, Dr. Qi Ren, Jennifer Beam, and Barry Borgman after graduation. We were all part of the same research group.

William I. (Bill) Woods (retired executive assistant in the Department of Geological Sciences) shares, "2015-16 was a very good year. I continued working part-time at WPR, but that position expired on June 15th, so I'm back in full retirement mode. In May-June, Francisco and I spent three weeks in Japan, visiting Tokyo, Hiroshima, Kyoto, Kobe and Osaka. It was a fantastic trip and we really enjoyed the culture, the high speed trains, the beautiful temples and shrines, as well as the local cuisine. Kobe was my favorite, although Hiroshima Peace Memorial also stands out, as well as the Great Buddah in Tokyo. On our trip to Mt. Fuji, we were blessed with a beautiful day. Occasionally I see a few of my former faculty friends at Gregory Gym, where I continue to work out three times a week. If anyone would like to see pics of my travels, check out www.osote.net. I can be contacted at billw@utexas.edu."

Jackson School at a Glance 2014-15

CLOCKWISE FROM TOP LEFT: DAN (B.S. '58) AND JOANN SMITH WERE ALL SMILES AT THE 2015 EVENING OF THANKS; FUTURE ALUMNI YASER ALZAYER, NATHAN TINKER, ANDREA NOLTING, AND BEN SMITH BROUGHT BURNT ORANGE TO THE GREAT WHITE NORTH AT THE AAPG BOOTH IN CALGARY IN JULY 2016; NIKKI SEYMOUR (M.S. '15) CAUGHT UP WITH MAUREEN LEVOIR WALTON (PH.D. '16) AND HER HUSBAND DAVID AT THE ANNUAL JSG LUNCHEON IN CONJUNCTION WITH AGU IN DECEMBER 2015; ANA MANZOLILLO RAMIREZ (B.S. '06) AND HER HUSBAND DAVID TAUGHT THEIR KIDS HOW TO HOOK 'EM AT THE ANNUAL JSG TAILGATE PARTY; FRED OLIVER (B.S. '51) LEARNED A THING OR TWO FROM MASTERS STUDENT KELLY HATTORI AT THE ANNUAL SCHOLARS LUNCHEON IN NOVEMBER 2015; RECRUITING BEGAN EARLY FOR LUKE (B.S. '07) AND BLAIR (B.S. '07, M.S. '09) FRANCIS' DAUGHTER LILY, FUTURE GEOSCIENTIST.

MEMORIALS

Edwin Valentine Acker, Jr. (B.S. '56), age 86, passed away at his ranch in Tilden on Sunday, Dec. 20, 2015. He was born and raised in New Gulf, Texas. He attended Wharton County Junior College and Baylor University until called to serve his country in the Korean conflict. Upon his return, he graduated from The University of Texas at Austin with a degree in petroleum geology and worked for both Standard Oil and AMOCO, finding several major oil fields. In 1972, he moved his family from Houston to the family ranch in McMullen County where he raised cattle until he retired to enjoy life full time. Ed was a long time member of the Baptist Church in Tilden and many have benefited from his commitment to his faith and have enjoyed his spiritual legacy. He was a rock for his family and loved the outdoors—fishing, hunting, and riding around the family ranch which he jokingly called Poquita Nada. Ed passed away at home on the land that he and his family loved and worked for over 115 years. He is survived by his wife Beverly Shelton Acker, and all three of his children and their families; son, David Shelton Hollers and wife Linda; son, Edwin Scott Acker and wife Michele; daughter, Shella Deeann Bonner and her husband Wesley; five grandchildren and four great-grandchildren.

Jim Walther Adams, Jr. (B.S. '51), of Midland, passed away on March 9, 2016 at age 87. Jim was born to James Walter Adams, Sr. and Lula Marti Adams and grew up in Highland Park in Dallas. Jim spent two years at North Texas State University and loved fossil hunting, rocks and more rocks, and lecturing on geology. Jim also had a great love for steam locomotives and would visit the depot in Dallas, Texas. The University of Texas was his joy and where he got his degree in geology. Jim joined the United States Air Force and served as first lieutenant. Afterwards, Jim returned to Humble where he worked until retiring in 1994. Jim's favorite activity was camping with family, snow skiing, climbing mountains, and working with Boy Scouts, where Jim earned the Silver Beaver for leadership. Jim was devout in his faith and a loving man of God. He served as the 7th grade Sunday school teacher and a Royal Ambassador leader for many years. Jim was a faithful member of First Baptist Church in Dallas and later in Midland. Jim was a life member of AAPG. Jim leaves his loving wife, Terry; son, Robert Harrington; son, David and wife Barbara Harrington; son, Charles and wife Lou-Ann Adams; daughter, Leslie Adams Crawley and husband Jerry Crawley; daughter, Patricia Adams Wooldridge and husband Mark Wooldridge; three granddaughters and five grandsons; four great-grandchildren.

Effie D. Bay (spouse of the late Thomas A. Bay, Jr., B.S. '49, M.A. '54), 90, of Houston, died peacefully in her home on June 11, 2016, after a full, healthy and long life.

Mona S. Biskamp (spouse of the late William Taylor Biskamp, Sr., B.S. '54), passed away on April 16, 2016.

Alfred T. Carleton (B.S. '51, M.A. '52) of Midland, was born to Alfred T. Carleton, Sr. and Winnie Snell Carleton. He grew up in Houston and then earned a B.S. in 1951 and a M.A. in 1952, both in geology, from The University of Texas at Austin. While there, he was a member of Kappa Sigma Fraternity, through which he was introduced to a cute little blue-eyed blond named Corinne Phillips. They were married, and she became his best friend, business partner, and love of his life for some 63 years. His work experience includes: geologist with the Ohio Oil Company, chief geologist with Zapata Petroleum Corporation, general partner in Structurmaps, Ltd., vice president and Western Division Manager for Pogo Producing Company. He was president of Tocor Investments, Inc. and member in Imperial Operating company. He and his wife also operated ranches in Crockett and Val Verde Counties in Texas. Professional activities include: president of West Texas Geological Society, chairman Midland Chapter SIPES, chairman of House of Delegates and president of AAPG and national president of SIPES. Professional honors include Honorary Membership in WTGS, SIPES and AAPG. Social and community activities and/or memberships include: Midland Country Club, Petroleum Club (past president), Exchange Club of Midland (past president), and Dirty Dozen Luncheon Club. He and his wife are long time members of Holy Trinity Episcopal Church. Toby loved to travel and he and Corinne (and the children when they were younger) traveled extensively. They have driven around and through all 50 states and have been in every province of Canada. They have traveled in much of the Caribbean, Europe, Asia, South America and Central America, Africa, New Zealand, Australia, the Bahamas and Bermuda. More than any of the above, he was a loving and devoted husband, a caring father, and a doting grandfather. Toby is survived by his loving wife, Corinne Carleton; his children, Cathy Carleton Martin and David Martin; Elaine Carleton and Dori DeJong; Phil Carleton and Kim; as well as six grandchildren.

Mary H. Carter (spouse of the late Robert D. Carter, B.S. '48, M.A. '48) died July 7, 2016 after "a long battle with old age" (her words).

Jerrie H. Collins (spouse of the late Jerry H. Collins B.A. '53, B.S. '54) passed away Aug. 10, 2016 in Brenham with family at her side.

Rodger E. "Tim" Denison (Ph.D. '66) died July 8, 2016 at age 83. Tim was born in Fort Worth to A. Rodger and Maude Espy Denison. He was raised in Tulsa and graduated from Wentworth Military Academy in Missouri. He obtained a B.S. in geology from the University of Oklahoma. He was drafted and completed Ranger training in Georgia before serving two years in Korea. He was a well-respected platoon leader, although he rarely spoke of his service. It was in Korea that he developed a fondness for classical music, not as much initially for its beauty, but because classical music records were only a dollar. Tim returned from Korea and enrolled in the geology master's program at the University of Oklahoma. It was there, in 1957, that he met Caroline Holmes on a blind date, and they married three months later. After completing his master's degree, Tim did a brief stint at the University of California at Berkeley before coming to The University of Texas at Austin to complete his doctorate. His association with UT would last his entire life, and it was there he formed seminal and lasting relationships with other geologists with whom he would work for decades. He was one of the youngest people ever named to the Advisory Council and missed only three of the committee meetings in his more than four decades of service. By the time he finished his education, daughters Kelly and Cambria had been born. In 1964, Tim took a job with Mobil Oil and the family moved to Dallas. When he wasn't working, he rebuilt Alfa Romeos, played tennis, read a wide range of books and collected Bullwinkle memorabilia. His family will remember him as a superb team member to have in a game of Trivial Pursuit, a weekend cook whose specialties were nachos and grilled cheese made in the waffle iron and a connoisseur of both good and cheap beer. He was an avid Simpsons fan, could recall dozens of New Yorker cartoons, and was very fond of cats. He did not like vegetables or cell phones and tried to avoid both. Survivors include his wife of 58 years, Caroline Holmes Denison; daughter Kelly and son-in-law Tim Harrell; daughter Cambria and son-in-law Brian Reinsborough; and three grandchildren.

Jacqueline M. Ellsworth (spouse of the late Ralph I. Ellsworth M.A. '49) was born in Galveston, to Grace Bookman and James Arley McKay, and died July 21, 2016, in Dallas.

Franklyn R. Engler (B.S. '58) was born in Seguin to Robert and Louise Specht Engler. Frank enlisted in the United States Army and held all ranks from private to master sergeant before he graduated from Officer Candidate School, Class 28, Fort Benning, Georgia in September 1952 and was commissioned 2nd LT. Infantry. He was discharged from active duty in 1954 and remained in the U.S. Army Reserve, attaining the rank of captain, before resigning in 1958. Frank was extremely proud of his years in the service of his country. He attended The University of Texas at Austin and received a B.S. in Geology in January of 1958. He was an avid Longhorn supporter and Life Member of the Texas Exes. His first job after college was with The Pure Oil Company in Corpus Christi where he was oil scout. When Pure Oil closed that office, he was hired by Texas Eastern Transmission Corporation. He was very active in the scouting association and established and managed a sample service for that organization. In 1962 he married Bessie "Bunny" Wynn. In 1964 he was transferred to Pittsburgh, Pennsylvania where he helped develop a gas storage field in Accident, Maryland. During that time he participated in the drilling and completion of more than 60 wells. In addition, he worked on numerous projects in the Appalachian Basin and offshore United States areas. He also was part of a team that explored the possibilities of coal gasification. In 1979 he formed Engler Exploration, Inc. and remained active in the oil and gas business until his death. He was a founding member of the Eastern Section of AAPG and served as its first secretary/treasurer and was honored with its Distinguished Service Award. In the early 1970s he served as secretary of the AAPG Delegates. He was a member of the Trustee Associates of AAPG as well as the Washington D.C. and Corpus Christi chapters of AAPG. He was a certified professional geologist and a member of The American Institute of Professional Geologists. He is survived by Bunny, his wife of 53 years; his daughter Donna Ann Engler Howard; his son-in-law Nicholas Phillip Howard; and four grandchildren.

J. David Farmer (B.S. '81), 58, of Midland, passed away on June 13, 2016, in Dallas. David was born to Donald and Carol Farmer in Angleton, Texas. David attended Texas Lutheran with a football scholarship, where he was later inducted into the Hall of Fame, and finished his college career at UT Austin where he graduated with a B.S. in geology. He worked for various companies in various locations including Alaska and Russia. He most recently worked for himself as an independent geologist at David Farmer Exploration, LLC. Upon graduation, he moved to Midland and joined multiple geological societies where he could share his passion. He served on several committees for the West Texas Geological Society (WTGS) and the Permian Basin Section of the SEPM. He was elected vice president, secretary, and president of the WTGS. His exceptional leadership was recognized in 2011 when he received Honorary Life Membership, the highest honor the WTGS can bestow on one of

its members. David was also a member of the Midland chapter of SIPES where he served as secretary and Midland Chapter chairman. He joined AAPG in 1980 and served as a delegate for 17 years. His hobbies include hunting, fishing, snow skiing, wood working, riding motorcycles and sports, but must importantly spending time with his family. He is survived by his wife, Sharon (Richey) Farmer; son Jace Farmer; daughter Jordan Farmer; and their family dog, Roxy.

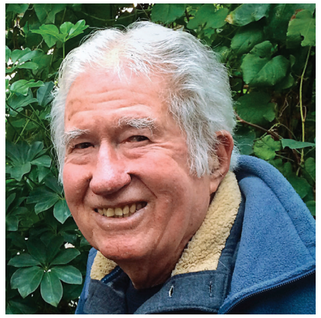
Priscilla Pond Flawn (spouse of Peter Flawn, The University of Texas at Austin president emeritus, former director of the Bureau of Economic Geology, and professor emeritus at the Jackson School of Geosciences) passed away April 12, 2016. She was born to Russell Pond and Berniece Brooks Pond in Sarasota, Florida. She graduated from Oberlin College in Ohio with a B.A. degree in English and a minor in music. She and her husband had two children, Tyrrell Flawn and the late Laura B. Flawn, M.D. Mrs. Flawn had a lifelong interest in the education of young children. For 14 years, she was teacher and Head Teacher at Good Shepherd School in Austin. She was a founding member of the Austin Association for the Education of Young Children and served on the Austin Child Care Council, the editorial board of the syndicated Child Care Column carried by the Austin American Statesman and the Parents as Teachers Committee of the Mental Health Association of Texas. Upon Dr. Flawn's first retirement from UT in 1985, friends of Mrs. Flawn set up a Professorship in Child Development within the Department of Human Ecology. In 2002, when the Sarah M. and Charles E. Seay Psychology Building was dedicated on the University of Texas campus, the Child and Family Laboratory School in that building was named in her honor. For more than 50 years, she loved and supported The University of Texas. In 1985, with matching funds from the Board of Regents, two additional Priscilla Pond Flawn Professorships were established —one in Organ for Piano Performance in the School of Music and one in Early Childhood Education in the College of Education. As part of the Bass Performing Arts Center 2001 Gala, two scholarships in the College of Fine Arts were created in her honor—one in theatre and dance, and one in music. She was an honorary member of the Advisory Council for the Texas Memorial Museum and served on the Executive Committee of the Chancellor's Council. Since arriving in Austin in 1949, Mrs. Flawn was very involved in the Austin community. This included her service on the Austin Community Foundation Board of Governors and the Executive Council of the Umlauf Sculpture Gardens. She was a member of the board of the Austin Children's Museum and had memberships in the Society of Mayflower Descendants and the National Society of the Colonial Dames of America in the State of Texas. In 1989, she was appointed to the Governor's Commission on Women by then Governor Clements. She served a three-year term on the St. Andrew's Episcopal School Board of Trustees and was the recipient of the Charles Alan Wright Award. Many knew Mrs. Flawn as the First Lady of The University of Texas at Austin. Prior to that, she was the founding First Lady of the University of Texas at San Antonio. She joined Dr. Flawn in building a new university from the ground up. There were only 25 employees when they arrived in San Antonio and five years later, when they returned to Austin, there were 7,000 students. She was a wonderful mother who taught her daughters to work hard and reach for the stars. She was fondly known as Mema to her grandchildren and great-grandchildren and would often be found singing, dancing and sharing a life lesson with the next generations. She is survived by her husband of 70 years, Dr. Peter Flawn, her daughter Tyrrell Flawn and her husband, John P. Howe III, M.D., four grandchildren and nine great-grandchildren. She was predeceased by her daughter, Laura Flawn, M.D.

Marjorie Thomas Folk (spouse of Robert L. Folk, professor emeritus at the Jackson School of Geosciences) Most of Marge's ancestors were Quakers in the Philadelphia area, stemming from William Penn's colony. She was born March 11, 1926, and spent her childhood in Kennett Square, Pennsylvania. After attending Westtown, a Quaker school, she entered Penn State. On March 14, 1946, she joined the Nittany Coop, a student rooming/boarding organization for boys and girls, and on her first supper, met geology student, Robert Folk, then waiting tables. They got engaged in four weeks and married September 7, 1946. She had two sons, Bobby and Mark, and a daughter, Jennifer. Eventually, Bobby and Mark were admitted to Travis State School, and there Marge and her good friend Martha Jonas taught an art class for retarded students. They went once a week for nearly 30 years, and Marge was honored by the State of Texas award for some 7,000 hours of volunteer work.

Bob and Marge joined the Wedding Ring Class at First Methodist in the mid-1950s, and for many years the class put on a Christmas parties for the boys in her art class. In connection with his geological/archaeological studies, they lived in Canberra, Australia and Milan, Italy for six months each and traveled extensively in both countries. Italy enriched their lives.

Daughter Jennifer is married to a geologist, Steven D. Mann, and they have four children: Jessica in northern California, Elena in Denver, CO, Heather in Austin, and Trevor in Birmingham, AL. Marjorie is survived by her brother Bob Thomas and wife Ellie in Florida.

Dan R. Frantzen (M.A. '58) was born in Fredericksburg. Dan was scrawny and became scrappy to survive. He hoped to be a professional jockey but grew over 6 feet tall. He planned to attend college on a football scholarship, but shattered his knee in his last high school game, ending his dream. Thereafter, Dan decided to study mining engineering. While doing postgraduate work deep in a uranium mine, despising the heat, Dan realized his decision was flawed. Dan returned to The University of Texas to earn a master's degree in geology to pursue a dream of wildcats, gushers and massive wealth creation. He met and married Nita, and they had three children. Dan formed Stone Oil with friend Jimmy Stone to find projects in onshore south Louisiana. Today, Stone Energy is a publicly traded company. Following his career with Stone, Dan was blessed by to marry his second wife Claire Delahoussaye in 2000. Dan often reflected on the unexpected twists and turns of life, and he lived by the unwavering rule that adversities were the building blocks of opportunities in life. In 2008, Dan authored a book, "Ode of an Oilman – A Life Examined," in which he offered motivational and inspirational thoughts and ideas based on his life. Dan died on Sep. 8, 2015, surrounded by the most gorgeous geology and maps he ever created. Dan leaves to cherish his memory, one daughter, Blayne Frantzen; two sons, Garron Frantzen, and Kohlar "Kohlie" Frantzen and his wife, Elise; mother of his children and dear friend, Nita D. Frantzen; former wife and dear friend, Claire Frantzen; four grandchildren; and his best friend for life, Joe Klutts.



Worth Merle Freeman (M.A. '50), 95, died Dec. 24, 2015 in Thornton, Colorado. Also affectionately known as both "Frank" and "Granddad," Merle was born in Shamrock, Oklahoma, to Edward and Goldie Freeman. His family moved more than 10 times during his childhood to small oil towns in Texas. Merle enlisted in the Marine Corps in 1941. For the duration of World War II, he served on the heavy cruiser USS Louisville as an anti-aircraft gunner and as a Marine infantryman. He fought in numerous battles, including Coral Sea, Surigao Straits, and Guadalcanal. In 1945, he was honorably discharged and married Norma Hammonds in Amarillo. In 1947, Merle completed his B.A. in geology at Colorado College in Colorado Springs and was employed by Phillips Petroleum in Amarillo. In 1950, Merle earned his M.A. in geology, with a minor in petroleum engineering, from The University of Texas. During his career with Phillips, he was transferred to Bartlesville, Oklahoma; Albuquerque, New Mexico; Durango, Colorado and finally Denver. He primarily worked the Rocky Mountains, which included Wyoming, Utah, Colorado and New Mexico. He left Phillips to become general manager of the Denver office of Banner Petroleum, an independent Midland, Texas, oil company. Merle was a lifelong hunter and fisherman who also enjoyed golfing, gardening, and woodworking. He was also a voracious reader and devoted bonsai enthusiast. Merle is survived by two sons, Donald R. Freeman and Frank W. Freeman; four grandchildren; two great-grandchildren; and one daughter-in-law, Toni Freeman.

Wadene Harrison (spouse of the late Hubert J. Harrison, B.S. '52, M.A. '57), died Oct.17, 2015, after a long battle with Alzheimer's disease.

Nell W. Hight (B.A. '48), a resident of Palm Beach for 44 years, died peacefully at home on Jan. 19, 2016 after a long illness. Mrs. Hight grew up in Beeville, Texas. She attended The University of Texas and earned a degree in gemology. Following graduation, she married Mr. Jack Hight of San Angelo in 1950. Mrs. Hight went on to work for President Lyndon B. Johnson in Washington, D.C. She was also very dedicated as a friend to Lady Bird Johnson and the Whistle Stop Tour upon reelection and hosted the engagement party for Lynda Johnson to Capt. Charles S. Robb. After moving to Palm Beach, Mrs. Hight continued her involvement with civic service activities: Flagler Museum, Palm Beach Civic Association, Palm Beach Community Foundation, Palm Beach Community Chest/United Way, general chairman of the Belles of St. Mary's Ball and supported the Patrons of the Arts in the Vatican Museum. Mrs. Hight and her husband served as co-chairs of the Red Feather Society and the Alexis de Tocqueville Society. She was also a member of the Everglades Club, Society of the Four Arts, the Preservation Foundation of Palm Beach and the Flagler Museum. She had a passion for flying and obtained her pilot's license. Mrs. Hight is survived by her daughter Anne Jacobs, son-in-law John Jacobs, two grandsons and a great-grandson. She was predeceased by her husband (of 50 years), Jack Hight, daughter Jane Horne and son James Hight.

Shirley Howard (spouse of Jack Howard, B.S. '51) was born to Arzola and James Hardgrave in Palestine, Texas. She died on Feb.19, 2016.

Betty Hall Jons (spouse of the late Richard D. Jons, B.S. '56), 85, of Midland, Texas passed away Saturday, May 21, 2016. Betty was born to John and Helen Hall in St. Louis, Missouri.

Roger W. Kolvoord (Ph.D. '75) passed peacefully in his home in Green Valley, on May 27, 2016, surrounded by family. Born in Battle Creek, Michigan, Roger excelled in all endeavors. After achieving Eagle Scout ranking with BSA in high school, he continued his education, receiving his B.S. from Michigan State, his master's degree from the University of Utah, and his Ph.D. from The University of Texas at Austin. As a geophysicist and geochemist, Roger's career included owning his own geological survey company, working for Texaco, senior vice president with Metalline Mining in Mexico and senior scientist for Boeing. Once retired, he was active with Green Valley Recreation and sat on the Green Valley Water Board. Besides being a true patriot and dog lover, Roger was an exemplary family man. He is survived by his loving wife of 25 years, Angela; children: Ted and Susan Kolvoord, Jay and Julia Kolvoord, David and Louise MacMillian, Nancy Parker, Glen MacMillian; four grandchildren; as well as many friends.

Eugene "Gene" J. Lipstate (B.S. '49) passed away on Feb. 19, 2016, at the age of 88, after a brave fight against cancer. He was born and raised in Tyler. Gene attended The University of Texas, where he met his future wife and developed his lifelong love of all things "Longhorn." Gene graduated in 1949 with a B.S. in geology. He proudly served his country as a lieutenant in the United States Air Force, in the Intelligence Division of the Strategic Air Command. After completing his military service in 1952, Gene began his career as a geologist in petroleum exploration. He worked with Petroleum Service Company, Caran Brothers Engineering, Ryan Consolidated Petroleum, Midstates Oil Corporation, Tenneco Oil Company and Northwest Oil Company. Gene's work led him to live in Tyler, San Antonio, Houston and Dallas. He then moved to Lafayette in 1968. Gene was active in AAPG and the SIPES. He loved golf and played at Oakbourne Country Club for many years. Gene was a member of the Petroleum Club and a regular at the round table with cherished friends. Gene loved his family, pets and all things burnt orange. He was a lifetime Texas Ex and a contributor to the Longhorn Foundation. Gene was a strong supporter of the Republican Party and conservative principles that serve to make our country great. Gene is survived by his beloved wife of 65 years, JoAnn Davis Lipstate; his children, Dr. James Lipstate and his wife, Linda; and Betsy Malambri and her husband, Frank; five grandchildren; a great granddaughter; his faithful canine companion, Peanut.

Doris Fondren Lummis (spouse of Edwin Allday, B.S. '51, M.A. '53) died on December 4, 2015.

Robert B. McCarty (B.S. '50) died March 17, 2016 at the age of 89 years in Austin. He is survived by his loving wife and partner of 33 years, Mary Louise McCarty, a son, six daughters, 13 grandchildren and nine great-grandchildren. Bob and Mary Louise were long-time residents of Lakeway, Texas. Bob was a fourth-generation Texan and proud of his heritage. He was a Son of The Republic of Texas and a Son of The American Revolution. He loved to play golf and dance, especially with Mary Louise. Bob was a devoted follower of Christ and a member of Shepherd of the Hills Lutheran Church. He was the fourth son of James Madison McCarty and Ila Beulah Stone and brother of Minnie Del Roberts (brothers predeceasing him were James E., Johnnie A., and Charles H. McCarty). Bob enlisted in the Army Air Corp during WWII where he was trained as a navigator on B-17 bombers. At the close of the war he attended The University of Texas on the GI Bill where he earned a degree in geology. He began a lifelong career with Humble Oil and Refining/ExxonMobil and was instrumental in the development of oil fields throughout Texas, Colorado and the South China Sea. At the close of WWII, Bob married Agnes Harris. The couple had children Linda McCarty and Robert Bennett McCarty, Jr. Upon the death of Agnes, he met and married Dorothy Matthew Costa and became the fortunate step-father to Carol Davis-Lewis. After the death of Dorothy, Bob was transferred to Denver, Colorado and was blessed to meet and marry Mary Louise Soeken-Luessenhop. Throughout the years he was well-loved by daughters, Marya McCrae, Stephanie Luessenhop, Valerie Luessenhop, and Tamara Smith and their families.

Raymond L. McKee (B.S. '49) was a man of integrity, compassion, and devotion to God, family and country who passed away peacefully on September 14. He was born in Glen Flora, Texas, to Ola Mae Kyle and George McKee. Ray lived a very full life in his 92 years. He was married to the love of his life, LaVerne Stindt, for 56 years when she preceded him in death in 2002. Ray was offered an athletic scholarship to The University of Texas at Austin, but he chose to first fight for his country after learning of the bombing at Pearl Harbor. Ray served as a bombardier and 1st Lt. in the Army Air Force when his B-17 was shot down in the Italian Alps on March 18, 1944. German SS Troops captured, tortured and interrogated Ray. After taking him to Gestapo headquarters, a judge sentenced him to death by firing squad. Ray never knew why the SS did not shoot him but rather took him on trains to Stammlager Luft Eine near Barth, Germany. He remained in the prison camp until the end of the war, well over a year later, and was profoundly affected by the war. He was awarded the Purple Heart. After the war Ray enrolled at The University of Texas where he earned his bachelor's degree in geology. He worked for Pure Oil Company for years but then set out on his own. For decades he ran his own small company in oil, gas and mineral exploration. Ray modeled a strong work ethic, perseverance, loyalty, kindness, compassion, honesty and unconditional love for his children and grandchildren. The grandchildren have lost one of their greatest fans at their sporting events. Ray leaves to mourn his five children, Raymond Lee McKee Jr., Walter Stindt McKee and wife Pam, Anna McKee Ashworth and husband Russell, Diane Alvarez and husband Adelbert, and Roxanne McKee and husband Jerry Speitel; six grandchildren; one great-grandchild.

Caesar W. Meade (B.S. '69) was born near Dripping Springs and grew up in Pollock, Louisiana. He received a B.S. in geology from The University of Texas and an M.S. and Ph.D. in history from Louisiana Tech University. He served as a marine during the Korean war and was awarded the Korean Service Medal, the United Nations Service Medal, the National Defense Medal, and the Louisiana Veterans Honor Medal. Meade taught history at Louisiana Tech University from 1967-2006, and the University of Texas at Tyler from 2007-2013. During his academic career, Meade wrote five history books and was working on his sixth. He held the McGinty Chair of History and served as the History museum director. He is survived by his daughter, Dawn Meade; and son Don Meade.

Charles M. Merrill (B.S. '56), 84, was born in Ladonia, Texas to Frances (Morgan) and Charles Wesley Merrill. He died at his home on Oct. 17, 2015, surrounded by many family members. He attended 13 schools in 11 years as his father was a government employee. He attended Hardin Simmons University one year before receiving his appointment from Rep. Omar Burleson to the United States Military Academy at West Point. After receiving a medical discharge, he attended The University of Texas where he was active in Alpha Phi Omega, Delta Upsilon, Texas Cowboys, Glee Club, University Singers and other activities. In his senior year he was named a "Goodfellow" for his volunteer services. He received his degree in geology in December 1955. He worked for Pan American Standard Oil in Abilene until 1960 when he returned to the classroom to study for a teacher's certification. He taught science at Madison Junior High in Abilene and attended summer classes at North Texas State University to receive his master's in guidance and counseling. After serving middle schools in Farmers Branch as a counselor, he joined Texas Education Agency in Austin as a guidance consultant. Charlie was a member of Big Bend Studies at Sul Ross, the Civil War Roundtable, the Nimitz Foundation, the Texas Exes Assn, S.P.E.B.S.Q.S.A, the Austin Runners Club, and an active member of Faith United Methodist Church for 48 years serving on many committees and singing in the choir. He married Johnnie Hutchens in Goree and enoyed 56 years of marriage. They have four children: Brian Merrill; Angela Merrill Head and husband Joe; Richard Merrill and wife Susan; and Gordon Merrill. He is also survived by six grandchildren and three great-grandchildren.

Robert "Bob" D. Merrill (Ph.D. '74) was born in southern California in 1941 and passed away in May of 2016. He had a long career as a geologist, earning a B.A. at University of California, Riverside, an M.S. at University of Massachusetts, and his Ph.D. at The University of Texas. During his 35 years as a professor of geology at California State University, Fresno, he taught and mentored both undergraduate and graduate students. Bob traveled widely and practiced civic activism relating to water, land use and energy by stressing the ethic of using knowledge of geology to protect the public interest. Bob will be remembered as a loving husband, father, grandfather, brother and friend. He is survived by his wife, Diane Merrill; son, Cyrus Merrill and wife Mindy Morton; son, Than Merrill and wife Cindy Phillips; step-son, Alex Martinez; one grandson and two more grandchildren on the way.

Kathleen S. "Trinka" Neal (B.A. '46), 90, died on Oct 3, 2015. She was born in Dallas to M. Stuart Seely and Louise Berwick Seely. She grew up in Dallas across the street from Baylor Hospital where her Pop was a physician. She graduated from UT with a geology degree. One of the highlights of her geology studies was going to Mexico in 1944 for the eruption of the cornfield volcano, Paricutin. Trinka married Air Corps pilot Thad M. Neal on July 19, 1946 in New York City just before he shipped off to Frankfurt, Germany to fly the Berlin Airlift. Trinka joined him, and they were soon joined by their daughter Lucinda in 1948. Next USAF assignment was Ft. Worth where Robert, Julie and Mark were born. The family then moved to Springfield, Virginia where Thad worked at the Pentagon and Trinka made sure no sight was left unseen, scout troop left unled or park unexplored. The final USAF stop was Atlanta. Thad was training in Florida when his plane crashed leaving Trinka to raise four teens. She moved back to Ft. Worth and a library science degree from North Texas State University enabled her to work many years in public and school libraries. She spent her summers and retirement travelling the world. The last seven years of her life were spent in Austin. She is survived by her daughter Cindy Morgan and husband Fletcher; son Bob and wife Betsy; daughter Julie Walker; and son Mark; four grandchildren, two step-grandchildren, and four great-grandchildren.

Howard W. Parker (B.S. '49) passed away on May 21. In 1943, Howard joined the U.S. Army Air Corp., stationed in England, and served as a navigator on a B17 with the 306th Bombardment Group. He completed 182.05 hours of Combat Flying, completing 22 missions, 20 of those over Germany. Howard remained active in the reserves for 30 years, rising to the rank of major. Howard graduated from The University of Texas at Austin with a B.S. in geology in 1949. He met Jane Switzer whom he married in 1950—the same year he joined Gulf Oil in Midland. In 1962, Howard Parker and Joe Parsley met through their wives and formed a partnership with a handshake. He was co-founder and CEO of Parker & Parsley until 1984 when the company was sold, ostensibly so Howard could retire to Austin. He watched as his firm grew into Pioneer Natural Resources following the 1997 merger with Mesa Inc. But oil field executives don't ever really retire. Howard continued to participate in the development of the Permian Basin in West Texas through equity funding of various company startups and ventures, including Parsley Energy, Inc. As a working interest owner, he also continued to participate in the development of oil and gas reserves with local companies such as Pioneer and RK Petroleum. In 2015, the two men were recognized with the Top Hand Award from the Permian Basin Petroleum Association and were inducted in the Petroleum Hall of Fame at the The Permian Basin Petroleum Museum in Midland. The Parkers served on several charitable boards and were active in the development and financial support of numerous organizations, including the Midland-Odessa Symphony Guild, The Musicians Club of Midland, and Midland Memorial Hospital. An enthusiastic University of Texas at Austin alum, Howard was a member of the Longhorn Foundation and the UT President's Council. He was also a member of the Austin Knights of the Symphony, the Heritage Society of Austin and a sponsor of "Bravo Vail." Howard Parker is survived by his wife, Jane Switzer Parker; daughter, Frances Parker Little, her husband, Gary P. Little and their two children; son Richard S. Parker and his two children; son Howard Winn Parker, Jr., his wife, Sandra Watson Parker, and their three children and two grandchildren.

Barbara Wampler Phillips (spouse of Jack Phillips, B.S. '49), affectionately called "Barbo," died on July 9, 2016, shortly before her 90th birthday.

Gary Don Richter (B.S. '79), 61, of Spicewood, Texas died Dec. 23, 2015 after a brief battle with a cancerous brain tumor. Gary was born in San Angelo to Mildon Ray "Chatchie" Finney Richter and Herbert Adolph "Buck" Richter. Gary was a 1979 graduate of The University of Texas, School of Geology. Gary married his high school sweetheart, Sandra McFarland, in 1978 in San Angelo and they had one son. After graduating UT, Gary spent several years in the exploration and development of the Austin Chalk oilfield of Central Texas and deep water oilfields in the Gulf of Mexico. Gary always believed in Sandra and encouraged her to get her law degree and pursue a legal career. When Eric was born, Gary left the oil industry to be a stay-at-home dad before being a stay-at-home dad was popular. Gary loved his wife and son, and they will miss his smile, sense of humor, loyalty and intelligence. Gary Don was a Texan every day of his life. He loved barbeque, TexMex and pecans. He was at home in the Hill Country surrounded by live oak trees and Texas bluebonnets. Gary was true to himself and his family. He lived a serene and Christian life. Gary is survived by his wife of 37 years, Sandra McFarland, and their son, Eric Richter, and a large extended family of Richters and Finneys as well as his in-laws, the McFarlands.

Leila E. Sigmon (B.A. '45) passed away on February 23, 2016. She was born to Mabel Ludder Eyoub and Djevad Eyoub in New York and lived in San Antonio until she was 10 years old. The family then briefly moved to Turkey until they made Austin their home. Leila's father was director of the Turkish government Petroleum Research Institute in Ankara, and he encouraged Leila to further her education in geology. She entered The University of Texas in Austin in 1941 and graduated with bachelor's degrees in chemistry and geology in 1944. While in college, Leila became a life-long member of the Phi Mu women's fraternal organization. After graduation, Leila worked at Gulf Oil Company in Amarillo where she met her future husband, Jack Sigmon, a landman. They had four children together. In the 1960s, Leila started her long career with the Midland Independent School District, teaching earth science and later geology. During this time, she earned a master's degree in Education from Sul Ross State University. Leila was an avid horsewoman and loved her horses, dressage, playing polo, vaulting and show jumping. She had a passion for teaching, books, music, dance, drama, participating in Summer Mummers productions, camping and backpacking, summers as a counselor at Cimmaroncita camp in New Mexico as well as extensive travels to Europe, Asia and Mexico. In her retirement years, Leila enjoyed spending time with her many animals that she kept at "The Farm" which she considered her oasis in the country. Leila is survived by daughters Christy Davis, Katherine Kessler, and son Tom Sigmon. Leila is also survived by three granddaughters and two great-grandchildren. Leila was preceded in death by her husband and her son, William.

Helen Spiegelberg (spouse of Frederick Spiegelberg III, M.A. '61) was born in Mt. Kisco, New York, to Helen and LeRoy Hancock of Brewster and passed on Dec. 12, 2015.

Bill E. St. John (B.S. '58, M.A. '60, Ph.D. '65), 83, died on Oct. 26, 2015. He is survived by his wife of 30 years, Nancy; sons Michael, Tad, Kevin and Doyle; and stepsons Tim and Christopher Rivali. Bill attended Hardin College but dropped out to enlist in the Marines in 1951. He had stateside training and duties until he requested a transfer to Korea where he served as a forward observer 1953. Bill returned to his studies in 1954 when he enrolled at The University of Texas at Austin. He graduated with a B.S. in geology in June 1958. With the encouragement of Professor Bill Muehlberger, Bill remained in school and received an M.A. in geology in June 1960. He worked briefly for the Bureau of Economic Geology in Austin before accepting an offer from Amoseas to work in Libya. A few years later he went back to UT to pursue a Ph.D. His dissertation work was in the Black Gap area of the eastern Big Bend, West Texas; again under the guidance of Professor Muehlberger. Upon receipt of his Ph.D. in 1965, Bill took a job with Esso Exploration for eight years. He then had an opportunity to work for a small independent, LVO. While there, his interest in exotic places led him to generate or support proposals in Africa, the Middle East and Southeast Asia. That was followed by an opportunity to lead another small company, Primary Fuels. Under his leadership it grew from virtually nothing to an attractive, successful, takeover target in 1989. Bill then hung out his consulting shingle. In 1990 he accepted a request by the World Bank to oversee a project intended to promote the petroleum potential of Ethiopia. Early on, a helicopter overflight of their concession area inadvertently landed in a small town in Somalia. All personnel were taken into custody as possible CIA, or even Israeli spies. They were flown to Mogadishu and placed under house arrest before being released eight days later. Life in Ethiopia included a fair share of interesting experiences such as running through a barricade set up by armed bandits, an evacuation due to a rebel insurgency and constant personal and company logistical problems. In 1994, Bill took Nancy's advice, resigned from Hunt Oil and returned to the USA. He was called upon to work on basins in India, Azerbaijan and a wide range of African countries. In his 'spare' time in 1984, he created the still popular map Sedimentary Provinces of the World which is also now available in digital format from the AAPG. Also in 1984, he was program chair for the Wallace E. Pratt Memorial Conference, Future Petroleum Provinces of the World, the proceedings of which were published in 1986 as AAPG Memoir 40. Bill authored/co-authored two contributions to that volume, on Antarctica and on giant oil and gas fields. In 1990, Bill was editor of AAPG Studies in Geology No. 31, Antarctica as an Exploration Frontier: Hydrocarbon Potential, Geology and Hazards. By mid-2010 he had authored and self-published the well-received Hydrocarbon Potential of the Eastern Africa Offshore. At the time of his death he was working on a Tectonic Map of the World.

Wilford Lee Stapp (M.A. '46) went to his reward peacefully Nov. 28, 2015, rejoining his wife of 67 years, Margaret, and daughters Linda and Laura. His was a life of service to his family, community, church and his country. Wilford earned his undergraduate at Baylor University before answering his nation's call, serving in the United States Army Air Corps until the end of WWII in the 456th Bomb Group (Heavy). He achieved the rank of captain before his return to civilian life where he earned his master's in geology at The University of Texas and began a career in petroleum geology. Wilford believed that God blesses us with the ability to hear our own calling, and his was heeded for life, from founding KPAC in 1983, to his role in saving San Antonio Symphony, and his participation in the founding of Orchestra San Antonio. Dedicated to sharing his love of music and culture, Wilford's enthusiasm for performance leaves behind the cherished memories of every song he ever sang for us. He is survived by his children, Betty and Richard, six grandchildren and six great-grandchildren.

Berry Sutherland (B.A. '61) was born to John Wesley and Georgia Elizabeth Sutherland in Pleasanton, Texas. The family moved to San Antonio in late 1930s. Berry joined the Navy and served in the Pacific Theater with Fighter Squadron VF24 aboard the U.S.S. Yorktown off Korea. He also served with the Military Air Transport Service

(MATS) Naval Squadron VR8 in Hawaii and Guam transporting supplies to Japan in support of the war effort, moving the wounded back to Hawaii and the United States. After completing four years of service, he attended San Antonio College. Berry transferred to The University of Texas at Austin and completed a B.S. degree in geology in 1961. He married Betty Thompson in 1961 and was employed by the Caran Engineering Firm. Berry received a fellowship for graduate school from the University of Houston where he completed his master's and doctoral degrees. Upon completion of his doctorate, Berry taught at the University of Florida at Gainesville. He moved back to Texas to take a professorship at the new University of Texas at San Antonio. He was one of the first group of faculty hired by UTSA in 1972. He served as a professor in education and environmental studies for 26 years. He also served as associate dean and several other administrative roles in two colleges for over 22 years. Berry co-authored a series of secondary school Earth Science textbooks that made the adoption lists of 18 states. Book sales exceeded 2.5 million units and were translated and used in both Spanish and Chinese. He retired in 1988 from UTSA and was awarded professor emeritus in 2000. He remained an avid fan of UTSA athletics after his retirement. Berry enjoyed trips to Hawaii, China, Italy, and annual visits to Colorado and the Big Bend Ranch State Park. Berry loved the outdoors especially in the western states where the geology was exposed and accessible. He enjoyed his membership and travels with members of the Street Rod Car Club to events throughout Texas and surrounding states. His red 1934 Ford Victoria was his pride and joy for many years. He was a member of the First Baptist Church and enjoyed volunteering for the International Outreach Ministry. Berry is survived by his wife Betty J. Sutherland; daughters: Dianne Elizabeth Sutherland and Cathy Jayne Davies.

J. Rodney Templeton (B.S. '59), 80, passed away on April 11, 2016 from complications due to Parkinson's disease. Rodney was born in Dallas and spent his childhood in San Antonio. He met his wife Margo at The University of Texas. They were married in 1957 and moved their family to California in 1964. Rodney was an avid sailor enjoying boating adventures with his family and friends. Many a windy day was spent on San Francisco Bay, the Sacramento Delta, as well as Hawaii, Mexico and the Caribbean. He built a fulfilling career as a commercial realtor, first with Coldwell Banker and then with his own firm. After retiring from the real estate business, Rodney took up farming, operating an almond and walnut orchard in Merced. Rodney was known for his entrepreneurial spirit which he passed along to his children as they each started and ran their own businesses. In his youth, Rodney played high school football and swam competitively. He studied geology at The University of Texas where he was an active member of the Kappa Sigma fraternity. Rodney enjoyed traveling with his wife and family, and made many trips to Europe and Mexico. His traveling style was one of discovery. He liked to just get in the car and head out—finding things to see and places to stay along the way. For years he enjoyed taking his family to Puerto Vallarta, Mexico where they often stayed in a villa overlooking the bay. Rodney's family includes his wife Margo, children Mark (wife Betsy), Cabot, Amy and Christopher as well as his two grandchildren.

W. Michael "Mike" Trant (B.S. '58) died peacefully at home on Feb. 25, 2016 at the age of 80. Mike was born in Longview, Texas and attended The University of Texas, where he played football and was a member of Phi Delta Theta fraternity. He graduated with a degree in geology in 1958. Mike was a Naval Aviator, 1st Lieutenant and was attached to U.S. Marine Attack Squadron 311 at El Toro Naval Air Station in Newport Beach, California. He served with the Marine Squadron on the U.S.S. Midway at the Iwakuni Air Station, Japan where he flew the A-4 Skyhawk during 1961-62. After his active service, Mike flew as a pilot for Braniff Airlines and worked in the oil and gas exploration business in Dallas, co-founding Watco Energy Inc. and later founding Mike Trant Energy Inc. He retired in 2013. He was an active member of Believers Chapel in Dallas and the Frank Hundley Bible Study at Highland Park Presbyterian Church. He is survived by Viginia 'Jinnie' Trant, his wife of 54 years; daughters Theresa Gandy and Holly Trant; three grandsons; and two granddaughters.

Margaret S. Underwood (spouse of the late James R. Underwood, Jr. M.A. '56, Ph.D. '62) passed away peacefully in her sleep at her home in Dallas, Texas, on July 30, 2016, at the age of 86.

Julian Walker (B.S. '52) was born to George Washington and Mary Frances Walker of Conroe. Julian grew up on a dairy farm and learned many life lessons there. Julian attended and played football at Texas A&M University, Allen Military Academy, and Sam Houston State University. Julian joined the Navy in 1942 to serve his country in WWII. He was a torpedo bomber pilot on the USS Wasp and piloted many successful missions in the Pacific. He was awarded various medals for his service, including the Distinguished Flying Cross. At the conclusion of the war, Julian worked in a surveying crew and became interested in geology. He obtained a degree in geology from The University of Texas. Julian went to work for Marathon Oil Company and worked in various locations, including Roswell, New Mexico, where he met the love of his life, Carole June Whitehurst. They married in 1955 and had three children. During retirement, Julian and Carole travelled to many locations in the U.S. to attend Naval reunions. Julian was also able to spend more time enjoying his favorite pastimes—playing golf, fishing, hunting and spending time family and friends. Julian loved and supported the UT Longhorns and his favorite NFL teams. In his later years, he enjoyed sitting outside in the sunshine and listening to birds. He will be remembered as a loving husband and father and someone who cherished his family, friends and his country. Survivors include his children, Julie Smith and husband David, Stephen Walker and wife Rita, and Stacey Walker and partner Sally Ulman, five grandchildren and three great-grandchildren.

Gilbert R. Ward (B.S. '75) passed away suddenly in Austin on June 14, 2016. He was born in Plainview, Texas, the son of Haskell and Eloise Ward. He moved to Austin in 1971 to attend The University of Texas, graduating in 1975 with the B.S. in geology. He and Ruth Hughes were married in 1973 and divorced in 1989. A licensed professional geoscientist, Gilbert studied the geology and hydrology of Texas for his entire professional life, working for Espey, Huston & Associates, Inc., International Technology Corporation, and, since 1995, the Texas Water Development Board. For the board, in recent years, he was responsible for managing state and federal grants for projects in flood mitigation throughout the state. Gilbert loved music and his tastes were eclectic. He enjoyed the natural areas of Texas and frequently took his family camping. He was an avid sportsman throughout his life, playing baseball, softball, golf, racquetball and handball, and had an encyclopedic knowledge of collegiate and professional sports, especially his beloved Longhorns. He is survived by son Allen Ward and wife Julie, daughter Crystal George and husband Shawn, daughter Robin Cunningham and husband Gabriel, son Nathan Ward and wife Chelsea, and 11 grandchildren.

Herbert E. Ware (B.S. '84) passed away on April 17, 2016 at the age of 54. Born in Fort Worth to Carlene Traub Ware and Herbert Earl Ware, Jr., his family relocated to Midland when he was young. He graduated from The University of Texas at Austin with a degree in geology. After graduation, Herb followed in his father's footsteps in the oil and gas industry. Herb was co-owner and co-founder of Patriot Resources, Inc. and Patriot Resources Partners, where he managed the geological assets in the Permian Basin. Herb is best remembered for being a kind and compassionate employer, a team player, and an excellent oil finder. Herb cared deeply for the Midland community and served as president of the Petroleum Club of Midland and sat on the Board of Trustees for Midland Memorial Hospital. Herb had a deep love for the Lord and spent early mornings reading his Bible. He served as an Elder at First Presbyterian of Midland, sponsored various youth programs, and attended countless youth ski trips, Mystery Rambles and mission trips to Juarez, Mexico. He had a passion for being involved in his children's activities, including coaching various sporting teams. An avid outdoorsman, Herb loved hiking, biking, skiing, swimming and golfing. His passion for fly fishing was forged by annual float trips to the Smith River in Montana with family and friends. Herb also enjoyed his family's ranch in Coleman, Texas, where he spent countless hours hunting, fishing and arrowhead searching. He enjoyed golfing and honed his skills in anticipation for the BSI, a golf tournament Herb played each year. Herb's greatest life achievement was raising his two children along with their mother, Emily Chalfant Ware. Later in life, Herb was particularly proud of his new role as "Popi" to his 17-month-old grandson and felt blessed to have a granddaughter on the way this summer. Herb is survived by his wife, Lezlye Sherman Ware, who adored him and was by his side caring for him daily; his daughter, Alicia Ware Hudson and her husband, Seth; his son, Wesley Michael Ware and his wife Jenny; his precious grandson; and two stepchildren.

Joel S. Watkins (Ph.D. '61), 83, of New Braunfels, Texas, passed away from complications due to stroke on Tuesday, Feb. 23, 2016. Joel was born to Joel and Eva (Byers) Watkins in Poteau, Oklahoma, and grew up in Warren, Arkansas. In 1953, Joel was commissioned an officer in the United States Marine Corps upon completion of the Naval Reserve Officers Training Corps program at the University of North Carolina at Chapel Hill, where he received a B.A. in geology. After his medical retirement from the Marine Corps as a first lieutenant, he attended

The University of Texas at Austin, where he received his Ph.D. in geophysics in 1961. Joel worked as a geophysicist for the U.S. Geological Survey, the Massachusetts Institute of Technology, the University of North Carolina at Chapel Hill, The University of Texas at Austin, and Gulf Oil Corporation; ultimately retiring from Texas A&M University as a professor emeritus in 2002. For his work training astronauts and designing seismic instruments for Apollo 14, 16 and 17, he was awarded the NASA Medal for Exceptional Scientific Achievement and the USGS Outstanding Performance Award. He was the vice president of Exploration Research for Gulf, and was the Earl F. Cook Professor, Departments of Oceanography and Geophysics, at Texas A&M University from 1986 to 2002. Joel was an active member of the New Braunfels Lions Club and a member of multiple professional societies in the areas of geology and geophysics. Survivors include his two daughters, Catherine Barker and Victoria Pinkston; two sons-in-law, Bradley Barker and Robert Pinkston; one grandchild; and his dear friend Lilly Santamaria. Joel was a loving and beloved father, grandfather, brother, uncle and friend.

Bill E. Watson (B.S. '50) was born in Austin on to Mance E. Watson and Billie Mae Watson, and passed away peacefully on November 14, 2015 at the age of 93. Bill graduated from The University of Texas at Austin and earned a bachelor's degree. He joined the U.S. Air Force Academy and valiantly served his country. Bill was employed by the Texas Railroad Commission for 34 years where he worked and lived all over the great state of Texas. Bill is survived by his loving wife of 68 years, Marie Watson. In God's care, Bill leaves behind many other dear relatives and friends. Bill was a man of integrity and was dedicated and committed to caring for his wife, Marie. He will be remembered for his positive spirit and keen, sharp mind and was an inspiration to all who knew him.

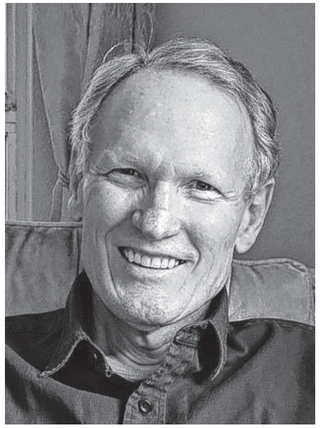
Charles G. Weiner (B.A. '48), born in El Dorado, Arkansas, to Sam "Skipper" and Lillian Blanc Weiner, passed away on April 6, 2016. He was 92. Charles grew up in the oilfields as the family followed Skipper from Arkansas, through Northern California and Wink, Texas settling finally in Fort Worth. As a founding partner of the original Texas Crude Oil Company (1941) with his brothers Ted and Stanley and sister Marjorie Weiner Bodzy, Charles, in his typical humble manner, always said, "Ted was the smart one; Stanley made it happen; and I was lucky to be their brother!" Significant to Charles was his WWII enlistment into the U.S. Army Air Corps. He completed AFTS for meteorology, radio and electronics communications training at Yale University, Class 1943-H, was commissioned a second lieutenant in the Air Force in 1944, and participated in the China-Burma-India Theatre. Among other honors for service, the Chinese Air Force awarded Charles the Order of Southwest Wind. Placed on Inactive Reserve, Charles returned to college graduating from UT Austin in 1948 with B.S. in geology—the first in his family to earn a college degree. Charles continued his lifelong passion for technology, science and medicine through unending independent study, interrupted only by recall to the Air Force during the Korean War where he earned a battlefield promotion to captain and received USMC and the Fifteenth Air Force commendations. Following Korea, Charles returned to active participation in the family business pioneering many oilfield applications of technology. In 1962, Charles assumed chief operating responsibility and moved the headquarters to Houston. At last count, he had participated in the discovery of almost a billion barrels of oil in eight countries on four continents as well as almost a trillion feet of gas. He also had experience in mining for lead, zinc, coal and barite. In 2004 at the age of 82, Charles formed Westerly Exploration to begin his own independent operations again. He served as chairman of Southern Crude Company, Texas Crude, Inc., Texas Crude Energy, Inc., Kane Industries, Frontier International Petroleum, Delta Communications in Meridian, Mississippi, Pipeline Transportation, Inc., Norton Coal Company of Kentucky, Old Soldier Mining, Coral Drilling, Inc., Tidal, Inc. and B. L. McFarland. He served on the board of Fluor Corporation and also as president of Mills Leasing, Inc., and president of Universal Data Acquisition, Inc. Charles actively participated in numerous professional organizations including AAPG (lifetime member), American Association of Petroleum Geologists Foundation (former chairman and trustee associate), American Petroleum Institute, and American Geological Institute (trustee). He was a founder of the Log Libraries of the Ordovician Society in Midland and Southern States Log Library in Houston. For The University of Texas at Austin, Charles served as a member of the Bureau of Economic Geology, the President's Associates, and the Advisory Council of the Geology Foundation of the Jackson School of Geosciences. Charles' professional awards and recognitions include: Induction into The Permian Basin Petroleum Hall of Fame; Legion of Honor Certificate from the Gulf Coast Section of the Society of Petroleum Engineers; the Drake Well Foundation's Colonel Edwin L. Drake Legendary Oilman Award; the Chairman Award from The AAPG Foundation; and the naming of the Charles Weiner Center for Geosciences and Society by the American Geosciences Institute established in honor of his continued support to their public K-12 educational activities to teach earth sciences with accurate scientific information and provide a source of unbiased information to the public. Truly Charles was a man of great vision, integrity, compassion and empathy. Charles is survived by the love of his life, Anita Kane, his wife, companion and muse of 63 years. Together they traveled the world for fun and business with many friends and family enjoying all it had to offer. They have five children: son Kane and spouse Randa; son Collier and spouse Patti; daughter Laurel Weiner; daughter Sally Weiner and spouse Ginny Moffat; daughter, Tevia McLaren and spouse Chris; and seven grandchildren. He was preceded in death by his parents, Sam and Lilian Weiner; his brothers Ted, Stanley and Max Weiner, and sisters Marjorie Weiner Bodzy and Ruth Weiner.

Andrew P. Werner (B.A. '54), 88, of San Angelo, departed this world on Nov. 6, 2015, in San Angelo. He was born in Abilene to Carl August Werner and Leila (Sandlin) Werner. He earned a B.S. in geology from The University of Texas and had a successful career as a petroleum geologist with the enduring support of his wife of 55 years, Margaret (Fry) Werner. Self-employed for almost his entire career, he was a true wildcatter—often battling conventional wisdom in order to explore unproven areas. He endured dry holes and he celebrated discoveries, always with his eye on the next prospect. A child of the Great Depression, he developed a determination and self-discipline that served him well throughout his life. He enjoyed many pastimes, but perhaps none so much as breeding, training and hunting with bird dogs. He worked with horses and mules all his life as well, and all of these activities allowed him to enjoy the great outdoors. He was a loving father and it was important to him that his children and grandchildren did well. To that end he spent time sharing his wisdom and values, as well as his keen sense of humor. He is survived by his son, Carl Werner and wife Marjene; his daughter Marsha Nichols and husband Craig; and three grandchildren.

Peter N. Wiggins (B.A. '52) was born to Mr. and Mrs. P. N. Wiggins, Jr., in Tulsa, Oklahoma. Three years later the family moved to Dallas to pursue the oil business. Peter attended high school at Kent Boys School in Kent, Connecticut, where he graduated Suma Cum Laude. He was awarded a Fellowship to Christ Hospital in Sussex, England. Peter was there the year after World War II, and they had two meals a day and cold showers. Following the school year, he traveled throughout Europe with his brother, Bill. Peter then attended Julliard School in New York City to pursue his lifelong love of music and piano. After Julliard, Peter enrolled at The University of Texas. After two years, he changed his major to geology and received his B.S. degree. He swam on The University of Texas Swim Team that was coached by "Tex" Robertson. Later, he received his master's in geology from SMU. Peter served as president for the Deke Fraternity, through which met his future wife, Barbara Franklin. They were married for 63 years and had two sons, Peter, IV, and Phillip. Peter and his brother, Bill, took over their father's oil and gas business and were actively involved for over 60 years, operating and investing mainly in the Southwest. Peter was a member of the Dallas Geological Society, the Dallas Geophysical Society, the AAPG, AIPG, and SIPES. He was a lifelong member of Saint Michael & All Angels Episcopal Church where he served on the Vestry. He was a member of the Dallas Art Museum, where he co-chaired the first Museum Ball. He was an active member of the Dallas Symphony, the Dallas Opera and was a board member of the Santa Fe Opera. Peter was a member of the Dallas Country Club, the Dallas Petroleum Club and the Park Cities Club. He is survived by his wife, Barbara Franklin Wiggins; sons Peter Wiggins and Phillip Wiggins and his wife, Donell; and three grandchildren.

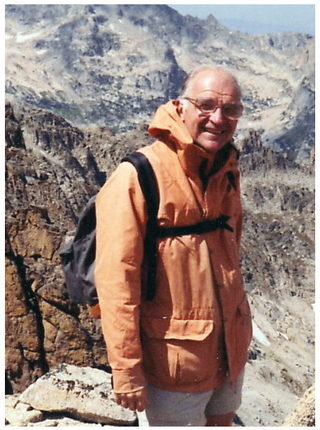
The staff and members of the Jackson School of Geosciences community would like to convey our respects to the families of the following alumni and friends:

Jess P. Roach (B.A. '41)
Murry V. Witzel (B.S. '50)



RESEARCHER

Dr. Martin P.A. Jackson passed away peacefully at home in Austin, Texas on May 31, 2016 from cancer. He was surrounded by his family. Martin lived a truly remarkable life. He was born in Rhodesia (now Zimbabwe), one of three sons of Honor and Gerald Jackson. Growing up, he developed a deep love of the outdoors and adventure. These interests became the bedrock of his life and led him into a career in the earth sciences, a field that he became passionate about. In 1980, Martin moved his family from South Africa to the U.S. to join the Bureau of Economic Geology at The University of Texas at Austin. During his 36 years with the Bureau, he founded the Applied Geodynamics Laboratory, a preeminent research consortium. A highly-regarded geologist, his work advancing the field of salt tectonics took him all over the world. He authored several books and over 100 papers and received countless professional accolades and awards. Martin was the epitome of humility—always curious and deeply interested in the lives of others. He was a delight to be with—and a true gentleman. Kind beyond measure and devoted to his family, he was an endless font of anecdotes and knowledge. In his free time, Martin loved playing the guitar, exploring the wild places of the world, and enjoying time with family and friends. Beloved husband of Jo. Loving father of Britt and Kirsty and dear father-in-law of Ed. Doting grandfather of Benjamin and James. Devoted brother of Brian and Andrew. Endearing brother-in-law, uncle and cousin to family and friends near and far. We all treasure and deeply miss you Marty and you are forever in our hearts.



FACULTY

Dr. Alan Scott, a professor in the Department of Geological Sciences from 1958-1984, passed away on May 29, 2016, in Round Rock, Texas. Alan was born on December 26, 1933, in Chicago, Illinois to Marvin and Prudence Scott. He spent his childhood in Lincoln, Illinois and graduated from the University of Illinois with a Ph.D. in geology. After college, he moved to Austin, Texas to teach at The University of Texas where he influenced generations of petroleum geologists. "All who were taught or supervised by Al or worked with him remember him vividly as an excellent teacher, supervisor, scientist and faculty member," said Jackson School Dean Sharon Mosher. "He was greatly missed when he left the department and is asked about frequently by alumni." Former student Steve Speer remembered Alan as an inspiration for those he taught. "The world's a far lesser place with the passing of one of the finest mentors I have had the pleasure of experiencing in my entire life. Dr. Alan J. Scott was a dynamic inspiration, both professionally and personally, in so many ways to not only me, but all of the "Dirty Dozen" as he liked to call our group of graduate students whom he advised back in the early 80s heyday at the end of his teaching stint for the UT Department of Geological Sciences," Speer said. "My prayers and thoughts are with his family, both immediate and worldwide, because he certainly created himself a wonderful family of friends and admirers everywhere throughout his distinguished teaching career. A truly great man and friend." After leaving The University of Texas at Austin, Alan worked as a consultant for several oil companies in Colorado and in The Woodlands, Texas. Alan is survived by his wife Lilian Scott-Baer of Boulder, CO; daughter, Diana and her husband Jim Moskal of Georgetown, TX; daughter, Liese Scott of Round Rock, TX; step-daughter Renata Tyree of The Woodlands, TX; step-son Scott Tyree. Alan was preceded in death by his father, Marvin Scott and mother, Prudence Blood Scott and brothers Chuck Scott and Merrill Scott.

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