Chicxulub Revealed
A first look at rocks from the crater left by the asteroid that wiped out non-avian dinosaurs
Dear Alumni and Friends

The devastation that Hurricane Harvey brought to Texas communities in August was a tragic reminder of how vital it is to understand our planet and its processes. Shortly after the hurricane struck, our scientists, through our Rapid Response program, began to conduct research to understand how Harvey has impacted the coast and offshore Gulf of Mexico. This research will help determine the best ways to deal with many coastal issues in the aftermath of the storm, and how we might better prepare for such events in the future. You can read more about the mission on page 18.

Rapid response efforts on the effects of abrupt, catastrophic geoscience events provide critical science that can benefit society. This is what we strive to do here at the Jackson School of Geosciences. This year's Newsletter holds some tremendous examples. I’d like to draw your attention to the story on page 58 about the scientific coring mission led by Peter Flemings to bring back samples of methane hydrate from beneath the Gulf of Mexico. This is a cutting-edge research project on a potential future energy source that very few schools in the world would be able to mount. We should all be very proud of Peter and his team.

On page 98 you can get a first look at the cores brought up by a team co-led by Sean Gulick from the Chicxulub crater—the impact site of the asteroid that killed all non-avian dinosaurs. On page 68, you will see a roundup up of the work our scientists and researchers are doing on Mars. Here again, these are large scientific missions with breadth and depth few schools could match.

It has been a successful year of science and education at the Jackson School, but one also punctuated by loss. We lost a tremendously talented researcher and friend with the passing of Kirk McIntosh, and a giant in the field with the passing of former UT President and Bureau of Economic Geology Director Peter Flawn. They will be sorely missed, but not forgotten. You will find a memorial to each in the back of the Newsletter.

Many of our own in the Jackson School family live and work in communities ravaged by Harvey. We hope that reading this year’s Newsletter will give you a little respite from the hard work of putting your homes and lives back together. We also hope it will make you proud to be part of the Jackson School family.

We are thinking of you, and you will continue to be in our thoughts.

Sharon Mosher, Dean

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A group of Jackson School scientists and students embark on a high-stakes research mission to retrieve cores of methane hydrate from beneath the Gulf of Mexico.

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Finding the Origin of Earth’s Iron

The iron at our planet’s core is unique among known worlds, having a higher level of heavy iron isotopes than anywhere else in the known solar system. The reason why our planet ended up with the heavy stuff has long been linked to the formation of the Earth’s core. But new research led by the Jackson School of Geosciences is calling into question the prevailing theory on the events that shaped our planet during its earliest years.

The research, published in Nature Communications in February 2017, opens the door for other competing theories on why the Earth, relative to other planets, has higher levels of heavy iron isotopes.

“The Earth’s core formation was probably the biggest event affecting Earth’s history. Materials that make up the whole Earth were melted and differentiated,” said Jung-Fu Lin, an associate professor in the Department of Geological Sciences and one of the study’s authors. “But in this study, we say that there must be other origins for Earth’s iron isotopic anomaly.”

Lin said that one of the most popular theories to explain the Earth’s iron signature is that the relatively large size of the planet (compared with other rocky bodies in the solar system) created high pressure and high temperature conditions during core formation that made different proportions of heavy and light iron isotopes accumulate in the core and mantle. This resulted in a larger share of heavy iron isotopes bonding with elements that make up the rocky mantle, while lighter iron isotopes bonded together with other trace metals to form the Earth’s core.

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Jin Liu, now a postdoctoral researcher at Stanford University, led the research while earning his Ph.D. at the Jackson School. Collaborators include scientists from the University of Chicago, Sorbonne Universities in France, Argonne National Laboratory, the Center for High Pressure Science and Advanced Technology Research in China, and the University of Illinois at Urbana-Champaign.
**Solid Earth & Tectonic Processes**

The oceanic crust produced by the Earth today is significantly thinner than crust made 170 million years ago during the time of the supercontinent Pangea.

The thinning is related to the cooling of Earth's interior prompted by the splitting of the supercontinent Pangea, which broke up into the continents that we have today, said Harm Van Avendonk, the lead author of the study and a senior research scientist at the University of Texas Institute for Geophysics (UTIG). The findings were published in *Nature Geosciences* in December 2016.

“What we think is happening is that the supercontinent was like an insulating blanket,” Van Avendonk said. “So when these continents started opening up and the deeper mantle was exposed, more or less, to the atmosphere and the ocean, it started cooling much faster.”

The research started when Van Avendonk and Ph.D. student Jennifer Harding, a study co-author, noticed an unexpected trend when studying existing data from young and old seafloor. They analyzed 234 measurements of crustal thickness from around the world and found that, on a global scale, the oldest ocean crust examined—170 million year old rock created in the Jurassic—is about one mile thicker than the crust that’s being produced today.

The link between crust thickness and age prompted two possible explanations, both related to the fact that hotter mantle tends to make more magma. Mantle hot spots—highly volcanic regions, such as the Hawaiian Islands and Iceland—could have thickened the old crust by covering it in layers of lava at a later time; or the mantle was hotter in the Jurassic than it is now.

Van Avendonk mentioned this problem during a casual conversation with Joshua “Bud” Davis, a Ph.D. student in UTIG’s plate tectonics research group and co-author, who said that the group could investigate both of the explanations using computer models of plate movement since the Jurassic and a global database of hotspots.

The analysis ruled out the hot spot theory—thick layers of old crust formed just as easily at distances greater than 600 miles from hotspots, a distance that the researchers judged was outside the influence of the hotspots. In contrast, the analysis supported the hypothesis of mantle heating during the age of Pangea, and mantle cooling after the breakup of the supercontinent.

**Paleo Lakes Hold Climate Clues**

Climate, Carbon & Geobiology

In Antarctica, some lakes that formed during the last ice age stuck around for up to 10,000 years. The sediment these “paleo lakes” left behind could provide a record for investigating the continent’s climate.

“We think of Antarctica as only producing climate history information from ice cores, but these lakes were probably much longer lived than previously thought,” said then University of Texas Institute for Geophysics Research Associate Joseph Levy, who led research on the ancient lake remains.

The study was published in April 2017 in the *Geological Society of America Bulletin*.

The research used both old-fashioned radiocarbon dating and newer optical/infra-red stimulated luminescence (OSL) dating techniques. The OSL technique dates sediment directly, instead of relying on algal mats and other organic matter as used by radiocarbon methods. The research found that radiocarbon dates were consistently older than OSL results, in some cases up to 100,000 years.

“I hope that it sheds light on the fact that there were relatively recent, long-lived lakes in the terrestrial parts of Antarctica that could be used to collect paleoclimate proxies for reconstructing what’s going on at the Antarctic coast,” Levy said.

**Dino-Killing Asteroid Made Rocks Behave Like Liquid**

Marine Geosciences

When the asteroid that wiped out the dinosaurs slammed into the Earth 66 million years ago, solid rock flowed like a fluid.

The finding was revealed by examining cores taken from the Chicxulub crater during a scientific drilling mission led by the Jackson School of Geosciences and Imperial College London in spring 2016. The results were published in the *Journal Science* in November 2016.

The research validates the theory that asteroid impacts cause the surface of planets to behave like a fluid, said study author Sean Gulick, a research professor at the University of Texas Institute for Geophysics (UTIG). It also puts a definitive end to an alternative explanation that suggested that such impacts, which are common on other planets and moons, deform the surface by melting most of the rock around the impact.

“It is the same exact kind of feature that we see on all large impacts on rocky planets, whether it be on Venus, on Mercury or on the moon,” said Gulick, who was the expedition’s co-principal investigator.

The team took core samples of the peak ring, which is now covered by water and the limestone of the modern Gulf floor. They found that the asteroid, which hit with the force of 10 billion atomic bombs, quickly opened a massive hole nearly 19 miles deep and 120 miles wide. Gulick said he knew they had solved the mystery of how large impacts affect the surface when the cores revealed an unmistakable pink granite, which is found deeper in the Earth, as opposed to the limestone that was present at the time of the impact.

Researchers found that the roughly 10-mile-wide Chicxulub asteroid, which hit in the Gulf of Mexico near the Yucatán Peninsula, pushed rock up from six miles below the surface to form the peak ring. Those rocks travelled approximately 20 miles in a few minutes, first being pushed outward from the impact, then rebounding upward above the Earth’s surface and finally collapsing outward to form a ring of peaks around the center of the impact.

The expedition was conducted by the European Consortium for Ocean Research Drilling as part of the International Ocean Discovery Program and was supported by the International Continental Scientific Drilling Program. The Yucatán Government, Mexican federal government agencies, and scientists from the National Autonomous University of Mexico and the Yucatan Center for Scientific Research also supported the expedition.
Sweltering Recipe for Southeast Asia

*Climate, Carbon & Geobiology*

Scientists at the University of Texas Institute for Geophysics (UTIG) have found that a devastating combination of global warming and El Niño is responsible for causing extreme temperatures in April 2016 in Southeast Asia.

The research, published in June 2017 in *Nature Communications*, shows that El Niño triggered the heat, causing about half of the warming, while global warming caused one-third and raised the heat into record-breaking territories. El Niño is a climate pattern that impacts the tropical Pacific, and usually brings warmer temperatures to Southeast Asia in April.

In April 2016, high temperatures in mainland Southeast Asia broke all previous records, exacerbating energy consumption, killing crops and causing human suffering in Cambodia, Thailand and other countries in the region.

The researchers used computer model simulations designed to disentangle the natural and human-made causes of the extreme heat. They also used observations from land and ocean monitoring systems and found that long-term warming has played an increasing role in rising April temperatures in Southeast Asia. Since 1980, this trend has caused a new temperature record each April following an El Niño.

“The El Niño system primes mainland Southeast Asia for extremes, although long-term warming is undoubtedly exacerbating these hot Aprils,” said UTIG postdoctoral fellow Kaustab Thirumalai, who led the study.

The researchers used statistical techniques to quantify the contributions from El Niño and long-term warming. Their analysis looked at the 15 hottest April temperatures over the past 80 years. All occurred after 1980, and all but one coincided with El Niño. They found that while the impact of El Niño fluctuated over the years, the impact of global warming has steadily increased over time. Looking at the model predictions for the next 50 years, researchers found that climate change could further amplify the effects of El Niño.

“Because of long-term warming, even a weaker El Niño than the 2015-16 event in the mid-to-late 21st century could cause bigger impacts,” said co-author Pedro DiNezio, “because of long-term warming, even a weaker El Niño than the 2015-16 event in the mid-to-late 21st century could cause bigger impacts,” said co-author Pedro DiNezio, who is a research associate at UTIG.

Other co-authors include UTIG research associate Yuko Okamuro and Clara Deser, a senior scientist at the National Center for Atmospheric Research.

### Exceptional Fossil Site Records Jurassic Reef’s Decline

*Climate, Carbon & Geobiology*

About 183 million years ago in what is now the Canadian town Banff, a marine ecosystem was teeming with shrimp, vampyropods and ichthyosaurs. But then a period of low ocean oxygen made life perish and perish beautifully, turning delicate exoskeletons into exceptional fossils.

Research led by Rowan Martindale, an assistant professor at the Jackson School of Geosciences, documented the diversity of fossils and investigated the impact the low oxygen event had on the marine ecosystem. The findings were respectively published in *Geology* in January 2017, and in *Palaeogeography, Palaeoclimatology, Palaeoecology* in July 2017.

Both studies investigate a recently discovered fossil site in Canada located at Ya Ha Tinda Ranch near Banff National Park in southwest Alberta. The site records fossils of organisms that lived about 183 million years ago during the Early Jurassic in a shallow sea that once covered the region.

The fossil site broadens the scientific record of the Toarcian Oceanic Anoxic Event, a period of low oxygen in shallow ocean waters that is hypothesized to be triggered by massive volcanic eruptions.

The fossils show that before the anoxic event, the Ya Ha Tinda marine community was diverse and included fish, ichthyosaurs (extinct marine reptiles that looked like dolphins), sea lilies, lobsters, clams and oysters, ammonites, and coleoids (squid-like octopods). During the anoxic event, the community collapsed, restructured, and the organisms living in it shrunk.

Since the oceanic anoxic event was a side-effect of climate change, looking back at ancient marine communities could be a window into the potential impacts of ongoing and future climate change.
Millions of years before the mass extinction that wiped out the dinosaurs, there was the Permian extinction, or Great Dying, the planet’s deadliest mass extinction event, and the event that had the longest recovery. Two studies led by Jackson School of Geosciences postdoctoral researcher William Foster have shed light on how marine ecosystems recovered from the catastrophic mass extinction event 252 million years ago, and why the overall recovery afterward was slow. Both center on research of marine fossil beds in Italy.

The Permian extinction is linked to climate change caused by prolonged volcanic eruptions in Russia’s Siberian Traps. The eruptions covered an area larger than Alaska with lava and released massive amounts of greenhouse gases into the atmosphere, which had dire consequences for life across the planet.

The first study, which was published in the Journal of Systematic Paleontology in November 2016, found that fossils show that some species thought to have died out during the Permian extinction had actually survived the event, and others originated tens of millions of years earlier than previously believed. Many of the fossil shells are unusually small, only a few millimeters in size. But they are so well-preserved that they reveal new details of their body shape and early life stages.

“The exceptional preservation of the fossil shells show how marine ecosystems survive global warming,” Foster said.

The second study, published in the journal PLOS ONE in March 2017, found that life recovered slowly after the Great Dying because of two smaller extinction events that followed the mass extinction. The extinction events are linked to climate change also caused by massive volcanic activity, said Foster. He added that the study is a step toward understanding how lifeforms survived during the extinctions, which could help scientists understand how modern ocean life evolved and how it might respond to climate change in the future.

The Jackson School of Geosciences has one of the best geosciences research programs in the world according to two global rankings that came out in spring 2017.

The Nature Index of scientific productivity ranked UT No. 4 globally among academic institutions for Earth and environmental sciences. The Center for World University Rankings, the largest academic ranking of global universities, ranked UT No. 3 globally for geology. Both rankings are based on publication of peer-reviewed research in top-tier journals.

In the most recent ranking of graduate education programs from U.S. News & World Report, UT ranked No. 5 for geology. The combination of rankings underscores the productivity and excellence of UT’s Jackson School of Geosciences, which is the largest geosciences program in the country with nearly 600 undergraduate and graduate students. "It’s rare to find a school that is the largest in a discipline and also operates at an elite level in both education and research," said UT President Gregory L. Fenves. “These rankings are a reminder of the global distinction and impact of geosciences at the University of Texas.”

The Jackson School consists of three world-class academic and research units — the Department of Geological Sciences, the Institute for Geophysics and the Bureau of Economic Geology. Combined, these institutions offer a depth and breadth of geosciences matched by few universities. They spearhead research vitally important to Texas, the country and the world.
Natural Methane Linked to Groundwater in Parker and Hood Counties

Surface & Hydrologic Processes

Scientists from the Jackson School of Geosciences have found that high levels of methane in well water from two counties near Fort Worth are probably from shallow natural gas deposits, not natural gas leaks caused by hydraulic fracturing operations in the underlying Barnett Shale.

The research, published in the journal Groundwater in March 2017, builds on previous studies on well water quality in the Barnett Shale, and uses chemical and geographic evidence to tie the elevated methane in natural shallow deposits.

The Barnett Shale, located in the Fort Worth region, is one of the largest and most productive natural gas fields in the United States with about 20,000 wells. As production has boomed, questions have been raised about the connection between hydraulic fracturing and potentially dangerous levels of methane in some water wells, most notably wells in the Silverado neighborhood in Parker County.

The research was led by JP Nicot, a senior research scientist at the Bureau of Economic Geology. Collaborators include Tori Larson, a researcher from the Jackson School’s Department of Geological Sciences, and scientists from the University of Michigan.

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The researchers analyzed samples from more than 450 wells across 12 counties in the western Barnett Shale. About 85 percent showed very low methane levels in the groundwater of less than 0.1 milligrams of methane per liter of water. However, a cluster of 11 wells in the vicinity of the Silverado neighborhood had methane levels above 10 milligrams per liter of water, a level that can trigger venting of well water systems to ensure the flammable gas does not become hazardous. These 11 wells are found in a roughly 6-by-8-mile area that also includes wells with low levels of methane.

Researchers used carbon isotope analysis to determine that the methane was thermogenic, which ruled out biogenic sources but didn’t pinpoint whether the gas came from the deeper Barnett or a shallower reservoir in the study area called the Strawn Group. Additional analysis of the samples’ noble gases conducted by members of the same research team and led by University of Michigan researchers linked the methane to the natural gas deposits of the Strawn. The results were complemented by another of the team’s studies in 2015 that found nitrogen isotopes associated with the Strawn.

"Combining alkane, noble gas and nitrogen compositions, and isotope ratios allowed us to distinguish natural gas sourced from the deep Barnett Shale from the shallow Strawn Group," Larson said.

Climate, Carbon and Geobiology

Computer climate models that include data about snow coverage can significantly improve seasonal temperature predictions. The findings, published in November 2016 in Geophysical Research Letters, could help farmers, water providers, power companies and others that use seasonal climate predictions — forecasts of conditions months in the future — to make decisions. Snow influences the amount of heat that is absorbed by the ground and the amount of water available for evaporation into the atmosphere, which plays an important role in influencing regional climate.

“We’re interested in providing more accurate climate forecasts because the seasonal timescale is quite important for water resource management and people who are interested in next season’s weather,” said Peirong Lin, the lead author of the study and a graduate student at the Jackson School of Geosciences.

The researchers found that incorporating snow data from the Northern Hemisphere collected by NASA satellites improved regional temperature predictions by 3 to 5 percent. These findings are the first to go beyond general associations and break down how much snow can impact the temperature of a region months into the future.

The study examined seasonal data from 2003 through 2009, so the researchers could compare the model’s predictions to recorded temperatures. The model ran predictions in three-month intervals, with January, February and March each used as starting months.

The study’s other co-authors are Jackson School researchers Jiaying Wei, Ph.D. student Kai Zhang, and Yongfei Zhang, a former Jackson School Ph.D. student who is now a postdoctoral researcher at the University of Washington.

The research was funded by a grant from the National Natural Science Foundation of China and the Jackson School of Geosciences.

Snow Data from Satellites Improves Seasonal Temperature Predictions

Surface & Hydrologic Processes

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Getting to Know the Texas Pterosaur

Climate, Carbon & Geobiology

The 35-foot wingspan of Quetzalcoatlus—the largest known flying animal to ever exist—has made it the subject of documentaries and museum exhibits. However, very little has been published based on data from the actual bones of the pterosaur, which were discovered in Big Bend National Park by UT geology professor Dewey Lawson in 1971.

A group of researchers plans to change that by publishing a monograph giving a comprehensive overview of the ancient reptile’s anatomy and physiology. The group consists of Brian Andres, a paleontologist and UT geosciences professor; Langston; an artist specializing in prehistoric animals; James Cunningham, a paleontologist and UT geosciences professor; and Kevin Pedan, a paleontologist and professor of integrative biology at the University of California, Berkeley. Each researcher got to know the pterosaur through a connection with the late Wann Langston, a professor at the UT Department of Geological Sciences. The group sees the monograph as completing work that Langston wasn’t able to finish before his death in 2013.

“Everybody knows about [Quetzalcoatlus],” said Cunningham. “But very few people have actually seen it, and we’re the only ones except Wann who have worked with it.”


To learn more about the conditions under which magma turns into crustal rock, Dygert and his collaborators examined rock samples that were part of the Earth’s mantle 100 million years ago, but are now part of a canyon in Oman. The team turned to geothermometers to calculate temperatures and reveal the cooling history of the rock, including a new geothermometer developed by Liang, which records the maximum temperature a rock attained before it cooled. The temperatures recorded in the rocks show that the lower crust and uppermost mantle cooled and solidified almost instantly, while the deeper mantle cooled much more gradually.

Glaciers around the world come in all shapes and sizes. Research led by the University of Texas Institute for Geophysics (UTIG) indicates that this fact should be kept in mind when predicting how much a glacier stands to lose. Using a newly developed method, researchers have identified glaciers in West Greenland that are most susceptible to thinning in the coming decades by analyzing how they are shaped. The research could help predict how much the Greenland Ice Sheet will contribute to future sea-level rise during the next century, a number that currently ranges from inches to feet. The study was published in Nature Geoscience in April 2017.

“Not long ago we didn’t even know how much ice Greenland was losing. Now we’re getting down to the critical details that control its behavior,” said Tom Wagner, director of NASA’s cryosphere program, which sponsored the research.

The analysis works by calculating how far inland thinning that starts at the terminus of each glacier is likely to extend. Glaciers with thinning that reaches far inland are the most susceptible to ice mass loss. The research revealed that most glaciers are susceptible to thinning between 10 and 30 miles inland. For Jakobshavn, however, the risk of thinning reaches over 150 miles inland almost one-third of the way across the Greenland Ice Sheet.

A pterosaur may sound like a mercury-laden probon a rock in a bucket in reality it’s a feature of the rock itself: a mineral signature scientists use to understand the cooling history of the rock in question. Postdoctoral fellow Nick Dygert applied a new geothermometry analysis technique to rock that formed in the Earth’s mantle and made a discovery that helps explain the crust formation process: water probably penetrates deep into the crust and upper mantle at mid-ocean spreading zones, the places where new crust is made. The finding adds evidence to one side of a long-standing debate on how magma from the Earth’s mantle cools to form the lower layers of crust.

Water in the Earth’s Crust

Solid Earth & Tectonic Processes

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The temperatures recorded in the rocks show that the lower crust and uppermost mantle cooled and solidified almost instantly, while the deeper mantle cooled much more gradually. The temperature change is indicative of water circulating through the crust and uppermost mantle beneath mid-ocean spreading centers, and the heat from deeper portions of the mantle being dissipated through contact with the cooler upper rocks.

The research was supported by the Jackson School of Geosciences, the National Science Foundation, the Alfred P. Sloan Foundation and an International Continental Drilling Program grant.
The Bureau of Economic Geology conducted a comprehensive study of the Bakken unconventional shale resource in North Dakota and Montana and found that it will remain a substantial contributor to U.S. oil production for several decades through a range of oil price scenarios. The study forecasts a wide variation in oil prices, with production increasing to 1.5 million barrels per day. If WTI oil prices were to recover to $100 per barrel, it could lead to 60,000 wells being drilled and capturing 10.5 billion barrels of oil. However, if oil prices remain near $40 per barrel would likely lead to declining production from the Bakken and Three Forks formations, resulting in about 14,000 future drilled wells and estimated ultimate recovery of about 5.4 billion barrels of oil. However, if WTI oil prices were to recover to $100 per barrel, it could lead to 60,000 wells added, capturing 10.5 billion barrels of oil, with production increasing to 1.5 million barrels per day. The study was funded by the Alfred P. Sloan Foundation. The initial results were presented in a series of presentations at the Unconventional Resource Technology Conference in Austin, Texas, on July 25, 2017. Final results will be published in industry journals in the coming months.

For the foreseeable future, rising sea level is, and will be, an issue facing coastal regions, including Middle Pacific islands. A seed grant from the Jackson School of Geosciences is supporting research into past sea level changes, work that could provide insight for what the future has in store.

Fred Taylor, senior research scientist with the University of Texas Institute for Geophysics (UTIG), and Jud Partin, a UTIG research associate, are leading the research, which involves conducting fieldwork in the Federated States of Micronesia (FSM) to determine if high-precision paleosea level records exist.
Jackson School Researchers Converge on Harvey Destruction

Rapid Response Program

 Shortly after Hurricane Harvey devastated Texas communities in August 2017, Jackson School of Geosciences researchers began drawing up plans to determine how Harvey impacted the Texas coast and bay system. The projects are part of the school’s Rapid Response program, which supports research in areas recently affected by natural disasters.

“As geoscientists, it is critical that we use our expertise to help find ways to mitigate the effects of such catastrophic weather events, particularly right here at home in Texas,” said Jackson School Dean Sharon Mosher. “This research will investigate the impacts of abrupt, catastrophic geoscience processes on coastlines. Most importantly, this research will help determine the best ways to deal with many coastal issues in the aftermath of Hurricane Harvey, and how we might better prepare for such events in the future.”

In the days following the storm, researchers at the Bureau of Economic Geology began an airborne LIDAR and imagery survey of parts of the Texas coast. The LIDAR data and imagery are being used to assess storm impacts on the beach and dune system along the Texas Gulf shoreline, identify debris and infrastructure damage in central Texas bays, and establish a baseline for monitoring beach and dune recovery in the months and years to come. These surveys are part of the General Land Office’s comprehensive response to the ongoing effects of Hurricane Harvey.

At the time the Newsletter went to press, researchers at the University of Texas Institute for Geophysics were resurveying the Lydia Ann Channel and Aransas Pass with marine geophysical instrumentation, and collecting sediment samples. Researchers believe that these locations have been subjected to substantial and measurable erosion and sediment transport by the storm surge and its ebbs, and that investigating these locations will provide valuable insights into the impact of storm surges on barrier and estuarine systems.

Jackson School researchers and students have previously surveyed these areas during their Marine Geology & Geosciences field camps in 2009 and 2012, which is providing important baseline data to compare with the post-Harvey findings.

Other Jackson School Rapid Response projects were being discussed when the Newsletter went to press.

Earthquake Triggers “Slow-Motion” Quakes in New Zealand

**Solid Earth & Tectonic Processes**

Slow slip events, a type of slow motion earthquake that occurs over days to weeks, are thought to be capable of triggering large, potentially damaging earthquakes. In a study led by the University of Texas Institute for Geophysics (UTIG), scientists have documented the first clear-cut instance of the reverse—a massive earthquake immediately triggering a series of large slow slip events, with some of the slow slip events occurring as far as 300 miles from the earthquake’s epicenter.

The study of new linkages between the two types of seismic activity, published in *Nature Geoscience* on Sept. 11, 2017, may help promote better understanding of earthquake hazards posed by subduction zones—areas where a tectonic plate subducts beneath an adjacent tectonic plate. These types of faults are responsible for some of the world’s most powerful earthquakes.

“This is probably the clearest example worldwide of long distance, large-scale slow slip triggering,” said lead author Laura Wallace, a UTIG research scientist. She also holds a joint position at GNS Science, a New Zealand research organization that studies natural hazards and resources.

Co-authors include other GNS scientists, as well as scientists from Georgia Tech and the University of Missouri.

In November 2016, the second largest quake ever recorded in New Zealand—the 7.8 magnitude Kaikoura quake—hit the country’s South Island. A GPS network operated by GeoNet, a partnership between GNS Science and the New Zealand Earthquake Commission, detected slow slip events hundreds of miles away beneath the North Island.

The researchers have also found that the slow slip events triggered by the Kaikoura quake were the catalyst for other quakes offshore the North Island’s east coast, including a magnitude 6.0 just offshore from the town of Paraparaumu on Nov. 22, 2016.
Study Quantifies Potential for Water Reuse in Permian Basin Oil Production

Hydraulic fracturing has once again made the Permian Basin one of the richest oil fields in the world. But the improved reserves come with some serious water management issues.

Research led by the Bureau of Economic Geology highlights key differences in water use between conventional drill sites and sites that use hydraulic fracturing. The study, published in Environmental Science & Technology in September 2017, also found that recycling the water produced at hydraulic fracturing sites could help reduce potential problems associated with the technology. These include the need for large upfront water use and potentially induced seismicity or earthquakes triggered by injecting the water produced during operations back into the ground.

“In the Permian we have a good opportunity for reusing or recycling produced water for hydraulic fracturing,” said lead author Bridget Scanlon, a senior research scientist at the bureau and director of the bureau's Sustainable Water Resources Program. Scanlon co-authored the study with bureau researchers Robert Reedy, Frank Male and Mark Walsh.

Since the 1920s, the Permian Basin has been a very active area for conventional oil production, peaking in the 1970s and accounting for almost 20 percent of U.S. oil production. Hydraulic fracturing technology has revived production in the Permian by allowing companies to tap into immense oil reserves held in less permeable unconventional shale formations.

The study analyzed 10 years of water data from 2005 to 2015. Up front, unconventional wells use much more water than conventional wells. But unconventional wells produce much less water than conventional wells.

For conventional operations, the produced water is disposed of by injecting it into depleted conventional reservoirs. Unconventional wells generate only about a tenth of the water produced by conventional wells, but this produced water cannot be injected into the shales because of the rock’s low permeability.

The study points out that instead of injecting the produced water into these formations, operators could potentially reuse the water to hydraulically fracture the next set of wells.

Installation of Earthquake Monitors Complete

The Bureau of Economic Geology installed the final permanent TexNet seismic station in August 2017, completing the system of 22 permanent sensors that will monitor earthquakes around the state and provide scientists the seismicity data to help determine what's behind a recent increase in seismic activity.

TexNet and its related research, led by the bureau, were authorized by Texas Gov. Greg Abbott and the legislature in June 2015 with $4.67 million in state funding. Since then, Research Scientist Alexandros Savvaidis and his crew have been traveling the state surveying potential sites and, with the help of former landman and bureau Director of External Affairs Mark Blount, negotiating leases for the locations of the permanent seismic sensing stations. The system also includes 36 portable seismometers, many of which have already been installed.

With these additional stations now operating, TexNet has been recording dozens of seismic events a month, most of them very small. Monitoring is only part of TexNet’s mandate. In parallel with the Center for Integrated Seismicity Research (CISR), a multidisciplinary research team led by bureau Research Scientist Peter Hennings and Professor Ellen Rathje in the Department of Civil, Environmental and Architectural Engineering, TexNet is working to conduct fundamental research to better understand natural and induced earthquakes in Texas.

At issue is how an extremely small subset of wells used to dispose of wastewater, co-produced with oil and gas, could be triggering faults and causing earthquakes, when the vast majority of disposal wells do not.

Mounting, yet still circumstantial, evidence points to a link between deep disposal of fluids and earthquakes, but comprehensive data and necessary interpretations are ongoing. The lack of data, coupled with the complexity of the science, makes definitive, causal answers difficult at the current time.

“TexNet will help collect the hard scientific data, and conduct scientific and engineering analyses required to understand an issue that affects many stakeholders—industry, government, academia and the public,” said bureau Director and State Geologist Scott W. Tinker. “Energy production is important to the citizens of Texas and the nation, but so is safe disposal and management of fluids. I am proud of our bureau team for working thoughtfully and objectively with all stakeholders in this difficult space.”
Experts from the Jackson School were featured in news outlets, documentaries and even a science show for kids. In addition, research findings — from what killed Lucy, to ice reservoirs on Mars, to exceptional fossil finds — made news across the world.

“This is a vote of confidence that the energy reform is moving forward and for the geological potential of the Mexican Gulf deep waters. Everybody paid a premium and that premium indicates the potential of the blocks.”
Jorge Pilon
Director, Jackson School Latin American and Caribbean Energy Program

“It has taken some time, but to our thinking it is better to do this slower and more methodically and the state will greatly benefit, rather than us rushing in and picking sites that are not very good. We want to get the sensors in the ground, but in the right way.”
Michael Young
Associate Director, Bureau of Economic Geology
Fort Worth Star Telegram, March 4, 2017

“We wanted to try to go into this business of ‘attribution,’ in which people try to parse out the temperature differences that are caused because of natural variability or man-made anthropogenic variability.”
Kaustubh Thirumalai
Postdoctoral Fellow, University of Texas Institute for Geophysics
Washington Post, June 6, 2017

“These uncertainties limit our ability to accurately predict the future of the ice sheet. We are in for a lot of change in Greenland in the future. The question remains — how quickly will it happen?”
Ginny Catania
Associate Professor & Research Associate, Department of Geological Sciences and University of Texas Institute for Geophysics

“What interested us was how long it took life to recover afterward. Because not only was this the worst mass-extinction event, but recovery took millions of years.”
William Foster
Postdoctoral Fellow, Department of Geological Sciences
The Atlantic, March 15, 2017

“In the News”

“Having returned samples from a known context/location on Mars would open up a huge suite of analysis techniques that the rocks could be subjected to.”
Analyzing the rocks in an Earth-based laboratory “will allow us to understand the geologic history of the samples in a way that we couldn’t accomplish in situ on Mars.”
Timothy Goudge
Postdoctoral Fellow, Department of Geological Sciences
Christian Science Monitor, Feb. 14, 2017

“Read Jackson School news: jsg.utexas.edu/news”

**NEWSMAKERS**

CLOCKWISE: 1. UTIG’S JUD PARTIN WAS FEATURED IN A SCIENCE PROGRAM ABOUT GLOBAL CATASTROPHES. 2. SATURDAY NIGHT LIVE GOT IN THE ACT WHEN THE JACKSON SCHOOL HELPED FIGURE OUT HOW LUCY DIED. 3. BEG’S SUSAN HOVORKA DISCUSSES HOW TO STORE CARBON UNDERGROUND ON PBS NEWSHOUR.
Rodent-proofing moisture sensors and plowing through dense forest undergrowth gives Ashley Matheny a glimpse into the survival dance of trees.

If not for the pliable nature of water, Ashley Matheny’s career might have followed a different course. Back in 2010, the West Virginia native was studying water interactions with dams for the U.S. Army Corps of Engineers after completing a bachelor’s degree in civil engineering. One summer morning, she witnessed a phenomena on the Ohio River that would forever change the way she viewed hydrology.

Matheny saw a front of rapidly moving water develop where there were no rocks or objects to raise the water height. The water rushed downstream to slam into slower water, and piled there were no rocks or objects to raise the water height. The change the way she viewed hydrology.

Matheny expanded her research focus during a postdoctoral position at her alma mater last summer to incorporate detailed tree hydrology data into computer models of the cycling of water and bioactive elements between the earth and the atmosphere. Jackson School Professor Jack Sharp noted that researchers have been “pretty ignorant” about how vegetative hydrological processes impact land surface models because plants have been harder to evaluate than satellite-accessible attributes like cloud moisture.

“Understanding vegetative water use is a missing key to the local and global modeling puzzle,” he said. “Matheny’s developed some effective, relatively low-cost ways of measuring water flow and storage in trees that could markedly enhance modeling efforts.”

For her part, Matheny looks forward to working on hydrology projects with Jackson School faculty. She plans to work on water research with Daniella Rempe, also an assistant professor of hydrology and water sciences; on climate modeling with professors Zong-Liang Yang and Bob Dickinson; and on soil moisture analyses with Todd Caldwell and Michael Young at the Bureau of Economic Geology’s Texas Soil Observation Network.

Matheny will likely expand her work to include studying native Texas trees. Yet she intends to keep in mind the broader need for enhancing land surface models’ representation of vegetation. Current models often incorporate measurements of moisture and other features for dozens of soil and atmospheric layers, while plants might occupy a single sliver of information between those data stacks. Moreover, modellers often represent all trees in one category as if they impact resource cycling equally.

“If we could make it so that temperate deciduous forests are not represented as one big leaf, but as the individual hydraulic classes that the trees actually represent, we could reduce the uncertainty in our models,” Matheny said.

The Michigan tree study highlights why lumping tree species fosters such uncertainty by showing that different species have a different way of handling water storage. Traditionally, modellers have measured gaseous exchange at leaf pores (stomata) as a catch-all for understanding plant interactions with water and gasses. Leaf stomata capture carbon dioxide needed for photosynthesis and growth. They also release water through transpiration, the conversion of ultraviolet radiation from sunlight into water vapor. That process helps trees shed heat and water.

To enhance vegetative details, Matheny has spent eight years developing some effective, relatively low-cost ways of measuring water flow and storage in trees that could markedly enhance modeling efforts. For her part, Matheny looks forward to working on hydrology projects with Jackson School faculty. She plans to work on water research with Daniella Rempe, also an assistant professor of hydrology and water sciences; on climate modeling with professors Zong-Liang Yang and Bob Dickinson; and on soil moisture analyses with Todd Caldwell and Michael Young at the Bureau of Economic Geology’s Texas Soil Observation Network.

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To enhance vegetative details, Matheny has spent eight years studying how native tree species adjust their water content in response to changing environmental stress. Combining her passions, the project turned into her master’s and doctoral theses (and her first paper). She measured gaseous exchange at leaf pores (stomata) as a catch-all for understanding plant interactions with water and gasses. Leaf stomata capture carbon dioxide needed for photosynthesis and growth. They also release water through transpiration, the conversion of ultraviolet radiation from sunlight into water vapor. That process helps trees shed heat and water.

In doing so, a plant could become dehydrated during a drought. Enhancing the ability to synthesize nutrients and grow in exchange. By clarifying their reduced fitness during water stress, the work could help inform forest management plans and improve modeling of how forests might shift arboreal species under future climate scenarios.

Not all of Matheny’s projects have been in temperate regions such as Michigan. As a master’s student at Ohio State, she spent weeks on a Panamanian island walking straight transects through a forest and dodging bullet ants, poisonous snakes and more. The work to catalog a vine’s presence in the tree canopy also required carrying LIDAR equipment.

“Hiking in 100 degrees with 100 percent humidity while carrying 50 pounds was not fun,” she admitted.

Knowing the value of field work, though, her first priority in research is to ensure the areas they represent their water use with that of mangroves across the arid coast, such as in Oman, to help clarify hydrological functions of mangroves in the region. Meanwhile, researchers are exploring the potential of mangroves as a natural water treatment system.

She noted that discussing the field experiences that sustain her spirit, and the multidisciplinary aspects of her research, help her being research alive while teaching.

“It’s exciting to continually learn new things,” said Matheny, who has presented at 15 scientific meetings since she was an undergraduate. “My tree research extends into engineering, hydrology and hydrogeology, but also into chemistry and biology, so there are always new possibilities to investigate.”
JACK SHARP

Inquisitive researcher. Giving educator. Dedicated citizen. John M. (Jack) Sharp Jr. is known as a hydrogeologist who approaches his professional life at full throttle. As a testament to his active 43 years of professordom, the four-foot-wide set of Longhorns above his office desk is dwarfed by a sea of plaques around it—a reflection of a commitment to serving his profession that takes five pages to recap on his CV.

by Barbra A. Rodriguez

Sharp has also built a reputation during 35 years on campus as a scientist whose wide-ranging interests have extended from basic research on groundwater recharge to understanding the formation of deep sinkholes.

“There are some people who know exactly what they’re going to do as a career. Sharp noted. “But mine … it’s just been an adventure.”

To analyze a Mexican sinkhole that is the Earth’s third-deepest, he helped obtain funding from NASA to build a rover that plunged 300 meters into Cenote Zacatón. He also is known for developing the first mathematical model of the effects of physical changes that occur on the surfaces of fractured rocks and of how layers of water with different densities can overturn of their own accord in sedimentary systems. As an offshoot of his analyses of natural springs in Central Texas, Washington D.C., and elsewhere, he uncovered the way waterborne contaminants use the sandy material that surrounds underground utility pipes as conduits for transport.

Sharp initially studied geological engineering at the University of Minnesota on the advice of that state’s Geological Survey director, a family friend. A sense of duty led him to Air Force officers training school instead of accepting Peace Corps or graduate school offers. While stationed in Wichita Falls, Texas, during the Vietnam War, he married his wife of 50 years, Carol, and began contemplating teaching.

The four-year break helped him refocus. He earned a doctorate in hydrogeology from the University of Illinois at Urbana-Champaign, studying the movement of heat through layers of sediment. The work earned Sharp the O.E. Meinzer Award—hydrogeology’s highest honor. Other awards have since followed from organizations large and small. In fall 1974, he first began sharing his love of learning on faculty at the University of Missouri–Columbia and came to The University of Texas at Austin in 1982. Over 100 graduate students and postdoctorates have benefited from his guidance.

Wendy Robertson, an assistant professor at Central Michigan University, completed her Ph.D. with Sharp at the Jackson School of Geosciences in 2014, and recalls his inspirational energy. She can still imitate his voice from when he awakened field camps at dawn with a song of reveille. His unguarded thoughts and candid musings and manuscripts such as a dense memoir merit, a hydrogeology glossary beckons, and a monthly newsletter must be kept alive.

When asked about his work, he often refers Robertson’s development of a side project that has led her to consult on water related challenges. Buried amidst mementos surrounding underground utility pipes as conduits for transport.

But mine … it’s just been an adventure.”

Sharp also helps citizens consider water-related challenges. Buried amidst mementos coating his office door is a bumper sticker with a quote from a character by author Robert Heinlein: “A generation, which ignores history, has no past and no future.” Sharp said that hydrogeologists are particularly poised to help explain resource challenges.

“We deal with the present, try to understand the past, and often project into the future with almost any water issue you look at,” he said.

His focus on the impact of urbanization intensified after moving to Austin to join the geology faculty in 1982. Among the dozens of talks he has provided pro bono, for have been several for West Texas residents wondering how Balmorhea Springs could be affected by possible hydraulic fracturing for oil.

“It’s important to put out the current science as best as we understand it [to foster wise decision making],” Sharp noted. “Sometimes it’s not appreciated, but it’s something every scientist should do.”

As for retirement, he still has presentations and manuscripts such as a dense memoir about the Edwards Aquifer to help develop, and classes to teach. When he accepts full retirement and shorter office hours next summer, a hydrogeology glossary beckons, and a monthly newsletter must be kept alive.

“For me, teaching is the best part,” he says. “I’ll continue to learn—and hopefully contribute—to science,” Sharp said.
Bridget Scanlon’s contribution to understanding our most precious resource cannot be overstated. As a world-leading authority on water research, her career has been characterized by a commitment to data as well as innovative approaches that cut across disciplines.

During her 30-year career at the Bureau of Economic Geology, Scanlon has published over 100 articles in numerous peer-reviewed journals, such as Groundwater, Water Resources Research, and Environmental Science & Technology. She has served on National Academy of Sciences committees, been involved with U.S. Department of Energy scientific endeavors, and has been a member of the NASA GRACE science team, a group dedicated to using satellite data to study Earth.

In 2016, she was elected as a member of the National Academy of Engineering, one of the highest professional honors a scientist can receive. Also in that same year, she received the National Ground Water Association’s M. King Hubbert Award for major science contributions to the knowledge of groundwater. Recently, she was appointed to the Jackson School’s William L. Fisher Endowed Chair in Geological Sciences, a distinction that recognizes research scientists, research professors or faculty members for their excellence in research, teaching and service.

“The Bureau of Economic Geology is fortunate to have a research scientist with the dedication, expertise and vision of Dr. Bridget Scanlon,” said bureau Director Scott W. Tinker. “Bridget is widely considered one of the foremost authorities on water resources. She is passionate about her work and what it means to the conservation and wise utilization of water sources in Texas, nationally and globally. I’m honored to call Bridget a colleague and friend.”

WATER, WATER EVERYWHERE

While Scanlon is widely versed in the elements that impact water usage, storage and conservation, she is particularly active in certain research areas: studies of groundwater exchange; the impact of climate extremes and land-use changes on hydrologic processes; water use and availability related to energy; and use of underground aquifers as water storage facilities.

Born in County Kerry, Ireland, Scanlon first studied geology at Trinity College in Dublin and also worked as a field assistant with the Geological Survey of Ireland. This field work formed the basis of her 1983 master’s in geology undertaken at the University of Alabama. Its focus on the hydrogeology of karst landscapes was a preamble to her chemical and physical work as a Ph.D. student at the University of Kentucky in the karst central Bluegrass Region.

After her Ph.D., she spent a year working for the S.S. Papadopoulos consulting firm in Washington, D.C., and then interviewed for positions in research and teaching in various U.S. universities.

“That’s how I ended up in Texas,” she said. Scanlon was first offered a position as research associate at the bureau in 1987. Her decision to remain for three decades is due mainly to the independence afforded to active researchers and the avenues such flexibility allows for collaboration across disciplines.

“The range of things we do at the bureau cannot be underestimated,” she said. “From satellite to deep subsurface, we go the whole gamut.”

“The bureau model has always impressed me,” she stressed. “They really promote collaboration. Every project is a team effort. This is quite different from working in traditional university departments where professors are frequently lone rangers in their respective fields. Fostering a collaborative spirit is so beneficial, particularly from a research perspective.”

BEYOND OIL & GAS

It is sometimes assumed the bureau is focused solely on oil and gas research and funded almost exclusively by major private energy producers. This is a misconception, and Scanlon’s tenure at the bureau is a testament to how diverse the research can be.

“When I first started here, my focus wasn’t on oil and gas at all, but various environmental issues, including low-level radioactive waste disposal,” she said. “Over the years, the bureau has worked with the Texas Water Development Board, Texas Commission on Environmental Quality, the EPA, and is currently conducting a major study into carbon sequestration with the support of the Department of Energy.”

More recently, however, Scanlon has found her expertise becoming increasingly relevant to oil and gas, given how central water is to the process of hydraulic fracturing.

“There is a lot of concern over the large amounts of water needed in order to hydraulically fracture wells in the first place,” she said. “Given its high premium in a state like Texas, much attention is focused on where water can be sourced to service major plays where hydraulic fracturing is being conducted.”

Another challenge is managing the water produced as a byproduct of hydraulic fracturing along with oil and gas. This “produced” water needs to be disposed of in some way, and there is often a lot of it.

“The U.S. produces about 10 barrels of water for each barrel of oil,” she stated. Between the water used in hydraulic fracturing operations and the water produced as a result of those operations, water management is a critical issue for industry. However, it is important to consider water use for the energy sector in a broader context with irrigated agriculture being a major water user in many semiarid regions.

“There is no one size fits all model,” Scanlon said. “Each play has its own particular set of variables that must be assessed individually. By studying the details of each play, then putting all those pieces together and taking a step back, we then begin to understand the broader picture. For me, this approach to research has frequently led to the discovery of workable solutions to the many challenges faced when it comes to water supply and demand.”
**Professor Randy Marrett, a structural geologist, retired this summer after 23 years of research and teaching in the Department of Geological Sciences.**

Marrett was a world-class educator and researcher whose work primarily focused on rock fractures and how fluids flow through them. It’s a key concept in geology, but a difficult one that often ends up frustrating many who try to take on the challenge, said Bureau of Economic Geology Senior Research Scientist Stephen Laubach, a longtime collaborator of Marrett’s.

“The path to solving any of these basic problems is just fraught with so many basic impediments ... it takes a certain stubbornness to stay in the fight,” Laubach said.

Research on fractures is so challenging in part because it’s difficult to study fracture systems that exist deep underground, and understand how fractures behave as the environment changes. Marrett’s most highly cited papers use thorough field observations, combined with conceptual and mathematical insights on fracture and fault behavior. One of those papers, a 1991 publication that is one of the most highly cited papers published in the *Journal of Structural Geology*, found that when it came to brittle-faults, most methods were underestimating the number of fractures present in a given area—a point of particular importance to oil and gas companies interested in mapping out paths where hydrocarbons could go.

While at the Jackson School, Marrett conducted much of his fieldwork in the Sierra Madre Oriental Mountains in Northern Mexico, and in the Central Andes of Argentina and Chile. He is fluent in multiple dialects of Spanish. His and his students’ research in Mexico ranged from regional structure of the Sierra Madre Oriental fold-thrust belt and timing of thrusting to structural studies of detachment folds and structure and stratigraphy within the evaporate decollement. In the Andes, they studied the intracontinental deformation and magnatism responses to late Cenozoic South American plate motion realignment.

Marrett was always more interested in sharing fracture research with those who could apply it, than rushing to publish in journals, Laubach said. To that end, in the 1990s, he and Marrett and collaborators in the Department of Petroleum & Geosystems Engineering (PGE) founded the Fracture Research and Application Consortium (FRAC)—an academic and industry partnership dedicated to studying fracture questions of interest to both groups.

Laubach credits FRAC’s success in part to Marrett’s skill in explaining the science of fracture research to any audience. Marrett, Laubach and Jon Olsoh, the PGE department chair and FRAC collaborator, used to run a lecture series on fractures in reservoirs for the American Association of Petroleum Geologists. Marrett consistently received high rankings for his presentations.

New research ideas could come to Marrett in a flash of brilliance. Laubach recalls a flight to Mexico where he saw Marrett doodling on a napkin. The sketch outlined a new technique for quantifying how fractures were arranged in a particular area.

“The new technique sprung out of his head fully formed,” Laubach said. “He is probably the closest thing to a genius the Jackson School ever had.”

Marrett was an educator extraordinaire. Known widely for his teaching, he earned the ranking of “Awesome!” from the website Rate My Teacher. For many years, he taught GEO 428 Structural Geology and GEO 420K Stratigraphic and Field Methods courses, as well as Advanced Structural Geology and Brittle Structure for graduate students. His devotion to teaching was most evident in his yearly participation in GEO 660, an undergraduate field camp course. Marrett excelled at teaching in the field, both traditional fold-thrust belt mapping and interpretation and integration of thrust kinematics and dynamic processes. Marrett, Laubach and collaborators, was quick to point out his contributions.

“In 20-plus years of team teaching with dozens of faculty, Randy was simply the finest field instructor I’ve worked with,” Helper said. “He trained hundreds of undergraduates. His field skills are unparalleled and his creative teaching methods brought something new to our classes every year. Like the best teachers, he has the ability to explain complex ideas in simple terms and sketches. His contributions to our field program will be sorely missed.”

During his time at the university, Marrett supervised 20 M.S. and seven Ph.D. students and published 57 papers, which have been cited more than 3,608 times.

Elizabeth McKinnon, a master’s student of Marrett’s, said that he helped build confidence in her that all ideas are worthy of consideration.

“Randy is good at helping people think for themselves,” McKinnon said. “If you have 20 ideas and even if only two of them could be plausible, he still wants you to be able to come up with those 20 ideas and expand your mind, and think of all the possibilities.”

Marrett was drawn to the field at an early age. A great lover of the outdoors and fishing, he moved to his cabin in Idaho when he retired and is now living off the grid. Far away from publications and people, McKinnon envisions Marrett spending the day going where his ideas lead him, with geology front and center.

“He takes things he’s heard, stories that don’t seem geology-related, and he can always see why geology is the most important part of the story,” she said.
Davis’ original advisor, who didn’t see a future in studying induced earthquakes at the university, left UT. “I said [to Davis], ‘if you’re working with me you need to work on deep earthquakes and earthquake statistics because there is obviously no future in manmade earthquakes,’” Frohlich recalls. “[Davis’] approach to my advice was he continued to work on induced earthquakes and also worked on deep earthquakes and earthquake statistics. And of course the result was that he drew me into discussions about manmade earthquakes.”

This led to Frohlich’s “hobby” on Texas-induced earthquakes. With no funding or great interest outside of his own, it was something he studied for years, leading him to become an expert when manmade earthquakes became a hot topic in recent years. When two earthquakes near Dallas occurred in 2008, he collaborated with colleagues at Southern Methodist University (SMU) to study the incidents. They turned out to be first manmade earthquakes of the new era. “I was on the forefront of the renaissance of manmade earthquakes,” Frohlich said. “I’ve often said, ‘an expert is somebody who was publishing on something before the smart people thought it was important.’”

Growing up in a family of writers, Frohlich determined that he was the third best writer and that maybe he’d try a different route. When Sputnik went into orbit, he remembers hearing that math and science were the future for careers, so he thought he’d try that. The joke was on him though, as he estimates a large majority of his job is actually writing. “In my career, publishing has been hugely important,” he said. “I think a lot of people publish because they have to because of a grant or otherwise. I’d say that many of my papers, I didn’t have to write. My knee jerk reaction as a scientist: if I figure something out, I should write about it.”

His advice to new researchers is to find problems that are important and do the best science that they can. “On one hand, be careful to publish as much as you can, but two, be careful to work on important problems. Take the time to do it right,” Frohlich said. “Those are kind of opposite—taking the time to do it right and working on a hard problem means that you publish less, but publishing a lot means that you’ve got to get something out, and they are both true.”

While Frohlich has spent most of his time at UTIG studying what interested him, he also served as associate director for the past 20 years. UTIG Director Terry Quinn said that he and the institute as a whole have benefited from having Frohlich at the helm for the past two decades. “Cliff has provided wise counsel and guidance to previous directors and me,” Quinn said. “I am especially grateful to Cliff for his friendship over the years as well.”

So what are Frohlich’s plans now that he’s retiring? He’ll still be around UTIG as a researcher emeritus, and will be a visiting scientist at SMU. He also plans to spend more time with family and working on some hobbies, like woodworking, cycling and writing. “In my career, publishing has been hugely important. I think a lot of people publish because they have to because of a grant or otherwise. I’d say that many of my papers, I didn’t have to write. My knee jerk reaction as a scientist: if I figure something out, I should write about it.”

– Cliff Frohlich

When Cliff Frohlich joined the University of Texas Institute for Geophysics in 1978, he didn’t move to Austin, he moved to Galveston, where the institute was originally located. His specialty was on ocean bottom seismography, but from the moment he was hired, he was told to focus on science. By Jessica Hall

“One of the wonderful things about the institute is that from the beginning they basically said, you’re a research scientist, we don’t know what you should be thinking about, but figure it out. As long as some of it is earth science, do the best science that you can,” Frohlich said. “I’ve had a career where nobody has ever prevented me from thinking about something I’m curious about and that’s something special because I’ve done a lot of things.”

And that’s exactly what he did for the past 40 years—the research that interested him. Over the years he has studied the ocean bottom, earthquakes statistics, deep earthquakes, Texas earthquakes and manmade earthquakes. The latter is what Frohlich is most known for recently; his phone regularly rings as soon as an earthquake is felt in Texas. His interest in manmade or induced earthquakes began thanks to a graduate student, Scott Davis, who Frohlich began to work with when
Karst Record Conference (KR8)

The Karst Record Conference, a four-day, international conference dedicated to sharing the latest progress in cave-based paleoclimate research, convened at the Jackson School of Geosciences on May 21-24, 2017.

Jay Banner, the director of the Jackson School’s Environmental Science Institute, and Kathleen Johnson, a professor at the University of California, Irvine, hosted the conference, called KR8 for short. The program included three full days of oral and poster presentations, and mid-conference workshops. The 115 attendees came from 18 countries and 18 U.S. states. Caves form in karst—a geological term for landscapes made up of rocks that are easily eroded by water, such as limestone and dolomite, and form underground drainage features, like caves and sinkholes. With that in mind, the karst landscape of the Texas Hill Country was an ideal locale to hold a conference dedicated in large part to sharing the latest research on how stalactites, stalagmites and other speleothems are used to study ancient climates.

Optional field trips to Inner Space Cavern, Natural Bridge Caverns, Barton Springs and West Cave gave conference attendees the option to see some of the most famous karst features of Central Texas during their stay.

Sarah Truebe, Director of Community Engaged Learning in Environmental Sustainability at Stanford University, enjoyed the mid-conference trip to Barton Springs—a trip that included a tour led by a U.S. Geological Survey hydrologist and an option to take a dip in the main pool — but was excited for the next day of scientific talks back at campus.

“So far, every talk has something interesting,” she said.

North American Workshop on Laser Ablation (NAWLA)

A who’s who of laser ablation and inductively coupled plasma mass spectrometry convened on Austin in May 2017 to share knowledge about this powerful analytical technology.

The meeting—the North American Workshop on Laser Ablation—was also the second time the group has come to the Jackson School of Geosciences. The three-day workshop was spearheaded by a small group that includes Jackson School Laser Ablation and ICP-MS Lab Manager Nate Miller, who wanted to help create a workshop environment where scientists and instrument vendors could exchange information about a rapidly changing field.

“The best way to learn something is from an expert, and very few of us get the chance to go visit an expert in a lab to learn a technique,” he said. “We’re trying create a workshop with shared experiences and opportunities where you can learn.”

The workshop constituted a snapshot of state-of-the-art laser ablation research. Some 130 scientists and vendors from 12 countries attended the workshop, including two internationally known pioneers in the field: Sam Houk of Iowa State University and Henry Longerich of Memorial University of Newfoundland. Jackson School research was presented by professors Richard Kyle and Daniel Stockli, postdoctoral fellow Federico Galster, and graduate students Stephanie Wafforn and Kylie Wright.

The workshop now being held every other year—on the off-years of the long-running European workshop on the same topic. Miller doesn’t know yet if the Jackson School will be the permanent home of the event, but said that the group is committed to keeping the meeting going. That’s good news for Longerich, who said he found the workshop much more constructive than some larger and better-known scientific conferences.

“It’s a perfect size,” Longerich said of the workshop. “That makes this meeting, for me, more productive. I can just sit there and soak it all in.”

Tomography for Scientific Advancement Symposium (ToScA)

For the past 20 years, The University of Texas at Austin’s High-Resolution X-ray Computed Tomography Facility, or UTCT, has been hard at work in the Jackson School of Geosciences, giving researchers a nondestructive look inside specimens ranging from dinosaur eggs to ancient meteorites.

On June 6–8, 2017, the far-reaching research facilitated by UTCT and other CT-scanning facilities was on display at the Jackson School of Geosciences for the first North American meeting of ToScA, the Tomography for Scientific Advancement Symposium. Hosted by UTCT and the Jackson School, and managed by the Royal Microscopical Society, the event brought together about 70 attendees from 31 different academic institutions and companies, and four countries, all united by a common research interest in CT-scanning.

Fazah Ahmed, the head of imaging and analysis at the Natural History Museum London and ToScA founder, suggested the Jackson School as the site of the first North American meeting, said UTCT research scientist associate and facility manager Jessie Maisano, who co-chaired the meeting with Ahmed.

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CONTINUED ON NEXT PAGE
“She approached us because we’ve been doing this for 20 years, and we were the first academic research lab in the United States to provide this kind of technology to academic researchers, as far as we know,” Maisano said. “The program has been amazingly strong, especially for a first meeting.”

The program included lectures on scanning and analysis techniques, as well as on how the technology was being applied in different scientific areas, including geology, materials science, and medical and biological science. The UTCT lab got its first CT scanner in 1997. Before that, researchers had to rely on military or medical contacts to scan specimens, said UTCT Director Richard Ketcham. By scanning specimens for all sorts of research ends, the UTCT lab has developed a broad expertise, and developed relationships with scientists across disciplines.

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Analog Modeling of Tectonic Processes

Studying tectonic processes presents geoscientists with a multitude of difficulties, but none of the challenges are more daunting than dealing with the scale of the science: tectonic processes are large and take place over a long period of time. Given these issues, models can be a very effective way of understanding some of the processes governing tectonic deformation. Analog, or physical, models contribute substantially to the development of new tectonic concepts, as well as benchmarking numerical models. Still, the analog modeling community is dispersed and small, and its interaction and collaboration with the numerical modeling community is limited.

The National Science Foundation sponsored an international Analog Modeling of Tectonic Processes workshop at the Bureau of Economic Geology in May 2017 to bring the two modeling communities together. Bureau researcher and workshop co-organizer Tim Dooley points to the success of a session where the attendees ran an analog and a numerical model of an extensional rift system. The results stimulated discussions on the strengths and limitations of both approaches, as well as ways to increase collaboration between the two scientific modeling groups.

“This hands-on approach during the workshop led to a direct exchange of ideas and facilitated networking between the different communities,” Dooley said.

The group visiting the bureau consisted of about 50 modelers from six countries and included early-, mid- and late-career geoscientists. The three-day workshop included 10 oral presentations on topics such as the application of model results to field and seismic data, different experimental techniques, and scaling and reproducibility issues. Some 22 posters and two teaching examples of modeling methods were presented.

The workshop concluded with a discussion where participants agreed that a better system was needed to exchange teaching material on analog models in classrooms, and that there is an ongoing need for a system or database to store and exchange model results, as well as a database of different model materials.
Update on the Future of Undergraduate Geoscience Education

The National Science Foundation (NSF) sponsored initiative on the Future of Undergraduate Geoscience Education continues to work on changing undergraduate education to meet the needs of the workforce and society.

The recommendations of this national effort involved input from over 1,000 academics and geoscience employers. About 100 department heads and chairs nationwide have started implementing these recommendations into their undergraduate programs and curricula. The organizing committee, led by Jackson School Dean Sharon Mohler, is evaluating the heads and chairs successes and problems in implementing change over the past 18 months. The goal is to find solutions that will help others in similar types and sizes of departments overcome roadblocks and obstacles to change. Over the next year, the organizing committee hopes to codify the recommendations and best practices for implementation into a “Vision and Change” document.

At UT, this effort dovetails with President Greg Fenves’ Undergraduate Degree Transformation initiative and Project 2021. This past year, the Department of Geological Sciences degree transformation committee formulated preliminary plans for enhancing our undergraduate degree to increase undergraduate research and experiential learning and incorporate the recommendations of the national initiative. 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. Recognizing this also applies to geoscience graduate students whether they have future careers in industry, government, academia or non-governmental organizations, or are studying Earth, atmosphere or oceans.

You can keep up to date on the initiative and view all the materials at jsg.utexas.edu. Click on the “Future of Geosciences Education” link.

JSG Students Represent Geosciences at NSF Expo

Jackson School of Geosciences graduate students Tomas Capaldi and Sarah George took Texas geosciences to Capitol Hill in May 2017, meeting with members of Congress and their staffs to discuss the importance of supporting geosciences research and education.

They were both part of the Coalition for National Science Funding Expo, a meeting that highlights research and education programs funded by the National Science Foundation (NSF), and creates an opportunity for NSF-funded scientists to engage with lawmakers. Both Capaldi and George’s research is supported by NSF grants, and George is funded by an NSF graduate research fellowship.

The coalition includes over 130 professional organizations, universities and businesses dedicated to increasing funding for the NSF and the research and education programs it supports. Capaldi and George represented the geosciences as a whole at the event, including the Geological Society of America and the American Geophysical Union.

During their time on the Hill, Capaldi and George met with the staffs of Sen. John Cornyn of Texas and Rep. Lamar Smith of Texas to explain how NSF-funded research at the Jackson School is beneficial to Texas.

“We let them know what we’re researching, and what we can give back,” George said, mentioning how research on sedimentary basins is key for hydrocarbons exploration.

George said the experience illuminated how science is often an overlooked topic when it comes to policy. She noted how slips of paper used to document topics constituents called about have overlooked topic when it comes to policy. She noted how slips of paper used to document topics constituents called about have overlooked topic when it comes to policy.

No one is calling on behalf of science,” she said.

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Mackin and Owen Added to Hall of Distinction

The Jackson School of Geosciences inducted two new members into its Hall of Distinction, an honor that recognizes individuals with a strong affiliation to the school who have made high-level accomplishments in academia, industry or government. Both are posthumous inductions.

Hoover Mackin was recruited by The University of Texas at Austin Department of Geology in 1961 to occupy its first endowed faculty position, the William Stamps Farish Professorship (later Chair). Mackin was first appointed as a visiting professor at UT to provide an opportunity for him to get a feel for the department and the Austin community. He liked what he saw and joined the faculty of the university permanently a year later.

Mackin was a distinguished scientist. He was a member of the National Academy of Sciences and served a two-year term as chairman of the Earth Sciences Division of the National Research Council. His early work was in geomorphology and his concept of “the graded river” became a mainstay in fluvial geomorphology. He later undertook research in engineering geology, structural geology and field petrology. Mackin was also involved in the mission to land a man on the moon and was one of four experts selected by NASA to study the first lunar rock samples returned to Earth. Both a lunar crater and Antarctic plateau are named in Mackin’s honor. He taught for 28 years at the University of Washington before joining UT, where he supervised four master’s students and five Ph.D. students while a faculty member of the department.

Ed W. Owen was a lecturer in the UT Department of Geology from 1952–1976, where he moderated Tech Sessions, participated in graduate seminars, counseled students, served on the advisory council, and helped organize a history of geology course—all while refusing a salary during his entire tenure. Owen was key in organizing the Geology Foundation and served on its advisory council.

While Owen was in the U.S. Army Air Corps in 1941. In 1942, as a captain in the Air Corps, he served in New Guinea and Australia in the photographic intelligence division. Attaining the rank of lieutenant colonel, he was awarded four campaign ribbons, five battle stars, a distinguished unit citation, and the Legion of Merit. Owen was key in organizing the Geology Foundation and served on its advisory council.

Julia Clarke Recognized for Research Career with Humboldt Award

Julia Clarke, a professor in the Jackson School of Geosciences Department of Geological Sciences, received a 2016 Humboldt Research Award. The award is granted by the Alexander von Humboldt Foundation, which promotes academic cooperation between scientists and scholars in Germany and other countries.

The award recognizes a researcher whose fundamental discoveries, new theories, or insights have had a significant impact on their own discipline and who are expected to continue producing cutting-edge achievements in the future. Award winners are invited to spend a period of up to one year cooperating on a long-term research project with colleagues at a research institution in Germany. Clarke’s research focuses on using phylogenetic methods and diverse data types to gain insight into the evolution of birds and avian flight. She is particularly interested in the evolution of living bird lineages and how the diversity, shape and form of birds have changed across their deep histories.

Scanlon Receives Hubbert Award, Appointed Fisher Endowed Chair, and Named Prieto Memorial Fellow

Bridget Scanlon, a senior research scientist and hydrologist at the Bureau of Economic Geology, was the 2016 recipient of the M. King Hubbert Award from the National Ground Water Association (NGWA). The award recognizes major science contributions to the knowledge of groundwater.

She was also was recently appointed as the William J. Fisher Endowed Chair in Geological Sciences, as well as being named a fellow of the Prieto Memorial Excellence Endowment, which benefits the Fisher Chair.

Scanlon leads the bureau’s Sustainable Water Resources Program, a research group that combines a variety of analyses 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.

Katherine Ellins Gets Neil Miner Award

Katherine Ellins, the program director for geoscience education research at the Jackson School of Geosciences, is the 2017 recipient of the National Association of Geoscience Teachers Neil Miner Award. Presented each year since 1953, the award honors an individual for exceptional contributions to the stimulation of interest in the earth sciences and is presented at the association luncheon at the national meeting of the Geological Society of America. Ellins is the third person from the Jackson School to receive this award. The other recipients are Professors Emeriti Bob Folk and Robert Boyer.

Ellins’ efforts to improve science learning and public engagement include curriculum development for earth science, professional development for teachers, multi-institutional collaboration to promote diversity in geosciences at the K–12 and undergraduate levels. Her work has been supported by state agencies and federal grants, primarily the National Science Foundation, and carried out in collaboration with geoscientists and learning scientists.
Chuck Abolt Receives NASA Fellowship
Chuck Abolt, a Ph.D. student, received a NASA Earth and Space Science Fellowship for his research on arctic soils titled “Feedbacks between topography and three-dimensional fluxes of heat, water, and carbon in ice wedge polygons.” Abolt is one of just 69 awardees chosen from 385 applicants in the earth science field. His award was based on scientific merit, relevance to NASA’s objectives in earth and space science, and academic excellence. Working with Ph.D. advisor and Bureau of Economic Geology Associate Director Michael Young as principal investigator, Abolt will explore two hypotheses regarding changing topography and the interrelationships between heat, water, and soil carbon levels of ice wedge polygons to better understand the geomorphology of the Alaskan tundra.

The study also includes development of a software application to survey a study area of more than 480 square kilometers of tundra to estimate rates of groundwater release at a landscape scale.

Bell Appointed New Associate Dean for Academic Affairs
Professor Chris Bell has been named the Jackson School of Geosciences’ associate dean for academic affairs, replacing Professor Richard Ketcham, whose term ended this summer. “I’d like to personally thank Rich for his fine service in the position,” said Dean Sharon Mosher. “Chris is an outstanding researcher, educator and mentor and will be a tremendous fit as associate dean for academic affairs.” Bell is exceptionally qualified for this position, where he will be responsible for academic affairs for the Jackson School, including the undergraduate program, student affairs and admissions. He is an outstanding educator as shown by his numerous teaching awards, including The University of Texas at Austin’s Chancellor’s Council Outstanding Teaching Award, Texas Exes Teaching Award, Jackson School’s Outstanding Educator Award, and five-time winner of the department’s Knebel Teaching Award. Bell just finished a four-year term as graduate advisor in 2016, and along with Bill Carlson, started the Jackson School’s Undergraduate Research Honors Program in 2005.

Christeson and Sen Named UTIG Associate Directors
The Institute for Geophysics has selected Gail Christeson and Mrinal Sen to be its new associate directors. Gail Christeson is a senior research scientist at UTIG and Mrinal Sen is a professor and Jackson Chair in Applied Geology.

Bell, who joined the Department of Geological Sciences in 1997 as an assistant professor, is the John A. Wilson Fellow in Vertebrate Paleontology. His research centers on understanding the complex dynamics of vertebrate faunal communities during the Quaternary Period. He is interested in investigating patterns of vertebrate evolution, biodiversity and biogeography throughout the Quaternary, and the responses of different vertebrate groups to the various changes in climate that took place during the past two million years.

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Bell, who joined the Department of Geological Sciences in 1997 as an assistant professor, is the John A. Wilson Fellow in Vertebrate Paleontology. His research centers on understanding the complex dynamics of vertebrate faunal communities during the Quaternary Period. He is interested in investigating patterns of vertebrate evolution, biodiversity and biogeography throughout the Quaternary, and the responses of different vertebrate groups to the various changes in climate that took place during the past two million years.

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Chuck Abolt Receives NASA Fellowship
Chuck Abolt, a Ph.D. student, received a NASA Earth and Space Science Fellowship for his research on arctic soils titled “Feedbacks between topography and three-dimensional fluxes of heat, water, and carbon in ice wedge polygons.” Abolt is one of just 69 awardees chosen from 385 applicants in the earth science field. His award was based on scientific merit, relevance to NASA’s objectives in earth and space science, and academic excellence. Working with Ph.D. advisor and Bureau of Economic Geology Associate Director Michael Young as principal investigator, Abolt will explore two hypotheses regarding changing topography and the interrelationships between heat, water, and soil carbon levels of ice wedge polygons to better understand the geomorphology of the Alaskan tundra.

The study also includes development of a software application to survey a study area of more than 480 square kilometers of tundra to estimate rates of groundwater release at a landscape scale.

Bell Appointed New Associate Dean for Academic Affairs
Professor Chris Bell has been named the Jackson School of Geosciences’ associate dean for academic affairs, replacing Professor Richard Ketcham, whose term ended this summer. “I’d like to personally thank Rich for his fine service in the position,” said Dean Sharon Mosher. “Chris is an outstanding researcher, educator and mentor and will be a tremendous fit as associate dean for academic affairs.” Bell is exceptionally qualified for this position, where he will be responsible for academic affairs for the Jackson School, including the undergraduate program, student affairs and admissions. He is an outstanding educator as shown by his numerous teaching awards, including The University of Texas at Austin’s Chancellor’s Council Outstanding Teaching Award, Texas Exes Teaching Award, Jackson School’s Outstanding Educator Award, and five-time winner of the department’s Knebel Teaching Award. Bell just finished a four-year term as graduate advisor in 2016, and along with Bill Carlson, started the Jackson School’s Undergraduate Research Honors Program in 2005.

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STUDENT RESEARCH SYMPOSIUM AWARDS

In February 2017 the Jackson School’s Graduate Student Executive Committee organized its 6th Annual Research Symposium. Winners and honorable mentions are as follows:

**LATE CAREER PH.D. STUDENT**

1st Place: Douglas Barber (Solid Earth & Tectonic Processes): Linkages between orogenic plateau build-up, fold-thrust shortening, and foreland basin evolution in the Cenozoic Zagros (Iran-Iraq)

2nd Place: Tomas Capaldi (Solid Earth & Tectonic Processes): Neogene foreland basin evolution during a shift to flat-slab subduction in Argentina (30.5°S)

Honorable Mention: Margaret Odlum (Solid Earth & Tectonic Processes): Detrital zircon (U-Th)/(He-Pb) double dating of Southern Pyrenees foreland basin fill: implications for sediment routing during tectonic inversion and orogenesis

**LATE-CAREER MASTER’S STUDENT**

1st Place: Nicholas Ettinger (Climate, Carbon & Geobiology): A Multiproxy record of the Toarcian Oceanic Anoxic Event in Shallow-Water Carbonates from the Adriatic Carbonate Platform

2nd Place: Reinaldo Sabbagh Maciel (Climate, Carbon & Geobiology): Sensitivity analysis of Lower Miocene sandstones to CO2 saturation in the inner continental shelf of the Texas Gulf of Mexico

Honorable Mention: Juan Munoz (Solid Earth & Tectonic Processes): Holocene Geologic Slip Rate for the Mission Creek Strand of the southern San Andreas fault, Indio Hills, California

**EARLY-CAREER GRADUATE STUDENT**

1st Place: Allison Lawman (Climate, Carbon & Geobiology): A Coral-based Reconstruction of Interannual Climate Variability at Vanuatu during the Medieval Climate Anomaly (950–1250 CE)

2nd Place: Kelly Thomson (Solid Earth & Tectonic Processes): Tracing Environmental Signals from Source to Sink: Zircon (U-Th)/(He-Pb) Double Dating Applied to the Foreland Basins of the South Central Pyrenees, Spain

Honorable Mention: Brandon Shuck (Marine Geosciences): Evolution of the Upper Lithosphere in the ENAM Area from 3-D Wide-Angle Seismic Data

**UNDERGRADUATE**

1st Place: Emilie Bowman (Solid Earth & Tectonic Processes): Investigating Magma Chamber Evolution using Mafic Enclaves and Plagioclase Zoning: Grasberg Igneous Complex, Papua, Indonesia

2nd Place: Cole Speed (Marine Geosciences): Late Quaternary Paleochannel Systems of the East Texas Inner Continental Shelf

Honorable Mention: Cody Draper (Solid Earth & Tectonic Processes): Trace Elements and Oxygen Isotope Zoning of the Sidewinder Skarn

**BEST REPRESENTED RESEARCH GROUP**

1st Place: Whitney Behr Research Group

2nd Place: Sergey Fomel Research Group
Walter Geology Library 2016–17 Annual Report

In keeping with the new organizational changes in the UT Libraries, The Walter Geology Library has begun redefining spaces by taking down two ranges of shelving and replacing them with additional study tables, making room for 20 more seats. Over the next several years, we plan to shift much of the legacy print collection to off-site storage and continue this transition to a more service focused facility. The majority of our journals are now available only by E-access, and historical access online is available for many of them. Improved scanning and delivery will help us provide needed access to the older print materials.

As the library’s reorganization takes effect, duties and responsibilities are shifting to provide more efficiency without sacrificing our standards of service. The librarian will focus more on collections, research services and outreach, while the ongoing daily responsibility for the unit will shift to Stacy Ogilvie, our onsite unit manager, and a new branch management structure. To prepare for these various changes, the Walter Library is starting the next phase of a de-duplication project. This means removing multiple copies of titles that are not circulating enough to warrant their retention, and shifting some materials to storage or to units where they may get more use.

We are still exploring the idea of converting our periodicals reading area to a display space for gem, mineral and fossil collections and a small seminar room. We will be able to put more specimens on display for more hours in a more secure environment than is now available, free up a room on the main floor, and the additional seating space will give us an opportunity to host small group meetings. This is a small remodeling project, and we have some seed money, but not enough to make it happen yet. Stay tuned!

Looking ahead, Library Storage Facility #3 is under construction at the Pickle campus; we expect to have it open next year. This is just in time, as LSF #1 and #2 are full, and one of our current facilities is in the way of the expansion plans for the medical school.

A couple of collections news items are notable. We have acquired hundreds of sheets this year to complete coverage of Italy, Greece and Western Australia at 1:100K or finer scales, as well as numerous atlases and other far-flung materials to support research. In addition, we teamed up with the other science libraries to pool funding and acquire e-access to almost 3,000 legacy physical sciences monographs from Elsevier at substantial discount, which we hope will make everyone very happy. Our colleagues at the American Geosciences Institute have also donated more than 20 cartons of pre-selected foreign geology periodicals and monographs, adding some hard to get new resources to our holdings.

On other fronts, the UT Libraries have hired a GIS data coordinator and a GIS technical staff person to help us push forward our vision of a geospatial data server and more involvement in GIS services for the wider campus community. We are also proud to note that some of our Texas ScholarWorks open access materials have been highly successful. We are making steady headway getting author permission to digitize theses, and we have added a number of meeting abstract volumes and other materials in ScholarWorks, ranging from historical to brand new, many of which have been getting a great deal of use. You can visit the open ScholarWorks repository here: repositories.lib.utexas.edu.

Last year, we mentioned the massive new UT Press book edited by Andre Bober, The Collections, featuring materials from our Tobin Map Collection, Barron Gem and Mineral collection, and other collection materials. The book is now available online for those that might want to browse it here: thecollections.utexas.edu.

Our social media presence is strong, with almost 700 people following our Facebook page (you should too!), and the Walter Library twice sponsored local therapy dogs near exam time to provide stressed out students with some fur-time.

Four student workers graduated over the course of this year after many semesters of service with us: Hector Peralez, Daniela Jauregui, Kevaughn Evans, and our GRA, Katelyn Helberg. We wish them well in their future endeavors. This year’s winners of the Guion service award were Kevaughn Evans for her efforts on our thesis database revision, and our GRA Katelyn Helberg for all of her excellent cataloging work on our large cataloging backlog. Head Librarian Dennis Trombatore attended the GSA meeting in Denver, continued to serve as chair of the AGI GeoRef advisory committee, and reached a milestone with his 20th year of pottery contributions to the Austin Empty Bowl Project for the Central Texas Food Bank.

Dennis Trombatore
Librarian
The 2017 GEO 660 class spent six weeks camping and lodging at geological sites in seven states, learning how to interpret geological relationships large and small. Their stops included the Permian Basin of West Texas and New Mexico; the Sacramento Mountains and White Sands National Monument of New Mexico; the Sawtooth, Big Belt and Pioneer Mountains of Montana; and the Valles Caldera of The Jemez Mountains, New Mexico. The group conducted about 15 projects that taught new skills and honed existing ones in sedimentary geology, structural geology and mapping, igneous and metamorphic geology and economic geology.

Distinguished Senior Lecturer Mark Helper led the class, which included site-specific instruction by other faculty experts including Whitney Behr, James Gardner, Peter Hennings, Brian Horton, Charles Kerans, David Mohrig, and Ronald Steel. Faculty were assisted by assistant instructor Tomas Capaldi and six teaching assistants who rotated through three-week appointments.

“Each week we were able to learn from experts of that field, and got a feel for the different areas of geology.”

– RILEY MONK, UNDERGRADUATE STUDENT

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.
We were given the reins to develop our own research questions, design a field methodology, process our data, and synthesize conclusions to help tell the hydrologic story of the caldera. This type of field experience is invaluable to me as I prepare for a career in hydrogeology in Texas and beyond.

– CAROLINE HACKETT, GRADUATE STUDENT

The summer of 2017 marked the 10th year of the Marine Geology and Geophysics field course. The class began with three days of classroom and lab instruction from experts at the University of Texas Institute for Geophysics (UTIG). The class then travelled to Galveston for seven days of at-sea fieldwork and on-shore lab work. Students rotated daily between an on-shore lab facility and two small research vessels: the R/V Scott Petty for multibeam, sidescan and sediment sampling; and R/V Manta for multichannel seismic reflection, chirp and coring. This year’s course imaged and mapped the buried river valley and associated channels of the Trinity River beneath Galveston Bay and the Texas shelf. Back in Austin, students, integrated and interpreted data for a final project that examined the geologic history of the survey area.

“All our amazing instructors have obviously put their expertise into the class. The main benefits of the class came from the field survey in the Gulf of Mexico and the final group presentation. I hope that all Jackson School students can take this class.”

– WOONG MO KOO, GRADUATE STUDENT

Students in the 2017 hydrology field course applied the knowledge and skills they learned in the classroom to investigate hydrogeologic processes in diverse settings. With the generous help of Geoprojects International (owned by Jackson School alumnus Pat Goodson) and hydrogeologists from the Bureau of Economic Geology, students drilled new wells and performed pump tests along the Colorado River in Hornsby Bend. Students then traveled to the Valles Caldera National Preserve in New Mexico where they used geophysical imaging, geochemical sampling, hydrological monitoring, and stream gauging to probe connections between groundwater and surface water dynamics.

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In 2012, the U.S. Geological Survey reported that Oklahoma experienced 34 earthquakes. By 2015, the number increased to over 880, an increase largely attributed to the surge in wastewater injections following hydraulic fracturing, or fracking, operations.

Mark Zoback, professor of geophysics at Stanford University, gave a presentation at the Bureau of Economic Geology in June about the connection between earthquakes in Oklahoma and wastewater injection sites. The talk centered on research published in Science Advances in June 2015 that linked earthquakes to wastewater injection sites. Using a new statistical model developed by Zoback and Stanford postdoctoral fellow Cornelius Langenbruch, the researchers predicted that high magnitude earthquakes will decline significantly if Oklahoma reduces wastewater injection.

“Our model allows us to forecast the rate of potentially damaging earthquakes associated with water injection in north-central Oklahoma and parts of Kansas in response to reduced injection rates,” Zoback said.

The physics-based model relies on information about pore space, stress state and fault orientation.

Wastewater collected during hydraulic fracturing, a process that injects water and chemicals into the earth to extract oil or gas, is disposed of in deep wells at high pressure. According to Zoback, billions of tons of wastewater are injected into deep layers of the Arbuckle formation and the underlying crystalline formation in Oklahoma. He said this pressure causes the fault slip that produces earthquakes.

Zoback added that earthquakes often occur on permeable, preexisting faults.

“Potentially active faults extend from the crystalline basement up to the Arbuckle,” Zoback said. “The pressure in the Arbuckle was really small, but it’s so permeable that the pressure spreads out and finds a critically stressed fault, called an active fault ... which allows a pressure change at this depth to trigger seismicity.”

Zoback and his team modeled potentially active faults by assessing whether the injection increases pore pressure in the rocks. Also, fault orientation, or the angle and compass direction of the fault relative to the ground, factors into fault slip probability.

“Fault orientation is very important,” Zoback said. “In general, few preexisting faults are likely to be problematic. They [preexisting faults] are either too perpendicular to the fault and have too much normal stress to slip, or are too parallel and have too little shear stress to slip.”

Zoback and his team concluded that all relatively large recent earthquakes in Oklahoma occurred on “predictable” faults, or those that show evidence for vulnerability to earthquakes. But the great majority of earthquakes do not occur on mapped faults.

This data can be used to predict future earthquakes, Zoback said, but cautioned that even with their exceptional stress data, there are many unknown fault sites.

“The important thing is not only identifying potentially problematic faults but identifying faults that aren’t problematic,” Zoback said. “But the weakness is, we don’t know about the number of faults ... so only half the problem is solved. We know there are a lot more faults but they are just not on the maps.”

Despite some uncertainties, the study results have spurred a recent decision by the Oklahoma Geological Survey to issue a statement that recognized injection of wastewater into wells, specifically in the Arbuckle formation, as the cause of the state’s recent earthquakes.

In 2016, regulators in Oklahoma mandated a 40 percent reduction of wastewater volumes, which Zoback said contributed to the reduction in earthquakes.

“We forecast that the probability an earthquake will exceed a magnitude of 4.5 in 2017 is 70 percent,” Zoback said.

“These high probabilities are basically cut in half from years ago, since injections have decreased.”

The work of Zoback and his team has pushed regulators to acknowledge the source of the recent earthquakes in Oklahoma, but hydraulic fracturing and wastewater disposal continues in the area.

Potential solutions to induced seismicity include completely halting injection of produced water into the Arbuckle formation entirely. Rather, Zoback suggests injecting the waste back into producing formations such as the Mississippian Lime, a limestone layer where much of the produced water in Oklahoma originates.

Zoback said his team also plans to continue developing a Texas stress map as hydraulic fracturing operations continue to increase in the state.

“They [oil companies] are still injecting, and our model shows that, at least in respect to magnitude five earthquakes, we are still on track,” Zoback said. “We are going to know in the next few years how the model is holding up. The problem, while not solved, is at least getting better.”
Studying Alaska’s Glaciers from Land and Air

I am in Alaska surveying glaciers for NASA’s Operation IceBridge. I work with Chris Larsen and Martin Truffer of the Geophysical Institute at the University of Alaska, Fairbanks (UAF). Chris is the principal investigator and Martin and I are co-investigators on the project. UAF has a decades-long history of monitoring the surface elevation of Alaskan glaciers using airborne LIDAR, and we are continuing that tradition with the addition of radar sounding to measure the thickness of the ice. That’s my main responsibility. It’s quite a challenge to sound Alaskan glaciers because they are warm, wet, heavily crevassed and usually close to mountains and valley walls that reflect the radar energy, obscuring echoes from the base of the glaciers. But it is all new information and important for understanding the rapidly changing ice of Alaska, so it’s also rewarding work.

In order to do this, we outfitted a turbine Otter aircraft that operates on wheel-skis so we can land on hard surfaces or snow, as needed. We sometimes land on glaciers just to have a convenient spot to add fuel from drums. Our “home base” is a remote lodge that is only accessible by bush aircraft, nestled against the Chitina River and surrounded by Wrangell-St. Elias National Park. Paul Claus of Ultima Thule Outfitters owns and pilots the Otter, and he is one of the most experienced bush pilots in Alaska. This is important due to the steep terrain, some of the steepest in the world, and rapidly changing weather with the potential for strong winds and turbulence at any time.

From this outpost in the wilderness we cover all of the major Alaskan glaciers, from the Juneau icefield in the southeast to the Kenai Peninsula in the west. We put in some very long days when weather is good, and can rarely make specific plans beyond what the 24-hour weather forecast holds. Even then, it is often a matter of heading out for a flight half expecting to turn back. When it’s clear and calm, it is some of the most spectacular scenery anywhere. When we are grounded but local weather is okay, I try to fit in some work on nearby debris-covered glaciers for Mars analog work. Just today I flew out to a nearby airstrip and hiked up to a debris-covered glacier where my students Eric Petersen and Stefano Nerozzi have conducted a great deal of surface geophysics. I checked on a weather station we installed to make sure it’s operational before winter sets in. A nice way to spend a “day off.” As long as I don’t encounter a grizzly up close.

Jack Holt
Research Professor, University of Texas Institute for Geophysics

Tracking Tectonic Links Among Andean Mountains

Tomas Capaldi, a Ph.D. student who studies mountain building in the Argentine Andes with Professor Brian Horton, spent time this summer in Argentina conducting field work in the San Juan province two hours north of the city of Mendoza. His research involved studying Andean tectonic provinces and the respective sediment record during mountain building by conducting geologic mapping, measuring stratigraphic sections, and collecting rock samples for sediment provenance analysis.

This actively deforming mountain belt has produced destructive earthquakes greater than 7.0-magnitude. The goal of his research is to understand the tectonic links among Andean mountain building and foreland basin evolution during Miocene to modern low-angle subduction of the Nazca oceanic plate.

Capaldi was assisted in the field by Margo Odlum, a Ph.D. student who studies Pyrenean tectonics with Professor Daniel Stockli. Distinguished Senior Lecturer Mark Helper and Jackson School Dean Sharon Mosher joined the group for a week to help map the geology around the seismically active Sierra Villicum and Sierra Pie de Palo ranges in San Juan, Argentina.
Ocean Front Property in Colorado

The most wonderful time of the year for a paleontologist is field season. It’s when new discoveries are made, and friendships and collaborations are strengthened. This year’s field season was special for me because I began what will be a long-term project in the Upper Cretaceous Mancos Shale of Colorado. Those rocks represent almost 15 million years of deposition in a shallow ocean, one that stretched from the modern-day Gulf of Mexico to the Arctic.

My long-term research goal is to understand the evolution of ecosystems throughout the greenhouse climate of the Cretaceous, with an eye toward using those data to hypothesize how ecosystems of the future may respond to warmer global climate. For my dissertation, I am focusing on one particular group of marine reptiles called mosasaurs. Mosasaurs were a group of fully marine lizards that ranged in size from a couple of meters up to 18 meters. My investigation of the Mancos Shale in western Colorado was originally motivated by a mosasaur specimen collected by Brigham Young University (BYU) in 1975. That specimen has a 1.2 meter lower jaw and represents an important part of the story of mosasaur evolution. I wanted to find this animal’s type locality to better understand its stratigraphic position within the Mancos. Very few notes were kept during the excavation, but I was ultimately able to track down the locality using Google Earth and a paper map from one of the BYU geologists. On the first day, Dr. Noe led my volunteers and me to a few localities of the Mancos near Delta. High in section, we began prospecting a few outcrops, and sure enough, we found several specimens of the BYU mosasaur. Those fossils will be incredibly helpful for refining the stratigraphic position of that specimen with reference to radiometrically dated sections. In the days to follow, a volunteer of mine, Lexy Holfeltz, struck gold by finding fish specimens in carbonate layers that correlate to the BYU mosasaur. Those fossils will remain key questions regarding the interactions of geological processes (tectonic uplift, magmatism, erosion, sedimentation) with the Amazonian biological and climate system. UT students joined forces with Ecuadorian colleagues and worked with UT professors and researchers Brian Horton, Ron Steel and Cornel Oltariu to assess the long-term sedimentary and structural evolution of the Oriente foreland basin, Inter-Andean Valley, magmatic arc and western forearc basin, with consideration of active magmatism, active faulting and varied hydrocarbon systems. Several additional highlights included a bewildering array of flora and fauna, huge waterfalls, and the unexpected viewing of an active volcanic eruption from a safe distance. The trip was made possible by funding from Chevron.

Joshua Lively
Ph.D. student

Exploring the Link Between Amazon Ecology and Geology in Ecuador

A 3-credit course in Dynamic Field Stratigraphy (GEO 391) explored the diverse geologic record of the Andes of Ecuador, with emphasis on the sediments, stratigraphic, climatic and biological consequences of Andean uplift. The course culminated in a 10-day field trip (April–May, 2017) across the orogenic belt, from the Amazon basin in the east to the Pacific coast in the west. As a region with some of the highest biodiversity on Earth, there remain key questions regarding the interactions of geological processes (tectonic uplift, magmatism, erosion, sedimentation) with the Amazonian biological and climate system. UT students joined forces with Ecuadorian colleagues and worked with UT professors and researchers Brian Horton, Ron Steel and Cornel Oltariu to assess the long-term sedimentary and structural evolution of the Oriente foreland basin, Inter-Andean Valley, magmatic arc and western forearc basin, with consideration of active magmatism, active faulting and varied hydrocarbon systems. Several additional highlights included a bewildering array of flora and fauna, huge waterfalls, and the unexpected viewing of an active volcanic eruption from a safe distance. The trip was made possible by funding from Chevron.

Joshua Lively
Ph.D. student

Studying Flux in Arctic Lagoons

In collaboration with colleagues from the University of Texas Marine Science Institute (MSI), we are trying to understand groundwater fluxes in Arctic lagoons. Groundwater is an unknown component of the coastal water cycle, and could be an important pathway for nutrients and carbon from land going to the sea. The picture on the left shows Professor Jim McClelland from the MSI. He is looking at a seepage meter which captures and measures groundwater seepage from the sediment. The trip also involved measuring a dissolved gas tracer in seawater across Kaktovik lagoon. The nearby village was a popular hang-out spot for polar bears. There were at least 21 bears in the village while we were there!

Bayani Cardenas
Professor, Department of Geological Sciences

Professor Jim McClelland of the UT Marine Science Institute with a seepage meter in an Arctic lagoon.
Standing on the helideck of the Helix Q4000 with nothing but waves in sight, Peter Flemings is bleary eyed and exhausted. But, for this moment at least, the Jackson School of Geosciences professor and chief scientist of the coring mission is relieved and something akin to happy.

The scene marks a seminal moment in a groundbreaking project, an $80-million, multi-year national effort that the U.S. Department of Energy (DOE) picked the Jackson School to lead. Flemings and his team have finally hit pay dirt, pulling a core of frozen methane hydrate from about 1,300 feet under the Gulf floor, through a mile of water, and to the deck of the deep-water coring vessel, while still keeping the methane hydrate under pressure. Under pressure—that’s the important part. Pressure, in many ways, is what this mission is about.

The science crew’s chief goal is to return samples of this ice-like, energy-rich hydrate to the surface of the ship under the same immense pressure it is found in its natural state (about 230 times the pressure found on the surface) so they can begin to unravel its properties. This involves keeping the pressure on the cores throughout their mile-plus journey up the drill string to the deck of the coring vessel, and eventually through their 500-mile journey to Austin to the new state-of-the-art lab in the Jackson School.

The ultimate goal is to figure out how to one day tap the potentially enormous energy resource. "This is the start of a systematic experimental and theoretical effort to understand the potential to produce methane hydrates in an environmentally sustainable, safe and economic manner,” Flemings said.

It’s big science. Important science. And it involves lots of pressure.

Flemings and his team have felt immense pressure of their own during the mission, particularly in the early days of coring. They were met with failure after failure when the experimental coring tool didn’t work properly and returned a soupy, muddy mess to the deck instead of the pressurized cores they were seeking.

On this particular day in the middle of the operations the team was feeling relieved, at least temporarily, with the first successful core. But soon after this success, the pressure would return as core after core afterward came back a failure, prompting Flemings to halt operations and consider abandoning the coring altogether.

“We spent the first 10 days out here in a state of complete and utter failure,” he would later remember. “I was within 24 hours of abandoning the expedition and cutting our losses. Each day, we would update our budget and would find us $350,000 further in the hole with nothing to show for it.”

At risk was the future of the project, including a much larger coring mission planned for 2020 in partnership with the International Ocean Discovery Program (IODP). Ultimately, Flemings didn’t abandon the mission but halted operations and instructed the team to do what scientists and engineers do: work through the problem and find a solution—all with the clock ticking and budget mounting.

The pressure was on.

MORE THAN FIRE AND ICE

Much about methane hydrate is a mystery even to the small group of scientists who study it. To the general public, it’s largely unknown. There has been a smattering of news stories about the energy-rich substance, many focusing on the peculiar and entertaining fact that even though methane hydrate appears and feels like ice, you can light it on fire. It’s a trick that is easy to find on YouTube, although it’s nearly always accomplished with a small sample created in a lab, not methane hydrate found in nature.

This much is known about methane hydrate—there’s a lot of it. It is found all over the planet in places where methane is under sufficient pressure and low temperatures, generally under frozen permafrost or beneath the ocean floor.

The substance is made up of water molecules that form a crystal lattice, which traps the methane inside. The
dense, ice-like structure holds more than 100 times the energy per unit of volume than methane found at the atmospheric pressure of the surface of the Earth. That’s why people like Jackson School postdoctoral fellow Stephen Phillips made the trip to the Gulf in May, working 12-hour shifts (and often much longer) to set up labs, plot the best coring locations, and process and analyze core samples as they are pulled on deck.

“One liter of methane hydrate down below the seafloor, if you bring it up here, is 160 liters of methane,” said Phillips, smiling from beneath the brim of his ever-present Cubs hat. “But if you bring it up to the surface, it’s basically going to melt and the methane will escape, and you’ll be left with just water.”

This difficult-to-reach methane—the chief constituent in natural gas—represents a potentially vast energy resource for the future, especially for coastal nations with limited resources striving for energy security. Japan, China, South Korea and India, for instance, have active programs trying to tackle many of the same questions as Flemings’ group.

The estimates of how much energy is held in methane hydrate throughout the world vary greatly, but they are enormous. Some estimates contend these deposits hold more energy than all other fossil fuels on the planet combined. Flemings mostly discounts those numbers because they are based on flimsy extrapolations, and so little is really known about the properties and concentration of methane hydrate deposits throughout the world.

In addition, much of the hydrate that’s been studied to date is found in shale and mudrocks, geological formations whose characteristics make recovery more difficult. Flemings’ team is looking at methane hydrate in areas that should theoretically be easier to one day produce.

“What’s different here is that we are directly targeting sand layers that have, we think, high concentrations of methane hydrates,” he said.

The actual magnitude of the equipment is insane,” he said. “Humans constructed this. We engineered this. We thought of a way to build a city on the ocean. Seeing it come to life is quite inspiring.”

Petrou is among a handful of young Jackson School scientists who made the trip in May with Flemings, a group that includes two graduate students. Petrou did a year abroad at the Jackson School in 2015–16 where he took Flemings’ energy exploration course. He jumped at Flemings’ offer to join the mission after graduating and is using the experience as an opportunity to judge whether he’s cut out for a career in energy exploration. His mind is far from made up at this point, but Petrou said he’ll definitely go offshore again.

“We had no idea of the complexity of what we were proposing to do.”

- Peter Flemings

UNFAMILIAR SURROUNDINGS

The deck of the Q4000 is an alien and dangerous place for anyone not used to deepwater operations. Jackson School Research Engineer Associate Ethan Petrou is in that group. Petrou, who hails from the United Kingdom, had never been on a large boat before and finds the setting formidable and exciting.

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“We had no idea of the complexity of what we were proposing to do.”

- Peter Flemings
“You can’t really comprehend it until you’re here,” he said. “Everybody is like a little family.”

The vessel itself is a semi-submersible, meaning it doesn’t anchor to the Gulf floor. It stays in one location during operations through the use of a dynamic positioning system that employs six thrusters to continually move the vessel minute distances to keep it zeroed in on the right spot. On deck are massive cranes capable of moving loads of hundreds of tons. The main tower, which is used to build a drill string pipe by pipe to the Gulf floor and beyond, rises more than a couple hundred feet above the deck.

You can’t just come aboard a vessel like the Q4000 when it’s engaged in operations. Every member of the science crew was required to take and pass several certification courses. One focused on teaching you how to react, and hopefully survive, if the helicopter that ferries people to and from the vessel goes down. Another is a basic safety course for simply setting foot on a deepwater vessel. These courses are also required of the crew, although most have training well beyond the basic classes.

The lessons learned in these courses are further drilled into you by the Helix safety team and the crew itself. Among the lessons: always wear full protective equipment on deck and look up before doing anything or going anywhere. A few days of working around the massive cranes instills the sense and necessity of this rule pretty deeply. Another rule: keep your hands off everything except safety rails unless you have a specific need and the correct training. Why? Because everything on deck is metal and massive, and putting your hand in the wrong place could be a potentially dangerous—or even fatal—mistake if a load unexpectedly shifts or powerful equipment starts moving. And finally, if you’re doing most anything on the deck—like say, taking pictures or videos—fill out a permit that explains exactly where you’ll be, what you’ll be doing, and what safety precautions you are taking, and get it signed by the officer on duty and the tool master.

In very short order, everyone on the science team seemed to understand that the rules are sensible and important and help instill a sense of order and familiarity in a setting that first seemed chaotic and unrecognizable.

“It’s an interesting environment,” said Jackson School graduate student Kevin Meazell. “You have to focus on safety at all times.”

“Isn’t it hard to imagine,” Ethan Petrou asked, “to think of the people who built this vessel and made it possible for a student to be here, to be part of this mission?”

Adapting to life on a deepwater oil and gas vessel is not a seamless process for professors, scientists and students used to the classroom and the lab. The quarters are tight and noisy, the hours are long and the overall setting is unlike most anything the science team had ever dealt with.

There are 24 members of the science team in all. In addition to the Jackson School cadre, there are professors and students from The Ohio State University and Columbia University Lamont-Doherty Earth Observatory as well as scientists from the DOE, the U.S. Geological Survey (USGS) and Geotek, a scientific coring company.

Peter Polito, the Jackson School’s methane hydrate laboratory director, has literally spent months preparing for the mission, working countless hours to make sure nothing was forgotten. Now that he’s in the middle of the Gulf, he can only shake his head and manage...
TO VIEW A VIDEO OF THE MISSION, GO TO WWW.JSG.UTEXAS.EDU.

...to pull cores out of the ground, but we need to be able to print plots in real time, we’ve got to be able to transfer data in a quick and easy way.”

He said. “You think about this huge big project and we’ve done all of the big stuff. We’ve done everything we need to pull cores out of the ground, but we need to be able to print plots in real time, we’ve got to be able to take notes, we’ve got to be able to transfer data in a quick and easy way.”

The deck of the Q4000 is about the size of a football field. The only empty space of any size is the green octagon where the cores are transferred to more portable containers capable of holding them under pressure for X-rays and scans of velocity and density measurements.

This is also the area where samples are cut so they can be transferred to other labs on the ship for a first blush analysis. These are places like the mudlab, where scientists prepare core samples for microbiological and chemical analyses.

Another container holds the lab where scientists run quantitative degassing. This involves holding the core in a pressurized vessel and slowly bleeding off the methane hydrate and water into a bubbling chamber, and then carefully measuring as the pressure rebounds. This occurs because the frozen methane hydrate, which is under intense pressure, contains roughly 160 times the methane per volume as it would under surface pressure. As pressure is reduced, the methane hydrate dissociates, or melts, and the methane in the hydrate expands, causing pressure to spike again. By carefully conducting this test over a long period of time, the scientists are able to obtain exact measurements of the amount of methane in the core sample.

“We need to know the amount of methane in the core because it gives us a good metric to quantify how much methane is in the area where we took the core from,” explained Josh O’Connell, lab manager of the UT Pressure Core Center. “And then we can actually extrapolate that out further across the area.”

When the first pressurized core came in, the degassing duties were shared among the team through the night and into morning, as members took turns bleeding off the gas and taking measurements every hour.

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O’Connell and Jackson School Ph.D. student Tiantong “Skyler” Dong pull the first duty. Dong has studied all facets of methane hydrate, and found the process of working with real pressurized cores particularly exciting. This, he said, is when scientists will finally begin to understand if their more theoretical analysis of the substance has been accurate or off-base.

“Usually we just drill a hole and put some sensors into it and take some geophysical measurements,” he said. “With those geophysical measurements, we try to infer the concentration of methane hydrate, but we cannot verify the interpretation. By taking this [gas] out, we can actually know very precisely how much methane hydrate is in the sediment.”

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examining the boundaries of sediment layers for the telltale signs that methane hydrate was present.

“There has been a test in this area, so we know the presence of methane hydrate and what we see in the seismic data also matches that,” he said. “We really think we will get methane hydrate in this area.”

All the tests being conducted are first-order science to determine not only the concentration and amount of methane hydrate in the sediment, but how it will react or change when depressurized in the event the methane is ever harvested.

Beyond the science, the mission, Flemings said, offers a learning environment for students and young scientists that no classroom can match. The multidisciplinary nature of ocean drilling is like few other settings. It brings together geology, geophysics, chemistry and engineering.

“By them being in the middle of this and seeing how all these pieces fit together, this is an environment that literally drives students to whole different levels,” Flemings said.

Petrou was particularly struck by the experience of being part of a team that was collecting data directly in the field and then working with it in real time, an experience not often replicated in an academic setting.

“It’s definitely helping me grow as a scientist,” he said. “To actually see things I’ve read in text books. I’m developing new ideas and talking to people I never would have come in contact with. It’s definitely given me a lot of ideas to think about.”

The extreme deadlines placed on the students to plot data in real time and come up with solutions to critical problems, is also a driving force in their education, said Flemings.

“You need to make a decision, and you have to come up with your best estimate or your best analysis in the time you’ve got, and that’s it,” he said. “I can see the students; they’re like, ‘Holy cow, now Flemings is asking me where to locate exactly where to drill on the ocean floor. No one has ever asked me to do that before and that’s a multimillion-dollar decision. I better not screw it up.”

The young scientists aren’t the only ones learning, Flemings, who has been on many drilling missions and sports more than a few gray hairs, said the mission has stretched him in surprising ways.

“The logistics and the paperwork alone associated with getting a vessel like this to come to the middle of this particular spot is challenging in a way I never imagined,” he said. “It’s like trying to grab a hold of a bear. It sort of overwhelms you, just planning the pieces and keeping the things from falling off the tracks.”

TURNING IT AROUND

May’s coring mission was a trial of technology and methods pioneered to bring up samples of methane hydrate under the same pressure and temperature where they are found under the seafloor. The tool being used is called the pressure core tool with the ball valve, or the PCBT for short. It’s basically a long tube that is lowered through the pipes of the drill string and pulled up the same way after it has retrieved a sample. It is capable of coring samples about 10 feet long. But in order to retrieve the cores under pressure, the ball valve must close correctly to seal the container, and a nitrogen boost within the container has to fire. Afterwards, they continued their work for two weeks in Port Fourchon, Louisiana, where the science facilities were relocated after the mission.

From there, 21 pressurized cores of between one to three feet long were loaded on a truck and brought to the Jackson School, where Polito and O’Connell wheeled them into the newly built UT Pressure Core Center. This is where an integrated team of scientists and engineers from the Jackson School and UT’s Department of Petroleum and Geosystems Engineering will continue their research. At the heart of the analysis is a desire to understand the dynamic evolution of hydrate reservoir properties as methane is extracted.

The Jackson School will be the hub of the ongoing work, but it’s a national effort. A multidisciplinary team of scientists from institutions around the country is also joining the research. Depressurized core samples recovered during the mission, looking for clues to the hydrate under the same pressure and temperature where they are found within the container has to fire. Afterwards, they continued their work for two weeks in Port Fourchon, Louisiana, where the science facilities were relocated after the mission.

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"I’m really excited for the science that’s going to come out of this,” Polito said. “A year from now I’m going to know things that no one knew today. That’s really exciting to me.”

Now that the cores are safely in the Jackson School lab, the real work is just beginning. Still, Flemings can’t help but think about how close he is. "I guess what I learned, once again, is that unbelievable work and really, truly working the problem can lead to amazing achievements,” he said. “When everybody truly gives their all to make it happen, you can actually pull these things off.”
As technology has advanced, the planet Mars has gone from a faintly glowing red orb in the night sky to a familiar landscape. The NASA rover Curiosity releases new pictures of the surface of Mars every day while the Mars Reconnaissance Orbiter, a NASA satellite, monitors the planet from space.

An eclectic group of researchers at the Jackson School of Geosciences is studying the Red Planet from afar using the constant stream of data provided by these NASA probes. Their work is taking them deep inside craters, through millions of years of ice deposits at the Martian north pole, and over sedimentary rock that was deposited when Mars was wet and has since been sculpted by wind into mile-high mounds.

Members of the same group are also studying Mars-like locales on Earth to learn more about what the two worlds have in common. "Terrestrial analog work is a strength of UT," said Jack Holt, a research professor at the University of Texas Institute for Geophysics (UTIG) who is leading research on Mars glaciers and similar glaciers on Earth. "We have a really strong, field-based geology program, and when people in the Jackson School do planetary science, they bring a very strong background in the fundamentals in geology based on fieldwork on Earth."

The Mars researchers are helping develop an understanding of the geological history of our planetary neighbor, and how its distinctive landmarks formed over time. This in turn can improve the understanding of how similar forces shape our own planet and planets outside of our solar system. It is also vital knowledge to have when planning future missions to Mars, whether it's sending more advanced rovers, or placing the first pair of astronaut boots on the ground.

Two recent Jackson School graduates exemplify how conducting Mars research builds skills that can be used for studying Mars or our home planet. Cassie Stuurman, M.S. ’17, will be working at Planet Labs, a company in San Francisco that builds Earth-monitoring satellites. And Mackenzie Day, Ph.D. ’17, will be continuing her research on Mars at NASA's Astrobiology Institute in Seattle, with the goal of one day making it to Mars herself.

"It's Mars or bust," Day said.

Turn the page to learn more about Mars geology, Mars-like places on Earth, and discoveries made in both places by Jackson School researchers.
RESEARCH ON THE RED PLANET

Mars research at the Jackson School of Geosciences spans across the Red Planet. The findings are helping us learn more about our planetary neighbor, including the best spots to potentially look for signs of ancient extraterrestrial life, and where future Mars colonists could go to find water. This basic research on Mars could become vital information for future space missions.

Holt at the Helm of SHARAD
Research Professor Jack Holt is the co-principal investigator for SHARAD—a radar instrument on NASA’s Mars Reconnaissance Orbiter. Holt’s radar expertise, honed on ice sheets and exotic terrain on Earth, prepared him for managing an instrument than can see about half a mile below Mars’ surface. Much of the Mars research at UT—and around the world—depends on SHARAD data.

The “Great Lake” of Utopia Planitia
Cassie Stuurman (M.S. ’17) discovered a buried ice deposit in Mars’ Utopia Planitia region that holds as much water as Lake Superior and creates distinctive “ice-cream scoop” surface terrain.

The Ice Cauldron of Hellas Basin
A volcano beneath an ice sheet—a structure called an “ice cauldron”—is likely responsible for creating a funnel-shaped depression in Mars’ Hellas Basin. UTIG Research Affiliate Joe Levy found the structure after noticing a bulls-eye pattern in the ice that resembled marks made by ice cauldrons on Earth.

Paleoclimate on Ice
Ice deposits on Mars record the planet’s climate history. Ph.D. students Stefano Nerozzi and Dan Lalich are researching the climate history of Mars by analyzing ice deposits layer by layer—a feat made possible with ice-penetrating radar on NASA’s Mars Reconnaissance Orbiter.

River Research
Ancient eroded river deposits on Mars called “sinuous ridges” are leftovers from a time when Mars was a wet world billions of years ago. By comparing a locale on Mars with similar ridges on Earth, Ph.D. student Ben Cardenas has found they likely formed along an ancient coastline and retain the curvature of the Martian rivers that formed them.

Scientists Prefer Jezero
At a meeting in February 2017, scientists selected Jezero Crater as their top pick to send a new NASA Mars rover set to launch in 2020. Postdoctoral Fellow Timothy Gouge proposed the site because his research on the crater indicates it was once a wet, mineral-rich lake. Jezero is now among the top-three landing sites under NASA’s consideration.

Dunes on Mars and Beyond
In 2018, Mackenzie Day (Ph.D. ’17) found that wind likely shaped Mount Sharp, a mile-high mountain inside Gale Crater and the destination site for the NASA rover Curiosity. For her thesis, she compared dune patterns on Earth, Mars and Saturn’s moon Titan and found that dune fields form similar patterns across planetary bodies.

Chasma Boreale
Dunes of ice and sand are at the bottom of Mars’ Chasma Boreale, a deep indentation at the planet’s north pole. Sarah Brothers (Ph.D. ’16) studied the processes that shape these modern dunes to understand how ancient dunes, now covered by ice, were formed millions of years ago. Brothers is now a postdoctoral research associate at Texas A&M University.

NOTE: RESEARCH SITES LISTED ABOVE ARE NOT VISIBLE FROM VANTAGE OF MARS ON LEFT. PHOTOS: NASA.

NASA Scout
UTIG Research Associate Cyril Grima helped NASA select the Elysium Planitia region of Mars as the landing spot for its InSight lander, a probe scheduled to land in 2018. Grima used a statistical technique he developed to analyze the surface roughness of the site.
Visiting Mars on Earth

Some environments on Earth have a lot in common with places on Mars. Conducting fieldwork here gives researchers a chance to study features found on Mars and familiarize themselves with our own world at the same time.

WET STREAKS IN DRY VALLEYS

Antarctica’s McMurdo Dry Valleys are the most Mars-like landscape on Earth, said UTIG Research Affiliate Joe Levy, an assistant professor at Colgate University. These isolated, desolate lands have been frozen for more than one million years, with huge deposits of buried ice beneath the ground. In 2016, Levy co-led a mission to map the valleys using airborne LIDAR laser scanning. The project was specifically looking for areas where ice deposits showed signs of melting since the last scan in 2001. These melt features resemble those on Mars that have been observed flowing down certain slopes in warmer seasons.

BURIED GLACIERS

Jack Holt, a research professor at UTIG, is tracking the ice at the center of rock-covered debris glaciers on Earth and Mars. On Sourdough Rock Glacier in the Wrangell–St. Elias Mountains of Alaska, Holt and his students are using airborne photogrammetry, a technique that allows the team to calculate the glacier’s flowrate by studying its surface folds. Ph.D. student Eric Petersen is studying similar glaciers on Mars, using radar data to determine the composition of the ice inside and the thickness of their debris covering. He points out his research might come in handy to future astronauts looking to tap the glacier as a water source.
There are few living geologists who have shaped modern scientific thought as much as John Dewey. Since his first field studies in Newfoundland in the 1960s, he has helped build the foundation of the theory of plate tectonics and continental drift, specifically laying out how tectonic movements explain the geology of mountain belts.

Dewey, now an emeritus professor of geology at Oxford, has lived and participated in a history that students, and many professors, can only read about. And with a personality and wit straight from central casting, the noted scholar is a master of bringing that history to life.
A: Yes, Antarctica. That's the only continent I have not been on. [Jackson School Professor] Ian Dalziel has been trying to get me there quite a lot, but something always transpires, and I can't go. Trying to go down there is awkward in a way, because I did much of my work when I was gainfully employed during summer vacation. But of course in Antarctica, you've got to go in our winter.

Q: How did you come to be connected to the Jackson School?

A: When I retired I was in my 70s, and I thought, 'Well do I want to keep on going until I'm old and decaying or do I want to sort of pull out now of a full-time university job and just do research at my own pace?' If you're teaching a course, you can't just take off for field work in Australia or something like that. You've got students to look after.

I thought perhaps the way to do it is not to go anywhere permanently, but simply attach myself for a few weeks or months every year. Go somewhere and talk to the students so I haven't got a long-term commitment, and I haven't got masses of teaching to do.

So I wrote to [Jackson School Dean] Sharon Mosher and said, 'Would you like some sort of short-term arrangement? I'll run a field trip every year. I'll come for a few weeks every year and you can give me a consulting fee to cover my costs.' It has worked very well.

Q: What's your impression of the students at the Jackson School?

A: Really top-class. Absolutely top-class. Both the undergraduate and the graduate students are very, very good. The reason of course is they're very fuzzy about who they take as graduate students here. I guess undergraduates, too. It's highly competitive, so they can afford to be picky and choosy about who they have.

Q: One of the Jackson School's major focuses is to make sure that undergraduates have time in the field. Do you think that is an important part of an undergraduate geosciences education?

A: Yes. Training the students to look at rocks and how to analyze and understand them; some departments do it by remote sensing and virtual geology. That's not the way to do it. You need to go in the field and look at rocks. Francis Pettijohn, the great sedimentologist, once said, 'The truth resides in rocks.' You can model it all you want, but ultimately you've got to go to look at the rocks and see what they say. And students love it. Of course they love being in the field. That's why many kids go into geology. They want to go in the field and look at rocks and study the Earth that way. And many kids get apart at some universities when they find they're spending all their time doing chemistry and physics and god knows what in the lab.

Q: What was your first teaching job?

A: I came through undergraduate and graduate school in '55 through '60 at Imperial College in London, and then I got my first teaching job. In those days you could get a teaching job in academia straight away if you were any good. Nowadays people have postdocs and fellowships. It's now tough to get an academic position. Some people are 30 or 31 by that time. I was 23 when I got my first academic position as a lecturer in Manchester (the University of Manchester).

Q: You are credited with being one of the pioneers of plate tectonics. Can you discuss those early years of your career and how you became interested in plate tectonics?

A: I spent four years in Manchester. Then I got a job in Cambridge University from '64 to '70, and most of that time I was working away at structural geology. I was invited to Nova Scotia in 1964 to join an expedition looking at some Silurian and Ordovician rocks. I loved that. First of all it was great fun. It was the first time I'd been to the North American continent. I started mapping with a variety of people, and these rocks were fantastic over the whole area of Nova Scotia. And I realized some of these rocks were quite similar to some of the rocks I'd looked at in Ireland. It's not surprising because actually the Caledonian belt comes through Scandinavia through Scotland, through Ireland, is choppéd off by the Atlantic and reappears in Newfoundland and Nova Scotia. It's the same belt on both sides of the Atlantic. All that happened is that the Atlantic pulled it apart. They obviously do fit, you know, and that's what I worked on a lot.

That, in 1964, opened my eyes to the Appalachians. And I got very interested because I'd been in the Caledonian belt until then looking at small-scale structures. And then I got the opportunity to spend a sabbatical leave in Columbia at Lamont Debary. I was getting interested then in the correlation across the Atlantic and how the Appalachian Caledonian chain worked, what it was made of. I thought the way I should find out is this: I'm going to make a map, an incredibly long detailed map from Newfoundland all the way through to Alabama. I went through all the state geological maps: Vermont, New Hampshire, Maine, right down through the Carolinas, right down to Alabama. I synthesized and generalized the geology, and I put it on a map. And gradually, it was amazing, there was a belt of Ordovician volcanics that runs right down through there. It runs right down through Vermont, down through New York. It goes down to Pennsylvania; what
is it? And I started to see patterns of rock associations. And then I said, ‘What do they mean? They must mean something in terms of the modern world’—this was in 1967. And it’s got to have something to do with this new emerging plate tectonics that was developing at the time with Tuzo Wilson and people like (Dan) McKenzie and (Walter) Pitman and god knows who. I was in Lamont at exactly the right time. Serendipity. I was just dead lucky.

Q: What was your role in the emerging research?

A: I was doing this great map, which was emerging as a fossil example of things that are happening in the world today in plate tectonics. And I realized that this is a place where an arc has collided with a continental margin in mid-Ordovician times 470 million years ago.

It’s the sort of thing that’s happening in northern Australia in present day. It was kind of exciting. Lamont was the hotbed of the development of plate tectonics. Princeton, Scripps in California and Lamont in New York and Cambridge, too. So I just got swept up in it completely.

My role was taking old rocks, looking at the history of the world and saying, ‘Can we explain all this in terms of this new emerging science of plate tectonics?’ And I said, ‘Yes, you can do it,’ but at least back for 600 million years. Before that, things are different, but for that Phanerzoic time, it clearly is the result of the evolution of plate motion going on, making arcs and splitting and pulling continents apart and colliding them again and making mountains and all that kind of stuff. So that’s how I got into it.

Q: Was the plate tectonics theory controversial at the time?

A: In the early days BPT—before plate tectonics—the world was divided into the bulk of the people who thought continental drift was rubbish, and a small group including me and Lester King in South Africa and probably 20 or 30 people in the science who thought it must have happened because if you compare West Africa and South America, A, they fit together perfectly and B, you find old mountain belts coming through and it continues where they fit. It’s like a jigaw, and jigaws don’t lie. Obviously, there had been continental drift taking place by some mechanism.

There was a man called Harold Jeffreys who was extremely anti-continental drift. He said, ‘rightly in a sense, that the continents are made of weak rocks, rocks that deform and squash easily. Oceans are made of strong rocks. The continents are dominated by quartz, whereas the oceans are dominated by olivine, which is a very strong mineral. So if oceans are strong, how can you have continents flowing through hard stuff?’

But he thought of it wrongly. The continents don’t blow around. They split, and then you have seafloor spreading, which means the mid-ocean ridge starts to move, which means there is a gap, which keeps on filling up, and the continents are basically just passive passengers on the plates. They keep moving around where the plates move. They can’t flowing through anything at all.

Harold Jeffreys had a big influence on the world, particularly Britain. He was a professor at Cambridge, and what he was saying was rubbish because he hadn’t thought about it in quite the correct way. That happens in science a lot. Nevertheless, in Britain there were a lot of geologists who thought continental drift must have happened. In North America, it was different. It was a very anti-continental-drift nation at the time. They said in the ’50s, if you espoused the idea of continental drift you would never get a job at a university in America.

There was a change. It was progressive, and it was partly generational. The people who were proposing plate tectonics were mostly the younger generation, including me, Walter Pitman, Lynn Sykes. The only one who was older was Tuzo Wilson.

If you asked who was the founder of plate tectonics, it was a number of people of course, but it was really Tuzo Wilson who had the idea in 1965. He wrote a really classic paper in ’65. He didn’t call it plate tectonics back then, but all the classic elements of plate tectonics were in it. And then, in 1968, the cat was out of the bag. ’68 was the period where the idea was proposed and then it became generally accepted. But there was still a rear-guard action by some of the older people who didn’t like it. But basically by ’68 the thing had taken off, and it was all over. It was taught in many universities in ’68 to 70.

And then in the ’70s and even today lots of ideas are developing on the theme and how it works. There’s a huge amount of work left to be done, but the basic theory is there. It looks pretty good. It may be all wrong, but I’d be amazed if it is wrong. I take Carl Popper’s view of science. You can never prove anything right. All you can do is prove things wrong.

Q: How has geology changed since you started?

A: Geology has changed a great deal. For the better and the worse. There have been some wonderful developments in geology mostly new ways of measuring things. The machines we have now were unthought of even 20 years ago.

Danny Stockli’s lab, for instance, is just state-of-the-art. Right at the cutting edge of the science. You can actually measure the ages of the rock vastly more accurately right down to plus or minus a million years. It’s incredible. It’s unbelievable the things you can do. And you can do the chemistry of rocks very thoroughly and the physics of rocks. You can really pull rocks apart right down to the submicroscopic level. There’s an amazing lady at the Bureau of Economic Geology, (Research Associate) Esti Ukar, the things she can do would make your mind boggle.

For somebody in the last century, they would say it couldn’t be done. It’s just necromancy. They wouldn’t believe it. But on the other hand, we’re losing sight of some of the classic core of geology, which is very important. Not here. Not in Austin. I think it’s maintained very well.

This is partly because at one time you went around a geology department 50 years ago and everyone had a degree in geology. Now you go around a geology department, and there are people with degrees in physics, materials science, engineering, biology. It’s good. It’s become multi-and interdisciplinary, and that is what you want in science. You want people coming at things from a range of angles, but that in itself has taken its toll on the science. It’s lessened the basic core of geology. I’m afraid it’s gone too far for the moment. It’ll come back. Things go in cycles. In another 10 years we may have the young people saying, ‘Oh, this crazy instrumentation period back then!’ Attitudes change always, and old people tend to complain about the young. It’s inevitable. It’s probably healthy. It keeps the young under control (laughs).

Q: What advice do you have for young geoscientists?

A: I think I would tell them, ‘Don’t do what old people tell you to do. Follow your own nose. If you have an idea, a series of ideas, just follow it.’ If old people say, ‘No you shouldn’t do that, do something else come into my lab or work with me,’ ignore them. Forge your own career doing your own thing. Most of the great ideas in science come from relatively young people. So forge your own career, and don’t knock or bow before the old. I think that’s about it.
Antarctica wasn’t always a frozen, desolate continent. About 70 million years ago during the Cretaceous Period, it was green, lush and teeming with dinosaurs. Thanks to discoveries made by Jackson School of Geosciences Professor Julia Clarke and her collaborators, we know that during the Age of Dinosaurs the continent was also home to a much more familiar looking inhabitant: Vegavis iaai, an extinct member of the modern bird group that resembled a duck or goose and may have honked like one, too.

Argentine researchers found the first Vegavis fossil on Antarctica’s Vega Island in 1992. In 2005, Clarke, then a research curator at the North Carolina Museum of Natural Sciences, led a detailed examination of the fossil and found that it belonged to the same evolutionary order as modern-day ducks and geese. The finding was the first hard proof of modern birds living during the Cretaceous, a theory that evolutionary research suggested but needed bones to confirm.

“The really exciting thing about Vegavis was that, in most people’s minds, it was the first really, really good fossil evidence for a modern bird — in this case the duck group — living in the Age of Dinosaurs,” said Matt Lamanna, a curator at the Carnegie Museum of Natural History and a co-leader with Clarke of a 2016 fossil-hunting expedition to Antarctica supported by the National Science Foundation.

In the fall of 2016, Clarke and another team of collaborators announced that a second, even better preserved Vegavis fossil included the syrinx, the bird vocal organ. Its presence in the ancient bird, but not in other dinosaurs, indicates that the organ was not something birds likely inherited from their theropod dinosaur forefathers and mothers. (In case you missed it: scientists classify birds as living dinosaurs, the sole dinosaur lineage that survived the asteroid impact at the end of the Cretaceous that snuffed out all the others.) According to Clarke, the syrinx discovery could open the door to a new type of research into sound generation in extinct animals, and how it relates to sounds made by animals living today.

“I think that our work on the syrinx sets a starting point for studying other fossil records of vocal behavior or vocalization,” Clarke said. “We’re doing this in birds, but it can become a model for looking at similar questions in other animals.”

Clarke’s Vegavis discoveries are all smaller parts to a bigger question she’s chasing: how and why do unique bird characteristics — from feathers to birdsong — arise? Her Vegavis research exemplifies that these big questions can help strengthen current fields of study, while forging brand new research.

“I think that our work on the syrinx sets a starting point for studying other fossil records of vocal behavior or vocalization.”

— JULIA CLARKE
directions. As a part of the Jackson School faculty since 2009, Clarke has been mentoring the next generation of geosciences researchers as they take on their own big questions, showing that the so-called “impossible questions” can have big returns. “It really like the hard questions,” Clarke said. “The ones we think we can’t answer.”

Clarke’s Vojčić’s research is just part of the story. She has been part of ground-breaking discoveries on feather evolution and coloration, and lately, bird vocalization. It’s work that benefits from Clarke’s curious worldview that has resulted in numerous international collaborations and fossil-hunting excursions across the globe.

“If we want to understand the world, it’s a global enterprise,” Clarke said. “A big component of my research is international research, and I think it’s key to get data points from some of the most remote and inaccessible places.”

Feather Finds
When Clarke started graduate school at Yale in the 1990s, the first feathered dinosaurs had just been discovered. That new finding, combined with field experience in Argentina with a paleontologist who was working on the evolution of birds, made a compelling case for studying birds in the fossil record, Clarke said.

“It was a lot of new data and a lot of possibilities the year I started grad school,” Clarke said. “I could have asked similar questions about a lot of different groups and been really happy, but it was just timely to work on bird origins.”

Early in her career, Clarke dedicated a large amount of time to describing fossils, honing her observational skills, and building a strong foundational knowledge of animal anatomy. Clarke said that this strong technical knowledge is at the core of the questions she asks. “I don’t think we can even imagine the questions you want to ask until you have that basis in anatomy and how we study anatomy and what are cutting edge tool kits for studying anatomy generally,” Clarke said. “And once you get into that you can go, ‘How does this structure work, why is that shape, that’s weird,’ and let basic curiosity take you to some new area.”

Her sharp eye led to an important discovery in 2008. On a fossil hunting expedition in Peru, her research team discovered a gigantic species of extinct penguin, dubbed Inyuvial, which lived about 36 million years ago during the Eocene and stood about five feet tall. But the most exciting part of the discovery was that the penguin’s feathers were preserved.

The feathers contained impressions of melanosomes, color-containing organelles, which allowed the team to learn that the penguin was gray and reddish brown rather than the tuxedo that’s in vogue for most of its relatives living today. The pigment in the melanosome had long degraded; to determine the color of the feathers, the research team studied the shape of the preserved melanosomes—a feature determined in part by the pigment they once contained. The penguin discovery was important for its own sake, making the cover of the journal Science when it was published in 2010. But it’s also significant because it helped pave the way for research into feather coloration in general.

Shortly after the publication of the penguin research, Clarke and a team of collaborators deciphered the plumage colors of chicken-sized dinosaurs with feathers contained impressions of melanosomes, color-containing organelles, which allowed the team to learn that the penguin was gray and reddish brown rather than the tuxedo that’s in vogue for most of its relatives living today. The pigment in the melanosome had long degraded; to determine the color of the feathers, the research team studied the shape of the preserved melanosomes—a feature determined in part by the pigment they once contained. The penguin discovery was important for its own sake, making the cover of the journal Science when it was published in 2010. But it’s also significant because it helped pave the way for research into feather coloration in general.

The research on feather coloration is helping us envision the feathered dinosaurs of the Mesozoic Era more than 100 million years later, from the Holocene. However, she notes that studying the plumage color of individual birds and feathered dinosaurs is a means to understanding the bigger evolutionary picture. Her latest paper on feather coloration, published in Nature in 2014, integrated the dinosaur findings and compared them to nearly 200 melanosome samples taken from across vertebrates, including specimens of animals living today and fossils. The research found that an increase in melanosome diversity—and hence color—appeared with the first feathers.

“What I like to think I’m good at asking is, ‘Well, OK, we can say something about a dinosaur’s coloration, but what does that tell us about a major system that governs animal coloration,’” Clarke said. “The last major paper we had on coloration was about the melanin-based color system and how that evolved.”

She adds that the work the team did on plumage coloration was important to the field of palentology because it helped prove that fossils record evidence of ancient colors.

“Only a few years ago, we never thought we could use the fossil record to study coloration,” Clarke said.

Bird Calls to Dinosaur Booms
These days, Clarke has set aside most of her feather-coloration research to focus on the evolution of bird vocalizations. The discovery of the Yeongju syrinx last year opened doors to comparing the sound structures of living birds with ancestors from the Age of Dinosaurs. Clarke said, a field of study that has hardly been touched on by other scientists.

“The starting point here is the discovery of the fossil avian vocal organ, but we are also doing really core work on trying to figure out what’s changed,” Clarke said. “I don’t just describe fossils. I do a lot of work on living organisms so I can ask new questions about fossils.”

In some cases, the research on modern birds can not only give insight into a particular fossil, but a behavior of a range of extinct animals. Last year, Clarke and her collaborators turned their attention to closed-mouth vocalizations in birds and related reptiles, such as the coos of doves and the booming rumbles of crocodiles that are generated through throat inflation rather than by passing air through the syrinx, an organ that’s unique to birds.

“In some cases, the research on modern birds can not only give insight into a particular fossil, but a behavior of a range of extinct animals.”
Not all birds and reptiles can make these closed-mouth sounds. By statistically analyzing the characteristics associated with the ability or lack of it across 208 bird species, Clarke and her team determined that closed-mouth vocalization evolved at least 16 times in living archosaurs, the group that includes birds, crocodiles and alligators, and is associated with having a relatively large body size. Since dinosaurs are also part of the archosaur group, Clarke and her collaborators suggest that it’s not a stretch to think that some of the larger-sized ones—and there were plenty—could also make closed-mouth sounds. “This makes for a very different Jurassic world. Not only were dinosaurs feathered, but they may have had bulging necks and made booming, closed-mouth sounds,” Clarke said in the news release announcing the research finding.

Impossible Questions, Innovative Research

From feathers to vocalization and a variety of other research streams along the way, Clarke has always kept the big picture in mind as she conducts her work. Lamanna said that Clarke’s clear focus on larger research objectives is an asset for any research team, especially in Antarctica, where the environment can cause its own set of distractions. “Julia is super driven and focused, more so than almost anyone I’ve ever worked with,” Lamanna said. “Given the conditions in Antarctica, it can be easy even for seasoned field workers to lose track of goals, or to focus on things that don’t matter so much; but Julia just never loses sight of why we’re there.”

But Clarke doesn’t view her research approach as something unique to her. This spring, she spent a semester teaching a joint undergraduate and graduate course called Curiosity to Question about how to approach and conduct research. The new class encouraged students to embrace questions that they couldn’t answer and then develop research around related questions that they could, with students getting hands-on experience conducting research under Clarke’s guidance. “People were surprised with how much they could get done,” said Sarah Davis, a first-year Ph.D. student advised by Clarke and a student in the course. “Julia was helpful in that narrowing-down process.”

As her own research findings show, Clarke’s advice to pick a supposedly unanswerable question and then chip away at it with available data has made real scientific progress into what were once thought of as impossible research areas. From melanosomes came a colorful Jurassic world. And from a fossilized syrinx and modern analytical techniques came the calls of extinct birds and dinosaurs.

Clarke’s own crop of Ph.D. students is asking “impossible” questions of their own. For example, Davis is researching feather coloration. But unlike Clarke’s research, which focused on feathers colored by melanin, Davis is branching off into a new direction with potentially even more avenues to explore. She’s studying feather pigments made from carotenoids, a class of organic molecules that come strictly from an animal’s diet. They’re responsible for vibrant bird feathers, such as the pink of flamingos and the red of cardinals, as well as vital functions like immune system response and vision. “It’s an interesting mechanism that’s unique and has the potential to have been around for a very long time because it’s seen in a lot of modern-day birds,” Davis said. “So I’m interested when this basic, fundamental nutritional thing got co-opted to make the really bright and pretty colors.”

In true Clarke fashion, Davis knows she’s on the right track because of the constant questions her work keeps uncovering. “The more I continue on my current project, the more questions I find,” Davis said.
Deep underneath an old Texas oil field in Jackson County, science and economics have come together to achieve something unique. For the first time in this country, a commercial-scale project is taking carbon dioxide emissions (CO₂) from a coal-fired plant and storing them in rocks beneath the ground so they cannot escape into the atmosphere and impact the Earth’s climate.

The project — Petra Nova — is removing CO₂ from a unit of the W.A. Parish power plant near Houston and piping it some 80 miles to the CO₂ capture facility near the West Ranch oil field. The greenhouse gas is staying underground and not entering the outside environment. “We need the University of Texas for an independent, high-quality assessment of that side of the project so we can actually determine that the captured CO₂ is staying underground and not entering the outside environment.”

The idea of storing CO₂ emissions is not new. The bureau’s Gulf Coast Carbon Center has been leading research on the issue for more than a decade, helping perfect the technology in a series of pilot projects around the country. Given the bureau’s long history with the technology and its focus on research that tackles tough problems that combine technology and its focus on research that tackles tough problems that combine industry, the environment and public policy. It’s an area I like to call the radical middle — an area where solutions to tough problems are found and things get done.”

Capturing Carbon

Although the project has been in the design phase for many years, Petra Nova started operating in December 2016, taking more than 90 percent of the CO₂ from 240 megawatts of power production (enough power to serve about 200,000 homes) and piping it to the West Ranch oil field. The project was also the beneficiary of a $190 million grant from the Department of Energy’s Clean Coal Power Initiative Program, which helped pay for the carbon capture unit.

The resourceful approach earned the praise of Texas Gov. Greg Abbott. “NRG and JX Nippon’s Petra Nova is the type of innovative, technologically advanced project that proves time and again that Texas is the world leader in energy innovation,” Abbott said in a prepared release.

The enhanced oil recovery at West Ranch is expected to boost oil production from around 500 barrels per day to as much as 15,000 barrels per day, Kennedy said. This technique involves pumping CO₂ into the field, where it mixes with oil and helps release it from the rock formation so it can be pumped to the surface. The CO₂ is removed from the oil above ground and then injected back into the ground where it is trapped.
makes for a good indicator to identify CO₂ that leaked toward the surface from the deep subsurface. "Stakeholders could be concerned about any one of a number of environmental changes, and without these markers it would be hard to say for sure if the change is because of fluid from the project or some other shift in the environment," she said.

The Gulf Coast Carbon Center has developed these methods through pilot projects across the country over the last decade. The big difference in Petra Nova, said Hovorka, is the full industrial scale. "It is really exciting to take what you have been working on in R and D and take it to commercialization," she said.

Petra Nova is unique for now. But the project was designed with replication in mind, using commercially available technology. The carbon capture system was jointly developed by Mitsubishi Heavy Industries Ltd. and the Kansai Electric Power Co. Kennedy said the system could be used by any existing or new coal power plant.

At that point it’s up to researchers from the bureau to monitor the CO₂ to ensure it stays put. They are accomplishing this through a combination of techniques that monitor deep subsurface pressure, groundwater, soil gas and other parameters that provide information on the status of the CO₂ after it is stored underground.

Tracking Carbon

The monitoring project is being led by Susan Hovorka, a senior research scientist and principal investigator of the bureau’s Gulf Coast Carbon Center. Hovorka and her colleagues carefully studied the subsurface environment under the field for more than a year to understand conditions before the project began.

One of the main issues, Hovorka said, is that pumping CO₂ into the ground elevates pressure in the injection zone, which could theoretically lift fluids containing dissolved CO₂ through damaged or flawed wells toward the surface. Once out of the ground, the greenhouse gas would escape into the atmosphere. To ensure this doesn’t occur, Hilcorp Energy has inspected each existing well and brought all up to current standards so they do not exceed the original natural pressure of the oil field. As an extra precaution, researchers have installed pressure gauges in deep wells more than 3,000 feet below the surface. These gauges act as an early warning system for potential CO₂ leaks because they are above the zone where the CO₂ is injected. Increases in pressure at this level would indicate that fluids may be leaking upward, giving the operator time to find and repair wells if needed.

The extensive CO₂ monitoring at Petra Nova is a precaution, Hovorka said. She stressed that she does not expect any leaks to come bubbling from below and that none have occurred to date.

Hovorka said that crews are also monitoring groundwater and soil gas for signs of CO₂ leakage. To do so, scientists are watching parameters that would change during a spill or leak, specifically, the ratios of nitrogen, CO₂, methane, strontium isotopes, carbon isotopes, light hydrocarbons and noble gases. Hovorka described these parameters as “distinctive markers” of fluids from deep areas. They have a different chemical signature than fluids from shallower areas, a difference that makes for a good indicator to identify CO₂ that leaked toward the surface from the deep subsurface.

The equipment Hovorka and her team use to track carbon at the oil field employs off-the-shelf technology for the same reason. The goal is to work out any kinks in the monitoring protocol, so it can be used by other companies, a goal she believes is well within reach.

"It’s not super hi-tech, wizbang. It’s regular old equipment and a clever inversion," she said. "Get it cheap, get it practical, and get it ready to hand off. This is a tremendous opportunity."

Ultimately, Tinker said Petra Nova can act as a model for others interested in reducing CO₂ emissions from coal-fired power plants.

“The combination of carbon capture and sequestration from a coal plant, enhanced oil recovery to provide additional energy and offset costs, and monitoring and verification of the CO₂ is an important step along the path towards capturing and storing CO₂ at a much larger scale," he said.

CO₂ FROM PETRA NOVA WILL BE PIPPED TO THE WEST RANCH OIL FIELD WHERE IT WILL BE USED FOR ENHANCED OIL RECOVERY AND TRAPPED UNDERGROUND.  

**Beneficial use of the captured CO₂**

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In 1966, while on geology field camp at Colorado State University, Robbie Gries spotted a boulder as big as a house from the window of the class van as it moved through the White River Plateau.

“I think that’s granite over there!” Gries shouted to the other students—all men, save for the journalism-major wife of one of her classmates. Women were usually banned from the course, but Gries got in thanks to a mixture of the chairman being on sabatical, other faculty being willing, and her offer to cook. She suspects her classmates’s wife came so she wouldn’t be the lone woman on the three-week course, and to help with the cooking.

Gries’ classmates disputed her granite claim: “You can’t have granite here! We’ve got Pennsylvanian-aged rocks on top, how would granite get on top of that? That’s such a dumb observation!” But the professor turned the van around. The class ended up learning about glacial erratic boulders—large hunks of granite deposited by ice sheets as they carved the landscape during the last ice age. It wasn’t the last time Gries’ roadside observations made the professor do a U-turn.

“I loved field camp because I figured out that I really had an eye for geology in the field,” said Gries, who went on to earn her Master of Science in geology at The University of Texas at Austin, and serve as the first female president of the American Association of Petroleum Geologists (AAPG). “Many times on field trips I had experiences like that, and it gave me a lot of confidence.”

Gries’ story of overcoming gender barriers like the field-camp ban to find success in the geosciences is one of dozens compiled in “Anomalies: Pioneering Women in Petroleum Geology,” a new book about female AAPG members compiled in “Anomalies: Pioneering Women in Petroleum Geology,” a new book about female AAPG members that was. I was amazed at how little I knew,” Gries said.

Women from UT played a notable role in AAPG’s early history — nearly 15 percent of the first 100 female members of AAPG either graduated or studied at some point at UT. The Department of Geological Sciences also educated female students who made important contributions outside of petroleum geology, and provided a space for mentorship, often from male members of the school who supported female students and researchers, and female student bonding.

At the same time, the school was also a reflection of larger cultural biases and expectations. Women were banned from going on undergraduate field camp until about the 1950s, the UT chapter of the geological honors society, Sigma Gamma Rho, excluded women for most of its existence; and a 1960s-era bulletin about the department for high school and college students could more easily envision male geologists on other planets than women having a significant role in the field. One paragraph reads:

“A geologist’s activities may take him throughout the world. He may climb mountains, wade through swamps, descend into deep mines, brave the desert and attack jungles…. He may well be the first person to land on another planet.” Women were mentioned later in the passage: “A few women are engaged in geological work. … Successful outdoor women field geologists are rare.”

Reading the biographies collected by Gries, combing through UT archives, and listening to the recollections of Jackson School alumna and faculty, gives a nuanced view of the history of women in geosciences at UT and in geosciences research and industry over the past century. It’s far from a simple story.
The Department of Geology was founded in 1888 by Robert T. Hill, an orphan from Tennessee who earned his Bachelor of Science from Cornell University before coming to Texas at the invitation of the university regents. In an inaugural address to the university’s faculty, he emphasized that the state benefits when both men and women receive an education based on technical, cutting-edge knowledge.

In accordance to Hill’s vision, women were part of these early geology classes. One such student was Harriet “Hattie” Whitten, who enrolled in the university in 1896. Although having no experience with cutting-edge knowledge.

The Masterson legacy lives on at UT. When she joined the AAPG in 1923, Masterson’s geology experience included conducting reconnaissance work in oil fields in Kansas, Illinois, West Virginia, Pennsylvania, Indiana and Kentucky, and studying the structural geology of Oklahoma, Louisiana and Texas. According to surviving relatives, Masterson was at Damon Mound Field, a famous Texas gusher that kicked off years of oil and gas production in the area, and, by the time of her death in 1969, had mineral rights in more than 20 Texas counties and a tungsten mine in Colorado.

She was floored. When she began her career in the oil and gas industry in the 1970s, companies didn’t allow women to work on wells. And yet, here was a woman from the 1910s, showing up at well sites and parlaying her geological knowledge for some skin in the game.

The 1970s started to overturn the restrictive gender norms that crystallized during the post-World War II years. But before that, there was a flourishing of women in geology, especially in the area of micropaleontology. Riding on the heels of the 19th amendment in 1920, which granted women the right to vote, was an era of exploration geology’s experience and set of responsibilities.

The Start

"From my ancestors I inherited a liking — no, I shall put it stronger, a love — for the studies of geology and geography in all of their different phases," she wrote in a letter to her mentor Frederic Simonds, all of their different phases,” she wrote in the studies of geology and geography in — no, I shall put it stronger, a love — for she had for the subject.

According to her obituary in the 1959 Kniker, who earned her master’s in 1923, Masterson’s geology experience included conducting reconnaissance work in oil fields in Kansas, Illinois, West Virginia, Pennsylvania, Indiana and Kentucky, and studying the structural geology of Oklahoma, Louisiana and Texas. According to surviving relatives, Masterson was at Damon Mound Field, a famous Texas gusher that kicked off years of oil and gas production in the area, and, by the time of her death in 1969, had mineral rights in more than 20 Texas counties and a tungsten mine in Colorado.

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Foram Revolution

In 1919, E.T. Dumble, a former bureau director and then chief geologist of the Rio Bravo Oil Co., wanted to investigate the connection between macrofossils, such as shells, and Gulf Coast stratigraphy. So, he called the University of California, Berkeley Geology Department looking for a paleontology expert who could spend the summer in Houston conducting research.

"We haven’t a man; Will a woman do?" asked the head of the department.

"I don’t see why a woman couldn’t do it better than a man," responded Dumble.

The conversation laid the groundwork for a paleontology renaissance in oil and gas, led by a close-knit group of three women: Esther Richards, a Berkeley graduate, and Hedwig Kniker and Alva Ellisor, both graduates of UT.

Richards arrived in the summer of 1919 to work for Dumble, and was hired on the following year, after she earned her master’s, to conduct research on macrofossils and share her findings with a consortium of four oil companies: Rio Bravo Oil Co., Humble Oil Co., Gulf Oil Co., and the Texas Co. It didn’t take long for two of the companies to hire their own paleontologists. Ellisor went to Humble, and Kniker to the Texas Co. The companies encouraged collaboration between the women. The women took it further and moved in together.

"It was a splendid arrangement," wrote Richards in her journal. "We spent most of our evening talking over the day’s accomplishments and problems."

Macrofossils proved difficult to work with; the drill bit would shatter the specimens, making them hard to distinguish. Ellisor found that a type of microfossil—a single-celled protozoan called foraminifera, or forams—proved perfect for stratigraphy; the variety of types were closely correlated with different geological strata. And their microscopic size made them small enough to avoid the drill bit. When she told her boss Wallace Pratt, Humble’s chief geologist, about her discovery he told her to keep it a secret. But he couldn’t keep it quiet himself, leaking the news to Richard’s boss, Dumble.

"When I got home, Esther Richards greeted me with the news of my discovery," recounted Ellisor in the 1962 University of Texas Bulletin. "…Of course, the news of the foraminifera were out."

But it took some work to convince the larger scientific community of the value of forams—a creature then considered too simple to display the diversity needed to map geologic strata. When Richards presented a paper authored by Dumble on forams at a 1921 meeting of
To a Geologist:

Alone, you sit beside the little stream,
The highway thronged with traffic, the airplane
Roaring above, cannot disturb your dream,
Nor yet the gathered clouds which threaten rain,
Lost in a prehistoric mist, you sit,
Forgetting everything entirely

Because in the gray rock your pick has split,
You found a creature of an ancient sea.

Warmed waters flow around you, overhead
Strange armored fishes swim with pouting fin;

Weird cephalopods [sic] crawl slowly past your head,
Creatures of some far away age which long has been.

You have gone backward from this age of men,
And you are an invertebrate again.

Rock and Hamilton Pool. However, it could not help with larger institutional barriers at UT banning women from field camp. Until the 1950s, women were not allowed on the weeks-long field geology course, save for one year in the mid-1930s when undergraduate student Marie Gramann “raised a ruckus,” in Gries’ words, so she could earn her Bachelor of Science—a degree that required field camp. The department allowed her and two other female geology students, Mildred Winans and Katherine Archer, to attend. It then swiftly reinstated its ban on women.

Post-War Years

World War II decreased enrollment in the department for both men and women. College-aged men were off fighting the war, while women supported the effort by taking jobs the men left vacant or by joining the military. Esther Applin (formerly Richards) commuted from Fort Worth to teach geology classes at UT when several professors went to war. Julia Gardner was a geologist who mapped tertiary beds from Maryland to Mexico, was a key mapmaker for bureau on the first geologic map of Texas, and performed biostatigraphic work for dozens of oil companies.

But once the war ended, many went to graduate school or didn’t enroll in higher education after WWII. Post-war attitudes on working women and an expectation that women would give up jobs to men schooling careers, while the domestic “ideal woman” found on TV shows and advertisements became a figure that many actual women sought to embody. Gries herself said she looked up to June Cleaver, the suburban mom on the 1950s TV show “Leave it to Beaver.” “I thought, ‘If I’m like June Cleaver, then what goes with that is this perfect life,’” Gries said. “It meant so much to me for people to say, ‘You’re such a good cook, this is so creative.’ And I love the day I woke up and said, ‘I don’t think I need this anymore.’”

Women who did decide to pursue education or a career had to overcome or often go along with them to advance their careers. For example, after earning education or a career had to overcome or often go along with them to advance their careers. For example, after earning
her bachelor’s in geology in 1950, UT alumna Susan Cage started off her career as a file clerk at Gulf Oil, and after three years of working, was promoted to a geologist. In contrast, when her husband was hired by the same company two years later, he immediately started as a geologist with a salary 60 percent higher than her own.

Cage said that, although not judged on the same standard as her male colleagues, she was able to advance (eventually holding a managerial position) because her geology skills spoke for themselves. “When you do a good job of it, people are aware of it and that makes a difference,” Cage said. “They liked you, so they appreciated you, and that was it.”

However, she mentioned that whenever she joined a new office, she respected you, and that was it.”

People are aware of it and that makes a difference,” Cage said. “They liked you, and that was it.”

When she joined a new office, Cage was able to advance on the same standard as her male colleagues, she was able to advance on the same standard as her male colleagues, and her husband was hired by the same company two years later. “When you do a good job of it, people are aware of it and that makes a difference,” Cage said. “They liked you, so they appreciated you, and that was it.”

While women were working to advance their own careers, activists in the civil rights and women’s liberation movements of the 1960s and early 1970s were working for equitable treatment of minorities on a larger scale. And in 1972, when affirmative action legislation passed, it impacted the lives of individual women across the U.S., including Cage. When she retired in 1983, the value of her pension was adjusted so that it was equal to men with the same experience and contributions to the company.

“Sometimes you can change things from within, not fighting the system, just going after your own goals and achievements,” Gries said. “But I sure appreciate the women who made an effort to change things for everyone.”

Anomalies: Pioneering Women in Petroleum Geology is available for purchase on Amazon.com. For a copy signed by Robbie Gries, please email mkortsha@jsg.utexas.edu.
Deep beneath layers of limestone on the Yucatán Peninsula and continental shelf is Chicxulub—the best preserved large impact crater on Earth. It was created by an asteroid that slammed into the planet 66 million years ago and wiped out 75 percent of life on Earth, including all non-avian dinosaurs.

In May 2016, the Jackson School of Geosciences helped lead International Ocean Discovery Program (IODP) Expedition 364, to drill into the peak ring of the Chicxulub Crater to learn more about how the Earth responded to that catastrophic impact. Co-led by University of Texas Institute for Geophysics Research Professor Sean Gulick, the mission pulled more than 800 meters of core from the depths of the seafloor. But sheathed in plastic casing and stored in a tightly packed, refrigerated shipping container, the cores couldn’t be closely examined aboard the lift-boat where they were pulled from the sea.

That changed in fall 2016 when the IODP Chicxulub research team converged in Bremen, Germany. They conducted intensive analysis on the core samples using high-resolution photos and CT-scans that revealed the position of mineral grains and fractures throughout the cores.

The rocks themselves contain the truth about the impact and the recovery that followed. Each section has a story to tell. The science will go on for years, but you can turn the page and see what some of the cores tell us about the day the dinosaurs died.

Rocks record what happened to the Earth the day the dinosaurs died.

BY MONICA KORTSHA
A major result of the Chicxulub impact was a monstrous tsunami that reached up to modern day Illinois. When the water rushed back into the crater it brought untold amounts of impact debris with it. This core shows debris from the tsunami (lighter in the picture and darker in the CT-scan), including cross-bedding from the tsunami waves, and the transition to settled particles on the seafloor. Note the white particles of melt rock flecking the tsunami in the CT-scan. The material in the settling layer includes the particles and surviving plankton that filtered down from the water column. The debris and glass from the tsunami were deposited the first day after the asteroid hit, but scientists are still unclear on how long it took the debris in the settling layer to filter down. Theories range from a matter of weeks to tens of thousands of years. It is a hot topic of current research.

When the Chicxulub asteroid hit, the Earth rebounded, bringing pink granite from 6 miles below the surface. The force of the impact made the surrounding rock temporarily behave like a slow-moving liquid, with deep granite rocks moving upwards and collapsing outwards to form a ring of peaks surrounding the center of the crater. The dark color of the fault zone in the CT-scan shows that the zone was porous and likely a pathway for fluids. The porosity makes it an intriguing place for scientists to look for the recovery of life in the form of microbes in the peak ring.
DONORS

Honoring a Mentor

BY GEORGIA SANDERS

Blended gift pays off now and later

Ken Neavel’s attraction to geology started at an early age. Growing up as the son of ExxonMobil’s preeminent coal scientists, he realized that a degree in geoscience could lead to an intriguing career. Additionally, Boy Scout adventures to Big Bend National Park fostered dreams of a career in the outdoors, specifically, in the mountains. These dreams were, in part, fulfilled. Now, he is helping provide others the opportunity to follow their passion by establishing an annual scholarship at the Jackson School of Geosciences to help support undergraduate students as they begin their college education.

Neavel named the scholarship in honor of his friend and mentor, Dean Sharon Mosher. He began his geological studies at UT in 1978—the same year that Mosher joined UT’s Department of Geological Sciences as an assistant professor. Mosher taught structural geology to Neavel and soon after hired him as a student assistant. He later made a critical introduction to Professor Nicholas Rast at the University of Kentucky, who Neavel studied under while achieving his master’s degree.

"Without the encouragement of Dean Mosher and the experiences that I had working with her as a student, I am not sure where my path may have taken me," Neavel said.

Neavel is an independent geoscientist in the oil and gas industry. He volunteers regularly in public 5th grade classrooms, teaching earth and planetary sciences to students who might not otherwise be exposed to these subjects. He has developed a curriculum for his volunteer efforts which he plans to employ through a nonprofit organization to help provide advanced earth and planetary sciences to public schools.

"There is no greater feeling than seeing a young person getting excited about earth and planetary sciences," Neavel said.

Neavel said that it felt was a particularly important time for him to support the Jackson School because state funding is steadily declining, prompting universities to rely more and more on private funding. He said that it just made sense to name the scholarship after "someone who has influenced his life and the lives of so many other students. He welcomes others who have been influenced by Dean Mosher’s teaching and leadership to contribute to this fund that will support young geoscientists. In addition to establishing the annual scholarship, Neavel provided a very generous planned gift in his estate to continue supporting the scholarship fund in perpetuity.

The scholarship prioritizes freshmen and sophomores in good academic standing who are first-generation college students or those from historically underrepresented groups, which is a primary goal of the Jackson School’s outreach efforts. A geosciences education changed Neavel’s life. He hopes that the Sharon Mosher Scholarship Fund—as well as the scholarships that he established at the University of Kentucky and Purdue University, where he earned his master’s and doctoral degrees, respectively—will help students realize their full potential and experience the transformative power of a geosciences education and the career paths that it paves.

"I am humbled and honored by Ken’s decision to establish a scholarship in my name," said Dean Sharon Mosher. "His generous gift will play a direct role in educating the geoscientists of the future. Nothing could be more important. I am thankful for Ken’s support."

To contribute to the Sharon Mosher Scholarship Fund or for more information about how to recognize a mentor or friend with a blended fund or estate gift, please contact Belle German, Executive Director for Development and Alumni Relations at 512 471 1993 or bgerman@jsg.utexas.edu.

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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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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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L.T. Barrow Founders Circle

The L.T. Barrow Founders Circle recognizes friends and alumni who have given cumulative gifts of $100,000 and above. Named after Leonidas T. and Laura T. Barrow, creators of the first Geology Foundation endowment in 1953, Barrow Founders Circle members honor the legacy of these two guiding spirits of geoscience education at The University of Texas at Austin.

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Hill Society

The Hill Society honors friends and alumni who have given $20,000 or more over their lifetime in support of the Jackson School of Geosciences. This society is named after Robert T. Hill, the founding member of the UT Mineral Survey, which would later become the Bureau of Economic Geology.

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Mr. Abayomi Oluwosoh, B.A. ’12
Halliburton-Landmark

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. Maurie McInnis
Executive Vice President and Provost
The University of Texas at Austin
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Geology Foundation
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KEEP IN TOUCH WITH the JACKSON SCHOOL OF GEOSCIENCES

Visit www.jsg.utexas.edu/alumni to learn about upcoming events and ways to get involved.
ALUMNI NOTES

1940s

Howard R. Lowe (B.S. ’48) shares, “Old age has finally caught up. We are moving to Ft. Worth to a retirement facility to be near our daughter. We are in good shape, but my 94 years has slowed me down a bit — in fact, a helluva lot. I am continuing to work with a group of 35 retired NASA scientists and engineers on climate change. I also recently published a Kindle book on Amazon, Beyond Our Control: Debunking Manmade Global Warming. I have lunch occasionally with Dan Smith, and talk to Tom Burke frequently by phone. Time marches on. I have a photo of the Geology 660 Field Course crowd in summer 1948. As soon as I locate it, I’ll send it to the Jackson School.”

1950s

Raymond “Pat” Anderson (B.S. ’56) writes, “Joanne and I still enjoy frequent trips to Colorado Rockies. I still enjoy my bird dogs and quail etc. I can’t believe we’re producing frac., shale Eagleford, etc. Hook ‘em horns!”

Philip Braithwaite (M.A. ’58) says, “Barbara and I continue to enjoy retirement together in Dallas. This year will be our 59-year wedding anniversary. I have been retired for 19 years and did a fair amount of consulting and traveling in the first 10 years. I try to keep up with geological developments through AAPG, DGS and UT Dallas seminars.”

Robert E. Doyle (B.S. ’55, M.S. ’57) shares, “I am still in the business of completing and patenting inventions. These include oil spill containment systems, marine current power generation and wildfire control. Just received acceptance of patent No. 9745951 from the USPTO. This renewable energy power generating system will be available for public review through the internet beginning August 29, 2017. The system is called SEAVOLT, a large, mobile subsea turbine/generator that will create electricity from the Florida Straits, arguably the fastest ocean current body in the world. This has never been done before. This device is robotic in that it is self-propelled, self-anchoring and is maintained in a submerged position below large ocean vessels through remote control by onshore personnel. SEAVOLT is environmentally friendly since it contains both fish deterrent systems and water intake conduits covered by protective grids. Each system is designed to generate power for some 60,000 households. I had the pleasure of meeting UT President Greg Fenves again at his excellent presentation on November 1, 2016, at the Houston Country Club. The turnout was wonderful, and the attendees were spectacular. Feel free to call me should you wish to discuss the patent or just to catch up on earlier times: 713-334-4464.” Bob can also be reached at red.aeg@att.net.

Jimmie Russell (B.S. ’52, M.A. ’54) reports, “THE GOOD, THE BAD, THE UGLY: The GOOD, maybe, is that I seem to have become a Father Figure to the Fraternity that put up with me when I was a student at UT, during a time when you did not have to put some geography after “The University of Texas.” The “Good-Ole-Days” – the OLD is NOW!! The BAD, is the baggage that comes free(?) with the title “Senior Citizen”— Senior to The UGLY, Look in the mirror, DUDE!!! Most of the time this year, I was at home doing very little. I don’t do NOTHING, and it takes me all-day to NOT do it! Otherwise, a major percentage of my time is visiting many different members, and facilities, of the medical profession. One highlight was the visit I had with the young lady that was a teacher when I worked with/ for her as an assistant teacher, working with Special Needs Middle and High School students in Round Rock, Texas. She was home for a visit from working in a SE Asia country. Among other results, we processed and interpreted satellite images to identify a major new coal basin. Father Time has slowed me down, and I have foregone my annual fly-fishing trips to Alaska, Mexico and western U.S. I do have good memories of great fish that were landed, admired, photographed and released to fight another day.”

Leslie P. White (B.S. ’56) says, “Dianne and I continue on in SW Austin. The grandkids are close by and they are a great pleasure. We are so proud of JSG, and we enjoy staying in touch. I look forward to reading the Newsletter cover-to-cover every year. Your effort in making this publication so good is greatly appreciated.”

1960s

Russell S. Harmon (B.A. ’69) shares, “I completed my 5½-year appointment as Director of the
Unsure.
John Heberling (B.S.'85) shares, “I have not looked much at comments in recent years. Seems very distant. But then I received a message from a fellow student back in January. Her message changed the course of my life. A line from the movie Appaloosa, ‘Life has a way of making the foreseeable that which never happens, and the unforeseeable, that which your life becomes.’ True. Life is good! Hope everyone is well.” John can be reached at johnheberling92@gmail.com.

Christoph Heubeck (M.A.'88) reports, “I am busy as a professor at the University of Jena in central Germany. My field is General and Historical Geology, so my interests range widely. In the past few years, I have become somewhat of an expert on interpreting extremely old rocks, especially those in the Barberton Greenstone Belt of South Africa and Swanland.”

Jim Immitt (M.A.'83) shares, “Pam and I are in Spring, Texas and our children Adrian and Angela are enjoying living in Colorado. After a fun and challenging stint generating deep water prospects in the subsalt Miocene of the Gulf of Mexico for ENI, I got caught in the downturn and am in transition again. The twists and turns continue in a career that has included both exploration geoscience and corporate finance. Hello to my fellow Longhorns, and onto the next chapter?” Jim can be reached at jim.immitt@yahoo.com.

Charles Graham Johnson (B.S.'95) writes, “Three out of college, one a senior at Portland State and also a seventh grader. Ellen and I stay busy keeping up with all of the activities. It hardly seems like 35 years since my UT days. My company just made a major acquisition into the legacy Texas Woodbine at Cayuga Field. Hopefully we can bring our Frac/Yegua operational skills to bear on the Cretaceous. Strong water drives, high permeability and low oil gravity make for high hopes. Maybe oil can get back above $50. I never thought I would be saying that 20 years ago. Something tells me oil will not look the same 20 years from now.”

Richard Alan Kolb (M.A.'81) says, “I continue to work as a consulting geologist for a small firm in the suburbs of Raleigh, North Carolina. I am in my third year as chair of the North Carolina Board for the Licensing of Geologists, and in my third year as chair. We recently added a continuing education requirement, 12 hours a year, to maintain one's license. The many comments from the public to the proposed rules change were interesting, with the older licensees often against the requirement and the younger licensees overwhelmingly in favor. I attended the Council of Examining meeting of the Association of State Boards of Geology (ASBOG) in Flagstaff in April, and stopped in Austin for a few days on my way there to visit my kids. Daughter Jennifer will begin her second year of school at the UT School of Social Work this fall, where she is working on her M.S. degree. Son Travis recently began work at GeoSearch after graduating from Texas State in 2016 with a degree in geography. Austin and Raleigh are quite similar, both being the state capitals and home to several universities, many tech firms, and numerous microbreweries (to the delight of all geologists). I am active in the Carolinas Chapter of the Association of Environmental & Engineering Geologists, and am one of the planners for our second vapor intrusion conference, this time in Charlotte, on October 5 and 6, 2017. We have over 200 attendees at our first conference in Raleigh in 2016. VI is becoming more and more of an issue in contamination assessments and real estate transactions.”

Bruno Maldonado (B.S.'82) writes, “Hats off fellow Longhorn! I am still involved with the Jackson School of Geosciences' FANS Board and attending alumni events. It sure is great to see those of you who have attended. I hope to see more of you at future events, so that we can catch up with each other and see how we have aged. I have lots of gray hair and a few wrinkles. I guess living in NW Houston with high humidity has helped keep the number of wrinkles down. And now, I am still doing a bit of geoscience consulting, mainly overseas in China and Africa. I am hoping to closer to home and attempting to get some gigs in Latin America. Best of luck to all and hope to see you at the SEG conference here in Houston in September... Hook ‘em!” Bruno can be reached at bmaldon444@utexas.edu.


Scott Simmons (B.S.'87) reports, “I am still having a great time as the chief engineer for SINTEF Sea and Oil Technology (Chess). I have been working for Statoil since 1996 and still love geophysics! Currently I live north of the Arctic Circle in Harstad, Norway. Please get in touch if you are in town :-)

There is wonderful hiking, riding, skiing and scuba diving here, never a dull moment! You can email me at marmor@online.no.”

James Mark Null (B.S.'87) shares, “I continue to serve as the Director (Hydrologist-in-Charge) of the National Oceanic and Atmospheric Administration's (NOAA) West Gulf River Forecast Center in Fort Worth, one of 13 such river forecast centers across the nation. I am responsible for ensuring that citizens of Texas, New Mexico, and portions of Colorado and Louisiana, receive timely and accurate river and flood forecast information for the protection of life and property. I have served in numerous leadership positions within the Federal government including the US Geological Survey, the U.S. Army Corps of Engineers, and the U.S. Naval Oceanographic Office. Prior to my civilian career, I served as a U.S. Navy Meteorologic and Oceanographic officer retiring at the rank of Commander. Also, I actively involved with the Texas EXES and have been recently selected as the President of the Fort Worth Chapter! We have a great group here in Cow Town with many networking and scholarship fund raising activities for our next generation of Longhorns!”

Margaret Sipple Srinivasan (B.S.'82) writes, “In my 17th year at the Jet Propulsion Lab in California and my hats include Manager of the JPL Center for Climate Sciences, and Deputy Program Applications Lead for the SWOT, Sentinel 6 and Jason-3 satellite missions. In my spare time I, am getting an M.S. from Johns Hopkins in Environmental Science and Policy. Good times! Cheers to all of my former UT colleagues!”

George Brian Sutherland (B.S.'84) currently resides at Kinetic Upstream Technologies, LLC. He can be reached at gbsutherland@utexas.edu.

Bruce Swartz (B.S.'82) shares, “Sold all my production in late ’16. Starting over with some consulting in both exploration and production. In a few years I hope to quit chasing rigs and just slide logs.” Bruce can be reached at bruce.swartz@gmail.com.

Mark C. Walker (B.A.'83) is now with national law firm Dickinson Wright PLLC, and continues to practice from the EI Paso office, for which he acts as managing partner. Among others, Mark is delighted that life and law partner Kathleen Campbell Walker (J.D. 1980s Fred (B.S.'83) and Teresa Harkrader Becker (B.S.'82) share, “We are enjoying retirement here in beautiful Marble Falls. We recently travelled to the Amazon and to Scotland with the Flying Longhorns and are active in our local Highland Lakes Chapter of the Texas Exes. Would love to hear from any of our classmates!”

Julie Bonner (B.S.'83) writes, "Retired by choice last year and enjoying it! Hit the country this year and pondering what I want to be when I grow up!"

Richard Carroll (B.S.'80) reports, “I am still gainfully employed in the oil and gas industry and working the greater Permian Basin for Caza Petroleum. I can be reached at rcarroll@cazapetro.com.”

Harkrader Becker 1980s...
1990s

David Laurence Work (B.S. ’84) says, “Recently moved to Deepwater GOM after years of Eagle Ford at Anadarko. Enjoying come back for UT football and Geo Alumni events, especially getting to do some fossil hunting with wife Leailey (retired SOM geologist) and sons Evan and Henry — thanks to Dr. Sprinkle for the tip! Wishing all the mid 80’s grads well!”

Rimas Gaizutis (B.S. ’91) writes, “I have followed an awesome summer which culminated in an epic geology-focused road trip with my kids through West Texas, eastern New Mexico and Colorado and a week in Breckenridge with all of us. The kids got their first taste of swimming at Balneaheha State Park, and seeing the Marfa Mystery Lights. I’ll never forget hyrdo field camp in 1996: I begged Jack Sharp to take us to Marfa to see the lights. He told me if I could convince a TA to drive me then he’d let us go. I begged our TA, James, to drive me to Marfa from Ft. Davis and he graciously said yes, the whole way telling me, “You know, Christi, these probably aren’t real.” But they were, and are! The kids now have been bitten by the West Texas bug and are little rock hounds of course. Charlie, the kids, and I have all been doing karate together for the last 14+ months so don’t mess with the Gells! Drop me a line if you are ever in Houston or want to work in Merida, Yucatan, Mexico.”

Christi Gell (B.S. ’96) reports, “I just started a new job as Associate Director of Technical Sales at HIS Markit. This followed an awesome summer which culminated in an epic geo-geology-focused road trip with my kids through West Texas, eastern New Mexico and Colorado and a week in Breckenridge with all of us. The kids got their first taste of swimming at Balneahasa State Park, and seeing the Marfa Mystery Lights. I’ll never forget hynold field camp in 1996: I begged Jack Sharp to take us to Marfa to see the lights. He told me if I could convince a TA to drive me then he’d let us go. I begged our TA, James, to drive me to Marfa from Ft. Davis and he graciously said yes, the whole way telling me, “You know, Christi, these probably aren’t real.” But they were, and are! The kids now have been bitten by the West Texas bug and are little rock hounds of course. Charlie, the kids, and I have all been doing karate together for the last 14+ months so don’t mess with the Gells! Drop me a line if you are ever in Houston or want to work in Merida, Yucatan, Mexico.”


Sachin Shah (B.S. ’98) is the Chief for Hydrologic Studies and Research at the USGS Texas Water Science Center Gulf Coast Program in Houston, Texas. He has been part of the development of a new interactive web application on groundwater level changes and subsidence in the Houston region.

Becky Smyth (M.A. ’95) will be retiring from BEG after more than 20 years and return to private consulting.

2000s

Thomas Tydings Thacker, Jr. (B.A. ’08) writes, “My wife, Mary-Alex, and I welcomed our first child, a happy healthy boy, to the world on March 23, 2017. Thomas Tydings Thacker III. I also launched my own company, Wellcamp: Royalty Partners, LLC, which is a mineral and royalty acquisition fund focused on the Permian Basin. To date, the fund has closed over 75 transactions covering mineral/royalty interests in over 100 producing wells, under 20+ of the premier operators of the Permian Basin, across 7 counties and WRP is continuing to grow.” Thomas can be reached at thomas@wellcamp.com.

Nick Danger (M.S. ’16) says, “I am currently working at SOQ Environmental as a project geoscientist and environmental consultant. I am based out of Austin but conduct field work and commercial drone operations across the United States for several multinational corporations. When I have free time, I enjoy hiking, disc golf and van camping in National and State Parks.”

Mackenzie Day (Ph.D. ’17) reports, “I began a NASA Postdoctoral Fellowship with the NASA Astrobiology Institute at Jackson School of Geosciences | 2017 Newsletter
Tian Y. Dong (B.S. ’13) “After receiving a M.S. in Earth Science at Rice University in 2015, I am continuing as a Ph.D student and expecting to finish in 2019.”

Emma Heitmann (B.S. ’16) “spent about 5 months in Brazil managing the fieldwork for a cave monitoring project with Corrin Wong, and has now returned to Austin.”

Michael Lis (B.S. ’16) “I will be attending the University of South Carolina Fall 2017 and getting my Masters in Geology. I can be reached at Michael.lis@utexas.edu.”

Rania Eldam Pommer (B.S. ’13) shares, “Hello! As you may know, I self-published two STEM-related children’s books in 2016 (MD and Fnn Go Camping, and MD and Fnn: Solar Power! Both are available on amazon.com), but 2017 has been a pretty darn exciting year too! I’m working with my illustrator on a potential new MD and Fnn project (coming 2018).”

Makoto Sato (M.S. ’14) recently moved to Japan and can be reached at sadahiro@utexas.edu.

Nikki Seymour (M.S. ’15) shares, “Here are Dr. John Singleton and his three advisees doing field work along the Atacama Fault System in northern Chile. All four are JSG alumni. Pictured left to right: Rachel Ruthven (BS 2016, honors advisor Rich Ketcham), John Singleton (Ph.D. 2011, advisor Sharon Mother), Nikki Seymour (MS 2015, advisor Daniel Stockli) and Evan Strickland (BS 2010, honors advisor Mark Cloos).”

Michelle Stocker (Ph.D. ’13) writes, “I accepted a position as Assistant Professor of Paleobiology in the Department of Geosciences at Virginia Tech starting January 2017. I am a Faculty Affiliate in the Global Change Center at Virginia Tech while also holding research positions at the Virginia Museum of Natural History, the Smithsonian’s Natural History Museum, the North Carolina Museum of Natural Sciences, and the Jackson School’s Vertebrate Paleontology Lab at UT Austin. My research group focuses on the evolution of reptiles, and I am looking for curious and driven M.S. and Ph.D. students to apply to my lab for Fall 2018!”

Chak Hau Michael Tso (B.S. ’12) shares, “After getting my BS in English degree from UT, I moved to University of Arizona for a M.S. in hydrology. Now my wife Elizabeth and I live in the beautiful countryside of Lancaster, United Kingdom, where I am working on a Ph.D on hydrogeophysics.”

Kristopher James Voorhees (B.S. ’14, M.S. ’16) writes, “I graduated with a Masters from the Jackson School in 2016, where I also received a Bachelor’s degree in 2014. Since graduating from the Masters program, I started my career with Apache Corporation in June 2016 where I completed a rotation for a year with the International New Ventures group. I have recently returned to Midland with the Conventional Exploration team working the Midland Basin and am thrilled to be working on carbonate rocks again, considering I studied under “the Guadfather” himself, Dr. Charlie Kerans. Since graduating, I have made it a point to travel to new places such as Canada, Thailand, Bali, China, Japan and throughout the central U.S. My next adventure will be a Thanksgiving year trekking to the base camp of Mount Everest in the Himalayas.”

Angela Wu Li (B.A. ’15) writes, “I spent the year after graduation in Austin, working and travelling for Apple Maps. Then the west coast called my name and I’m now in San Francisco working at a startup. Though the beloved 512 will always be home, I will have to say that the hills out here are pretty impressive. Always up for coffee if anyone finds themselves out here studying faults and grains!”

William I (Bill) Woods (retired executive assistant in the Department of Geological Sciences) shares, “This has been another full year. In March and April, Francisco and I spent 3 weeks in El Salvador visiting family and another week in Big Bend National Park with friends. Both were fun, interesting trips. In June, we traveled to Costa Rica to visit his sister there. I have taken on a volunteer position at the Heart Hospital of Austin, working at their concierge desk. I enjoy meeting people and helping out. I still go to GREE to work out. MWF. Francisco retired from UT at the end of February, so we have time to travel together and plan a trip to Australia in November, 2017 and possibly New Zealand and Tasmania. I always enjoy hearing from my BS friends. I can be reached at billw@utexas.edu.”

Hector K. Garza (B.S. ’16) is currently a consultant geologist at Premier Oilfield Laboratories in Houston, Texas and can be reached at hector.garza@utexas.edu.

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Alaska, the Pacific Northwest and Yellowstone are favorites. Fall foliage most anywhere is a close second.”

Lynton Land writes, “I continue my quest to improve Chesapeake Bay water quality. Meaningful changes in agricultural crop fertilization practices must occur, such as replacing conventional chemical fertilizers with slow-release products. Equally important, sewage sludge, poultry litter and manure disposed cheaply by land application must be limited to supply the phosphorus needs of the crop, but no more. Current permissive regulations favor the waste-producers and guarantee much more nitrogen and phosphorus pollution than is caused by chemical fertilization. Quantitatively, meaningless changes, like growing more oysters, must not substitute for changes in crop fertilization practices as explained in the July 2014 issue of the "Bay Journal" and doi: 10.1007/s10498-014-9226-y. I grow and sell fertile (diploid) seed oysters. The more fertile oysters the better, they make great fertile (diploid) seed oysters. The more so 10498-014-9226-y. I grow and sell fertile (diploid) seed oysters. The more fertile oysters the better, they make great 10.1007/s10498-014-9226-y. I grow and sell fertile (diploid) seed oysters. The more fertile oysters the better, they make great"}

Ernest Lundellius (B.S. ’50) shares, “Although retired I still go to the Vertebrate Paleontology Lab at Pickle Research Campus nearly every day. I am just finishing a long-term study on a Pleistocene cave fauna from Western Australia. We are also involved in a study of a new locality north of Houston that so far has produced the first record for the U.S. of a South American animal, a toxodont. This animal was about the size of a small rhino. I have given several talks about the late Pleistocene fossils from Inner Space Cavern near Georgetown. I also send a little time trying to keep with three grown grandchildren. I stay busy!”

Earle F. McBride writes, “Just after the first of the year The Rocky Mountain Geology journal published my contributions on the sedimentology, petrography and diagenesis of the Lower Pz clastics that overlie the Precambrian basement in the area between Durango and Silverton, CO. I collected the first samples for this study on Geo 860 in the 1980s. Some projects move very slowly. Stratigraphic and editorial input from Jim Sprinkle was helpful over the years. The allegedly Cambrian Ignacio Quartzite is almost certainly Devonian. Luigi Folk and I have started a study of ‘ferricrete’ (iron-oxide-cemented sandstones and conglomerates) in central Texas. At our ages (RLF = 91; EFM = 85) progress is a bit slow!”

James Sprinkle shares, “I’ve been retired as a Professor Emeritus for 4 years now; so I’m not doing any teaching or supervising students, except for serving on one M.S. Committee in 2014-2015. However, I still do research on early echinoderms and Paleozoic marine communities with several co-workers and former graduate students. I usually come in to the Department 3 days a week and on Sunday afternoons, and go out to the Non-vertebrate Paleontology Laboratory (NPL) at the Pickle Research Center the other 2 weekdays to work on some of my fossil collections and to photograph specimens. 2015 was the last year that I did any extensive field work out in our major fossil collecting areas in Utah and Nevada, but I’ve made several shorter trips up to southern Oklahoma this year to visit fossil collecting localities and other workers up there. During the last 4 years, I’ve published 9 papers or book chapters, 6 abstracts for talks or posters at GSA or other conferences, and a book review. I still have at least 20 additional fossil echinoderm projects that I’ve accumulated over the years that need to be written up before I ‘really retire’. Our family is doing fine here in Austin and elsewhere. Wife G.K. retired 2½ years after I did. However, she then got hired to do some consulting work for a client during last spring’s Texas Legislative Session. Son David still lives and works in Austin, so we see him about once a week to help out with yard work and to keep our computers and electronics working. Daughter Diana, the artist of the family, recently got a full-time job with a graphics company in St. Louis, Missouri, and moved there in April; we see her whenever we talk on the phone.”

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

Dorothy W. Alcorn (spouse of the late Charles W. Alcorn, B.S. ’52) and her education advocate and community leader, died at her home in Victoria, Texas, on February 26, 2017. She was preceded by her husband of 45 years, Charles W. “Chuck” Alcorn, Jr.

H. Warren Bell (B.S. ’53) died at home on December 26, 2016. He was born March 20, 1933, to Daudy and Marzee Bell in the community of Minster, in Lamar County, Texas, where he lived throughout his youth, graduating Deerport High School in 1948. He attended TCU from 1950–1955, then transferred to The University of Texas at Austin where he earned a Bachelor of Science in geology in 1953. Warren worked as an exploration geologist with Unison Sulphur in Lake Charles and Superior Oil in New Orleans, and in 1969 relocated to Houston where he worked for Kiloyn Company through 1974. He then took a position with McCormick Oil & Gas where he remained until his retirement. He then became an independent geologist. He was an independent geologist for the rest of his career. While working in Lake Charles he met and married Jeannette Sutter in 1956. They have two children, Katherine Shipley (husband Tom), and Brian (partner Michael Cammareri), grandchild William and Anne Marie.

Robert L. Bluntzer (B.A. ’60) age 83, passed away on December 5, 2016. He was born in Cuero, Texas to Cornelius Sixtus Bluntzer and Lorena Tietz Bluntzer. After he graduated from high school in Cuero, he served in the U.S. Army and earned a bachelor’s degree in geology in 1961 at the University of Texas. Bob worked in the oil patch early in his career and then as a groundwater geologist for various Texas water agencies for 32 years. After retiring, he was a hydrogeologist consultant for 10 years and was involved in restoring the first water well on the State of Texas Capitol grounds. Bob was a very dedicated, loving and fun husband for 48 years, father, grandfather and friend. He loved Austin, Longhorn football, hunting, cultural activities, fossils, genealogy, history and traveling. Bob was very active in his children’s and grandchildren’s lives attending sporting and school events. He was a member of the UT Quest Continuing Education Group and Texas Board of Professional Geoscientists. Bob is preceded in death by his wife, Josephine Bluntzer, and his parents. He is survived by his son, Peter Bluntzer, of Austin, Texas; daughter and son-in-law, Alice and Joshua Ley, and grandchildren Andrew and Kate, all of Englewood, Colorado.

Jean I. Bowman (B.A. ’54) was born in Houston, Texas on September 5, 1929, to Agnes Baker Ingram and Leon Ingram. She attended Austin High School as well as an officer in the Scottish Brigade. After graduation, she earned a Bachelor of Science in geology from The University of Texas at Austin in 1951. She frequently referred to herself as a proud “tea-sip” and remained a lifelong “livestock,” his favorite term for several outstanding staff. Jean is preceded in death by her parents, siblings and husband. She is survived by her four sons Dan W. Jackson III, Todd Johnson, Bert Johnson and Matt Johnson.

Claude A. Campbell (B.S. ’50) Reverend (retired) Claude Alan Campbell passed away July 13, 2017, in San Antonio. He was born in 1927 and had recently celebrated his 90th birthday. Alan was a native San Antonio. He was the youngest child of Claude Amos Campbell and Kate cone campbell. Alan graduated from Thomas Jefferson High School in San Antonio at the close of World War II. He enrolled in Trinity University eventually transferring to The University of Texas at Austin where he earned a bachelor’s degree in geology in 1950. He worked as a petroleum geologist for Union Producing and then as an independent geologist for several years, retaining a lifelong interest in minerals and geological formations, especially those of West Texas, which he loved. In his 30s, he decided to change careers and enrolled in Virginia Theological Seminary in Alexandria. After graduating in 1964, he served the Episcopal Church in Texas parishes including St. Matthews in Edinburg and the Church of the Incarnation in Dallas before accepting a position at Deaconess Hospital in St. Louis as a clinical pastoral education supervisor. He was married to Katherine Elaine McDaniel from 1958 to 1972 and the couple had two children, Allison and Callan. In 1979, he met and married Linda Crick Campbell, his wife of 37 years. Alan was preceded by his parents and his sister, Cathryn Smith. He is survived by his wife, Linda, who works for his former undergraduate institution – Trinity, son Caleb Andrew Campbell, daughter Allison Kone Campbell, niece Cathryn “Tinka” Watts Langfeld, nephew David Watts, Jr., and his herd of “lived-in.” His favorite term for several beloved pets.

Calvin A. Chimene (B.S. ’50) passed away Friday, December 23, 2016. He leaves behind his three sons, J.B., Andre, and Beau, and eight grandchildren, Daniel, Gabrielle, David, Zachary, Beverly, Cooper, Coley, and Daisy. His first wife, Katie Allen Chimene, and his second wife, Ann Carol, both preceded him in death. A fifth generation Houstonian and native Texan, Calvin spent almost all of his life in and around Houston, Texas. The son of Julius and Fanette Chimene, Calvin grew up in Cuero, Texas, where he went to Lamar High School. He attended the University of Texas at Austin at 17, then left to join the U.S. Army for World War II. After serving in the occupation of Japan, he returned to the University of Texas where he graduated with a Bachelor of Science in geology. He then attended the University of Houston, where he acquired a Master of Science in geology with a minor in Physics. He was selected as a member of the SGE, the national geology honor society. Some of Calvin’s publications have been published in articles by The Oil & Gas Journal, other Exploration periodicals, the Journal of Sedimentary Petrology and even in books. He was a member of the various Field Memorials of the American Association of Petroleum Geologists. He has lectured extensively at AAPG conventions, Houston Geological Society, and meetings of the Houston Mesozoic Group. He was selected to present a paper at the World Geological Congress in Washington, D.C. in 1988. His master’s thesis in 1952 was the first one published from the University of Houston by an outside publishing company. Following his employment with the Quebec Minister of Mines he worked in the corporate world for 33 years, rising to the position of VP in charge of domestic exploration for hydrocarbons of a large American corporation, heading a staff of roughly 100. Retired in 1985, he formed his own company to carry on his interests in oil and gas exploration and raising pecans. Calvin also spent his working years raising three sons with Katie Chimene, providing them with life skills from dinosaur bone and rock identification to founding and working with all types of tools. All three sons followed their father to the University of Texas, and shared his passion for Texas football and hunting. He was an active participant in writing fiction in 1988 and has published three volumes of short stories and one novel. He was also an artist, creating charcoal drawings of fossils. Calvin played handball and table tennis into his eighties, and won several medals in competition at the local Senior Olympics.

Kenneth L. Diebel (B.A. ’82) peacefully May 30, 2017, in Austin. Kenneth was born February 13, 1926, at home in Meyersville, Texas to Erwin and Erna Diebel. He was the oldest of two brothers. His daddy died of appendicitis when Kenneth was seven. His mother never remarried, and she struggled valiantly to support and raise the two boys with a strong Lutheran sense of values and an unwavering moral compass. The Diebel family spoke German at home, and Kenneth did not learn English until he began first grade. As a boy Kenneth was active in Boy Scouts and earned the rank of Life Scout, but soon the foot-size six-inch redsandals were replaced by the Cuero High School basketball court. Basketball games interlaced with Boy Scouts, so “Red” Diebel switched his focus from scouting to football as a member of the Cuero Gobblers basketball team. After high school, he attended the University of Texas for a year on a basketball scholarship and studied chemistry before he was drafted into the Army. During World War II, Private First Class Diebel engaged in combat and gained his knowledge of chemistry to good use as a translator and medic in a hospital in Germany. After the War, he made his home in Crested Butte. Bill loved football, especially his beloved Sooners, being at the lake, movies, fishing and reading. He was renowned for his generosity and his larger-than- life personality, for which position he will always be remembered. He is survived by his wife, Kristine Stepan Curtis; his three biological children: Samantha Winn Curtis, Adam Curtis and Walter Alexander Curtis; his step-children Boyd Ryan Stepan (fiancée: Lauren); Ashley Stepem (husband: Ugo); Trevor James Stepan (wife: Jenny) and his grandchildren, Izu and Amara as well as his nieces and nephews. He was preceded in death by his parents Lawrence W. Curtis and Marilyn Buescher Curtis and his brother Robert L. Curtis.

William W. Curtis (B.A. ’82) age 59, formerly of Austin and Oklahoma City passed away September 19 in Crested Butte, CO. Bill was born on May 22, 1957. He was the youngest son of Lawrence W. Curtis and Marilyn Buescher Curtis. He graduated from Heritage Hall in Oklahoma City in 1975 and from Southern University in Georgetown, TX in 1980 with a degree in political science. He also earned a degree in geology from The University of Texas at Austin in 1982. Later in life, he returned to school and received his Masters in Education from Oklahoma City University. In 1982 he married Elizabeth McLain and went to work as a geologist in Oklahoma City. Later, he became a pharmaceutical representative for McNeil. That job allowed him to move back to Austin with his family. In 2008, he married Kristine Stepan and joyfully added her three children to his family. Later in life, 122 | Jackson School of Geosciences 2017 Newsletter | 123 2017 Newsletter 
survived by daughter Kay Diebel Brock

Ken was preceded in death by his

measured all his actions and decisions.

guiding principal upon which he

life, and his belief in his Lord was a

faltered in his belief in the saving grace

and became fluent in Norwegian and

enjoyed “guitaring” with a group of

First Presbyterian Church, where he

home to Conroe in the early 1980’s. He

loved to play the guitar and was well

and Norway. Ken and Nita made many

were keen driving forces in Bob’s life.

degree mason and received the honorary

were joined in marriage by Bob and Betty

(1947-1970) was transferred back to Midland.

Bob began a long time

association with the Boy Scouts when he

on many roles as a scout leader, helping

to train them to train the boys. Bob earned

the highest scouting award for an adult

leader, the Silver Beaver award. Bob

continued to serve the Boy Scouts for 50

years helping boys learn the ways of

scouting. Professionally, Bob was a geologist and petroleum engineer. In the mid-60s he received his Professional

Engineer license. He was awarded the Pioneer Award by the West Texas Geological Society in 2005. He served as President of the

Midtown Dallas Lions Club and won the Jack Welch Fellow Award for management excellence from U.S. News and

World Report in 1994. Bob was a founder of the University of Texas at Austin Alumni Association. Bob was an officer of the

United States Army Air Corps as a

Second Lieutenant. He served as Head of

adult scout leaders, helping to train

children’s program, and managed all fishing

both children. Thurman loved his family

left over 1800 acres to the University of Texas

northern Arizona. He also played golf and

and South Carolina. He loved to play the
guitar and was well known for his
guitar skills. Ken married Betty and they

had two girls, Kay and Ann. Kenneth grew up

as an exploration geologist and manager

with Exxon, and the family traveled all over

the world, living in Houston, Fort Worth,

Ken and Nita made many different
joints as a guitarist with the “old folks’ home.”

in the Jackson School of Geosciences.

and fish and took the family on

trips. He also played golf and

learn to live with all of their advantages

and disadvantages. Bob loved to hunt

(hunter) and enjoy fishing in many

countries, and his love for his family never

diminished. Bob’s life was filled with

great grandchildren. Thurman loved his

family, his friends, and the Texas

Longhorns. He is survived by his wife

Vallee Gaines and wife Edellweiss; his

parents Emmaleen and Vallee; his

sons, Alexiy, Rita and Kenny Brock, and

Lutsch of Houston, grandchildren

Alexiy, Rita and Kenny Brock, and numerous nieces and nephews.

Dennis Adolph Drake (M.A. ’58)

and left, in 1943, with the 75th Field

Artillery, 3rd Armored Division of the

United States Army. After the war, he

returned to UT and finished his degree

in geology on the GI bill. After enduring (and

enjoying) many roles as a scout leader,

helping to train them to train the boys. Bob earned

the highest scouting award for an adult

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Lutsch of Houston, grandchildren

Alexiy, Rita and Kenny Brock, and numerous nieces and nephews.

Dennis Adolph Drake (M.A. ’58)

81, of Dallas, Texas, passed away on September 13, 2016. “Bob” Gaines was

a petroleum geologist. His 50-year

career in the exploration for oil and gas

took him to Louisiana offshore, and

the Texas Gulf Coast on and offshore.

Dennis also traveled to China for oil

and gas study and research. He often

spoke of his goal to leave much energy

for the future generation. He served as

Vice President of Exploration for Strata

Energy-Armo Steel and worked for

other companies. Dennis retired from

Devon Energy Houston. His survivors

are his wife of 56 years, two children,

four grandchildren and a sister.

Robert B. Gaines

(1947)
died

November 5 at his home

in Austin surrounded by his family after a long battle with

sarcoma cancer. He celebrated his 95th birthday just days prior to his death. He was born in Grand Saline, Texas to

Tommy and Rachel Bett.

Thurman B. Geddie

(1926-2015)
died

November 5 at his Austin

home. He was a retired petroleum

geologist and oil and gas operator. Clem

entered graduate school at The

University of Texas at Austin and

graduated in 1948, number one in his class with a master’s degree in geology. On March 1, 1948, Clem rode the train from Ft. Worth to Midland to report to work with Stanolind Oil and Gas. In September of 1950, Clem went to work for Anderson Pritchard, and then in January 1954, became an independent geologist and oil and gas operator. Clem served as the Chairman of the Society of Independent Geologists in 1968 and served as President of the Geological Foundation in Austin for seven years (1970-1977). Clem served as a director of Midland Commercial Bank from 1977 to 1984. In June 2015, he was awarded the Pioneer Award with Midland Geological Society. Clem’s interest in the stock market dominated his time since his 1930s. All children and grandchildren had to know exactly how GE closed. Clem’s love of his children’s and grandchildren’s stories was ingrained into his two children, Meredith and Kenn, and his six grandchildren. Clem’s children and
grandchildren have all been part of the Boston Red Sox Fan Club, because of Clem’s predilection for the team, which began in spite of the curse of the Bambino. What a joyous day for Clem when the curse was broken. Clem hosted multiple grandchildren, Meredith, and Ken to relish in person three World Series wins. Clem is survived by two children, Meredith, and Ken and wife Tricia of Dallas; grandchildren, Kenneth George II and wife Carolyn, and great-grandchildren, Kenneth III and John, of Cheyse, Maryland, Patrick George and wife Elizabeth, Clement George and wife, Lee, and great-grandaughter, Joanne, who lived in Roswell, New Mexico.

Edward W. Hughston (M.A. ’50)

He served in the United States Navy from Worcester Polytechnic Institute. He graduated from the University of Texas in Austin and was a resident of West Boylston, Massachusetts. Edward W. Hughston (M.A. ’50) was married to Lee Harvard. He was a resident of Roswell, New Mexico at the age of 87. Ed was born in Hillsboro, Texas, where he spent the first five years of his life and his childhood. The stock market crash of October 1929 set the stage for his Great Depression childhood. “But this childhood was not all bad,” he said, “and any notion of the Depression came much later.” After eight years in Tyler, Ed’s family moved to Dallas, where he attended Dallas Hall, a preparatory school. He grew up in Elkhart, Indiana, where in high school he was not only a state championship center for the basketball team, but also played violin in the orchestra. In later years, listening to classical music became his favorite pastime, whether he be sitting in his VIP chair listening to the Grand Park Orchestra in Millennium Park, Friday afternoon concerts at The Chicago Symphony, concerts on the lawn at Ravinia or listening to his vast collection of CDs. He attended DePauw University, was appointed to the U.S. Naval Academy, and graduated from The University of Texas at Austin. He then embarked on a career in oil and gas spanning seven decades, based first in Corpus Christi, where his three sons were born, then Dallas and McKinney, and finally Taos, where Ed moved with Joan in 1979 and spent many happy years, making numerous good friends. He is survived by his wife Lane Hughston, son Mark Hughston and his wife Martha; granddaughter Katherine Kennedy and her husband Walter Kennedy, grandson Christopher Hughston and his fiancé Rendi Jergen, grandson Benjamin Hughston and Parker Hughston, and great-grandson Wyatt Kennedy. He is survived by his beloved father of Betsy (Gary) Ingram, Kay Briggs Hughston.

Robert S. Houston (B.A. ’50)

Rohert was a resident of West Boylston, Massachusetts at the time of his passing. He was a 1930 graduate of University of Texas and later earned a master’s degree from Worcester Polytechnic Institute. He served in the United States Navy during World War II. He was married to Blanche.

Edward W. Hughston (M.A. ’50)

Long-time Dallas resident Edward Wallace Hughston died peacefully on May 28, 2017, at his home in Taos, New Mexico at the age of 87. Ed was born in Hillsboro, Texas, where he spent the first five years of his life and his childhood. The stock market crash of October 1929 set the stage for his Great Depression childhood. “But this childhood was not all bad,” he said, “and any notion of the Depression came much later.” After eight years in Tyler, Ed’s family moved to Dallas, where he attended Dallas Hall, a preparatory school. He grew up in Elkhart, Indiana, where in high school he was not only a state championship center for the basketball team, but also played violin in the orchestra. In later years, listening to classical music became his favorite pastime, whether he be sitting in his VIP chair listening to the Grand Park Orchestra in Millennium Park, Friday afternoon concerts at The Chicago Symphony, concerts on the lawn at Ravinia or listening to his vast collection of CDs. He attended DePauw University, was appointed to the U.S. Naval Academy, and graduated from The University of Texas at Austin. He then embarked on a career in oil and gas spanning seven decades, based first in Corpus Christi, where his three sons were born, then Dallas and McKinney, and finally Taos, where Ed moved with Joan in 1979 and spent many happy years, making numerous good friends. He is survived by his wife Lane Hughston, son Mark Hughston and his wife Martha; granddaughter Katherine Kennedy and her husband Walter Kennedy, grandson Christopher Hughston and his fiancé Rendi Jergen, grandson Benjamin Hughston and Parker Hughston, and great-grandson Wyatt Kennedy. He is survived by his beloved father of Betsy (Gary) Ingram, Kay Briggs Hughston.

Gordon L. Ingrahm

Gordon L. Ingrahm (B.S. ’49), of Evanston, died peacefully on May 5, 2017. He is survived by his beloved wife of 59 years, Judy Ingrahm. He was the cherished son of the late Raymond and Glennah Ingraham; loving brother of the late Boots (Betty Lou) Ingram and Kenny (Betty Kay) Ingram; adored uncle of the six daughters of his brother, David (Matt) Frank, Margaret Ingram, and Michael (Rosina) Park Ingram. He is survived by six grandchildren who thought the world of his brilliant, grace-full spirit and favorite expression was “Let go, and let the wind fill your sails.”

Dean L. Leyerly

Dean L. Leyerly (B.S. ’50) died peacefully away on November 9, 2016. Dean was born in Caldwell, Kansas on June 8, 1923 to C. E. and Maude Leyerly. He graduated from Caldwell High school and he married Margy Lou Crumbliss on June 8, 1941, and soon after entered the USAF where he served as a radio operator and waist gunner. During Dean’s service to this country, he was shot down in combat and became a POW. He was awarded the Purple Heart, and other medals of honor. Upon returning home, he continued his education to receive a B.A. degree from The University of Texas. Dean began a 35 year career with Hughes Tool Company in 1945. At the time of his retirement, he was District Zone Manager in Midland, Texas. Dean was preceded in death by his wife of 64 years, Margy, his daughters Dana Gibbs Copeland and his sister Jane Strevel. He was survived by his wife, Mickey; his daughter Jo; grandson Kenny; granddaughter Ka Dee, all of Midland and Odessa, and sister Lois Morris of Wichita, Kansas.

Clifford R. McTee

Clifford R. McTee (B.S. ’50) was born on September 1, 1933, and died on December 9, 2016, at the age of 83. He was born in Houston to Clifford Ray McTee, Sr. and Gladys Lucille (Harris) McTee. Cliff had a degree and postgraduate work in geology from the University of Texas at Austin, where he belonged to Acacia Fraternity. He worked for Tidewater Oil and Gas Company as an exploration geologist. He also worked in Houston for both Midwest Oil and Gas Company and International Nuclear Corporation. In 1970 he moved his family to Corpus Christi. There he ran the exploration department for Texas Oil and Gas. He enjoyed a stellar reputation and was widely known and respected in the South Texas Oil and Gas community. After four years, he opened his own office and practiced petroleum geology for the next 20 years as an independent geologist. During this time, he served as the trustee of the United Methodist Church of the Corpus Christi Geological Society and the Petroleum Data Service. Cliff was active in his local church, having been initiated into the Order of the Arrow at the same time as his son, Ford. He immensely enjoyed hunting and many good times with his friends and relatives in pursuit of game. Cliff was also active in several other businesses; he ran a cattle ranch in McMullen County, Texas for many years. He was also very proud of his board position and work with the McMullen County local historic society. He was preceded in death by his parents. He is survived by his loving wife of 63 years, Elisa (Wheelie) McTee, sons, Ford “Ford” B. McTee of Huntington and Hunt McTee and wife Kimberly of San Antonio; daughter, Shelly Marie McTee and fiancé Jay Miller of Phoenix, Arizona and brother, Ronald James McTee of Spring Branch, Texas. Cliff is also survived by his granddaughter, Jordan McTee and wife, Mary Lee Ila Parsons.

Herbert G. Mills

Herbert G. Mills (friend and donor to the Jackson School) 86, passed away November 22, 2016, in San Antonio. Born February 20, 1930, in San Antonio, to Elton Herbert Mills and Rosalind Mangold Mills, he was preceded in death by his parents, his sister Rose Ann Northwest, and brother Eben Mangold Mills. Herbert graduated from Rice High School in 1947 where he played football and was president of his class. In 1951 he was a proud graduate of TAMU where he earned his B.S in geological engineering. His experience in the Corps of Cadets was quite memorable and very formative. He was a Ross Volunteer and Commander of the Armor-Engineer Regiment. Following two years of service in the U.S. Army,
He worked for Exxon Company USA which took him from various South Texas locations along the Gulf Coast to New York City and ultimately back to Houston. After retirement in 1987, he and his wife formed Mills Exploration. Herbert was a member of the Houston Geological Society, the AAGP and SIFES. He was an active member of St. John Vianney Catholic Church in Houston for 43 years. In addition to being a member of the Knights of Columbus, he found great satisfaction in volunteering in various ways through his parish and community. Of particular note was his work with the parish school board as Director of Catholic Education at St. John Vianney Catholic School, one of Houston’s inner city Catholic schools. Dedicated to his family, he was available to help whenever and wherever needed. John Herbert is survived by wife, Martha Bybee Mills; children Ruth and husband Mark Oordt, Herbert G. Mills, Jr., wife Cindy, and Peter B. Mills and wife Cheryl; grandchildren Andrew, Martha Rose, Carol, Ellen and Catherine Ord; Anna Marie Mills; brother-in-law John Ord; Andrea, Molly and Matthew Mills; Allisa Varga and Joveta Varga, wife Sarah and children Charlotte and Landon; and numerous nieces and nephews.

Josh W. Osmond (B.S. ’56, M.A. ’58) age 86, of Corpus Christi passed away Sunday, April 23, 2017. Josh was born July 26, 1929 to Lora Lee and Wm Hale Osmond who preceded him in death. Josh graduated from Tarleton High School in 1944 and moved to Corpus Christi to attend Texas A&M University where he developed his love of geology. After graduating, started his career as a geologist with Exxon Co., U.S.A. Earl Huntington served in the Army during the Korean War at Ft. Sill, OK from 1948 to 1951. He had a passion for hunting and fishing and most enjoyed wading along the shoreline or sitting in a deer stand, watching deer. John Herbert retired in 1995 and as a geologist for Humble Oil Company married Diana Etchison. He began work for Exxon in 1952 after graduating from the University of Texas. He left Austin to join the Army in 1950 and proudly served in the Korean War earning the rank of 1st Lieutenant. In 1956, he was married to Veta. After his release in May 1945 when his plane came under enemy fire. Rather than parachute to safety the uninjured crew members decided to land the plane in order to try and save the crew members who had been injured in the attack. The plane and crew crashed-landed in enemy territory. Fred was captured and became a POW until his release in May 1945 when the European conflict ended. He was awarded three Bronze Stars and the Air Medal and has a Purple Heart pending. Upon his return to the United States, Fred enrolled at The University of Texas at Austin where he met the love of his life, Margie. In 1948 they were married in a joy and a smile to make those around him feel good and laugh. John and June both loved to travel. Some of their favorite vacations were taking cruises to Europe, Greece, and Alaska. We will all miss him a great deal. John was preceded in death by his parents, Eva Buckman and John Chambers Osmond, Sr. and by his wife, June Marie. He is survived by his sister, Beatrice Millar, his sons, his stepson, his stepdaughters, and his grandchildren: Elise Thomas, Janelle Hattech, Ethan Cardwell, Donald John, Tiffiny Osherall, Harvard, Tiffany Osherall, John, William Osherall, John Osmond. Also surviving are nine great-grandchildren.

Carroll E. Stroman (M.A. ’58) age 86, of Sweetwater, Texas, passed away on September 9, 2016, at Hendrick Medical Center in Abilene, Texas. Carroll was born April 28, 1930, in Hylton, Texas to Roy and Grace (Campbell) Stroman. He had been a resident of Sweetwater for over 50 years. He married the love of his life, Dorothy Farley, on April 3, 1953, in Sweetwater, Texas. He was a longtime member of First Presbyterian Church in Sweetwater where he served as an Elder. Carroll was a U.S. Air Force veteran serving in Japan during the Korean War. After his service, Carroll lived in Austin from 1953 to 1978. In Austin, Carroll and Dorothy raised their four children while Carroll attended the University of Texas and graduated with a B.S. in geology. Carroll continued to be an avid Texas Longhorn fan throughout his life. He then worked for the State of Texas where he helped to bring closure and compassion for people with special needs led him to work with Goodwill Industries in Austin where he became the Executive Director for 11 years. Carroll, Dorothy and children then moved west living in San Angelo, California, then back east, and then Sweetwater, Texas. Throughout this chapter in life, Carroll continued to work on different programs and projects to develop business opportunities in which to teach and employ people with special needs. In 1979, Carroll and Dorothy opened the first independent living care facility in the State of Texas for individuals with special needs in Sweetwater. This program was owned and operated by Carroll and Dorothy from 1979 until 2001. During that time it grew to several different training and employment opportunities for these residents. Later in life Carroll earned a Bachelor of Social Work from Abilene Christian University in Abilene, Texas. He is survived by his wife Dorothy; children Brent Stroman and Cindy of Waco, Texas; Scott Stroman and Julie of Sweetwater, Texas; Pam Stroman and Cecilie of Austin; Kirk Stroman of Sweetwater, Texas; four grandchildren; Stephanie and Nick Depauw of Boston; Kyle Stroman of Austin; Brett Stroman and Tana of Midland, Texas; Aaron Stroman and becky of Lubbock, Texas; and Cory Stroman and Ashley of Sweetwater, Texas; four great grandchildren and one on the way; his brother Jim Stroman and Patricia of San Antonio, Texas; and his nephew’s friends and dear friends Michael and Dustin Hammitt and their family of Sweetwater, Texas. He is preceded in death by his parents, Eva and Grace Stroman ofSweetwater, Texas; five grandchildren; Stephanie and Nick Depauw of Boston; Kyle Stroman of Austin; Brett Stroman and Tana of Midland, Texas; Aaron Stroman and Beck of Lubbock, Texas; and Cory Stroman and Ashley of Sweetwater, Texas; four great grandchildren and one on the way; his brother Jim Stroman and Patricia of San Antonio, Texas; and his nephew’s friends and dear friends Michael and Dustin Hammitt and their family of Sweetwater, Texas. He is preceded in death by his parents, Eva and Grace Stroman of

Hal S. Stubbfield (B.A. ’54) passed away January 14, 2017, in Kingwood, Texas. Hal’s career included working for GSL Occidental Petroleum Co, and retiring

Earl W. Shahan (B.S. ’56) was born on April 11, 1925, and passed away on July 20, 2016, after a long illness. He was born in Wichita, Kansas on April 11, 1910 to Herbert M. and Anne Stanley. He moved to Dallas as an infant. He grew up in Highland Park, attended Holy Trinity School, and graduated from Jesuit High School in 1947. He remained lifelong friends with five Jesuit men, “The Brotherhood.” They were “90’s” years before the current craze. Don, an ATO was graduated from the University of Texas with a degree in geology in 1952. He learned the oil business from the ground up, starting with his father’s driving company. In later years, he was a real estate broker and investor. He married Linda Sargent in 1985. Don suffered a severe stroke in 1998. The last 17 years of his life, he showed us how to gracefully accept physical limitations. He is preceded in death by his parents, his wife Linda, and his sister Ann Stanley. He is survived by his sister Peggy Gormley, and brothers Herb Stanley of Midland and Edward Stanley of Dallas. Also surviving are his stepchildren Lydia Dean and John Sargent, and 14 nieces and nephews.
-from Mosbacher Energy in 1997. Hal was born to Rona and Zella Jo Stubblefield in Electra, Texas. He met the love of his life, Barbara Muir Banks at Church Sunday School in Lake 
Chiliha, Texas, where they were married in 1956. They were blessed with three 
was a member of the USGS Gold Star - GS645. In 1954 to 1964, then in 
exploration with Occidental Petroleum Co in Houston from 1969 to 1980, 
followed by his position as VP of 
Exploration with Mosbacher Energy in Houston from 1980 to 1997 until 
his retirement. Hal is preceded in death by his 
wife, Amy and his brother Joe 
Stubblefield, Hal is survived by wife 
Barbara Banks Stubblefield; daughter, Susan Gail Waggoner and son 
Stuart Hal Stubblefield; grandchildren, Chad Francis, Kathryn Brewer, Conner 
Francis, Martha Bea Francis, Rebecca Francis, Henry Francis, Erica Laible 
and Miranda Laible.

Don E. Wade (M.A. '54) died peacefully on Wednesday, October 19, 2016, at the age of 85. Surrounded by his family and friends, he decided he was unable to live through another 
presidential debate. After a life of grand adventure, filled with laughter and 
shenanigans, this world-class man 
was unable to live through another 
day. He was born on March 6, 1934, in Wichita Falls, Texas, on June 20, 2017 at the age of 83. Tommy was 
born to parents, Jane and T.J. Waggoner, and was a graduate of Wichita Falls High 
School and an Eagle Scout with Troop 1. Tommy was a member of the Kappa 
Sigmata fraternity at both Southern 
Methodist University and then 
The University of Texas at Austin. He graduated from UT with a Bachelor 
of Science in geology. Tommy married the love of his life, Marilyn Wheeler 
Waggoner, on June 23, 1956. Subsequent to his graduation, he served in the 
United States Air Force. Upon discharge he was a geologist with the Bridwell 
Oil Company in Wichita Falls until moving with his family to Dallas in 1969. There he was the founder and chairman of the 
board of Trans-Western Exploration Company. He was a member of the 
Salaman Club of Dallas, Highland 
Park Presbyterian Church, the Dallas 
Country Club and the North Texas 
Oil and Gas Association. Upon his 
retirement in 1994, Tommy and 
Marilyn moved from Dallas to Barton 
Creek Lakeside in Spicewood, Texas, 
and then to 20s. He is survived again 
Bigfork, Montana. In 2015, Tommy 
and Marilyn’s journey came full circle when they moved back to Wichita Falls.

Tommy was grateful to be back in North 
Texas, surrounded by family and 
life-long friends. Tommy and Marilyn 
traveled the world and had many 
advances together in their 60s + years 
of marriage. He was an avid sportsman 
who loved hunting, fishing, summming 
at Possum Kingdom Lake, golf, butter, 
jetblykes, and, of most, all his family. 
He was preceded in death by his 
parents, Jane and T.J. Waggoner. Jr, his 
brother and wife, Richard Moore “Dick” 
Waggoner and Lucia Hartgrove 
Waggoner, and his sister-in-law and her 
husband, Barbara Wheeler Cullum and 
James A. “Old Sport” Cullum as well as 
many wonderful friends. He is survived 
by his wife, Marilyn Wheeler Waggoner, and his children, T.J. “Jeff” Waggoner, IV, his daughter, Jamie Waggoner 
and Amy Jeanette Waggoner, his 
granddaughter, Jamie Wheeler 
Waggoner, as well as his beloved 
cousin. He is also survived by his 
brother John Stephens Waggoner and wife 
Elizabeth “Betsy” Dennam Waggoner as a 
supervisor at Wonder Kay Waggoner Lambert. He also had many 
loving and caring nieces and nephews 
who doted on him and brought much 
joy to his life.

William Edward Watkins (B.A. ’54) 
passed on November 15, 2016, to be with our 
Lord at the age of 85. He was born in Wichita Falls, Texas, on May 29, 1931. 
He achieved a bachelor’s degree in geology 
from The University of Texas at Austin. 
Ed and Cheryl created a love story 
by the love of his wife, Mariah Wade, 
and Miranda Laible.

John B. Wesselman (B.A. ’54) 
died September 6, 2016, to be with our 
family. He was the eldest of seven 
siblings, with three brothers and three 
sisters. Born to parents T.J. and 
Patricia, Bob was raised in 
the Dallas area and known by all as Ed. 
While attending the University of Texas 
at Arlington, he met Clydene Grace. 
They were married on May 29, 1951. He 
country music was an example for them to follow. He enjoyed 
traveling with his family and friends, he 
was a big sports fan and liked to 
watch his longhorns and the Dallas 
Cowboys. Ed and Clydene settled in 
Duncanville and then Cedar Hill both 
just south of the Dallas area. Ed owned 
and operated Acme Rubber Stamp Co in 
Dallas, which has remained within the 
family. Ed and Clydene were married 
for 62 years during this time they 
bought an Airstream and continued to travel. 
Clydene is very thankful for all her 
family and friends throughout the 
Airstream Community. Survivors: 
Clydene Watkins married to Ed 65 years.

Children: Carol and her husband Larry 
Sama, Susan Adams, Bill and his wife 
Vicki Watkins, Diane and her husband 
David Fonzi, and Denise Watkins 
Grandaughter that grandparents 
and Tyler Fonzi, Brandy and her husband 
Jason Pinkham, Bobby and Billy 
Great Grandchildren: Philip and Archer 
Paz, Ashley and Sean Pinkham.

Davida Word (Spouse of the late 
Charles F. Wesselman) was born on September 15, 1918, and 
passed away on March 22, 2017. Davida was a resident of Kerrville, Texas at the time 
of her passing. graduated from Abilene 
High School in 1935 and attended 
Abilene Christian College. She was married to Charles Freeman Word. 

Vestal “Pappy” Yeats (B.S. ’58) 
passed away peacefully in 
his sleep on July 28, 2017. He was a 
vetern and retired 
Navy officer, and a 
professor of geology at 
Texas Tech. Pappy was born in 
Fort Worth in 1919, and later moved to the 
Rio Grande Valley where he grew up. 
He discontinued his studies at 
Texas University to enlist in the 
Navy after Pearl Harbor. After the 
New Orleans between tours of duty in 
the Pacific, he met his future wife, Ouida 
Mae. After the war, they moved 
to Austin where Pappy completed his 
degree in geology and later moved to 
Lubbock to complete his master's 
degree. As a professor of geology, he 
taught the freshmen classes, mineralogy 
and ran the geology labs. During his 
tenure, he participated in three Texas 
Tech expeditions to Antarctica, mapping 
groundwater basins in Shasta and 
Bear Mountain. Yeats Glacier is named for him. 
Ouida passed away in 2003. He is 
survived by his son Austin, daughter-in- 
law Nina, grandson Tyler, and nephew, 
Robert Haynes.

Charles F. Wesselman (B.S. ’53) 

was born on September 15, 1918, and 
passed away on March 22, 2017. Davida was a resident of Kerrville, Texas at the time 
of her passing, graduated from Abilene 
High School in 1935 and attended 
Abilene Christian College. She was married to Charles Freeman Word. 

Vestal “Pappy” Yeats (B.S. ’58) 
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his sleep on July 28, 2017. He was a 
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survived by his son Austin, daughter-in- 
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Robert Haynes.

Researcher

Kirk McIntosh, a talented marine 
ecosystem specialist who specialized 
in mapping and imaging deep-sea trenches, 
continental margins, and mountain 
bells, died unexpectedly in Austin at the
age of 59, after an 18-month battle with leukemia. Kirk, a senior research geophysicist at the USGS, died May 7, 2017, at age 91.

Peter Tyrrell Flawn joined the Institute for Geophysics at the University of Texas at Austin in 1961 as part of the efforts to study the geology and resources of the western United States, a project that was ultimately completed in 1951. Results were published in a Bureau of Economic Geology publication authored jointly by Flawn and Kirk, the first part of the study—Peegmites of the Mica Mine Area, Culberson and Hudspeth Counties, Texas—was the subject of Flawn’s dissertation at Yale, where he received his Ph.D. in geology in 1951. His Precambrian work evolved into an interest in basement rocks, where Flawn began subsurface work, coupled with surface geology work in the Franklin Mountains and Sierra Blanca area. The results of his work are published by the Bureau under the title “Basement Rocks of Texas and Southwestern New Mexico.” He was to chair a major committee of the American Association of Petroleum Geologists compiling data for a basement rock map of the United States. This project was ultimately completed by Bill Muehlinger.

In the latter part of the 1950s Peter pursued an extensive subsurface and surface study of the Ouachita System, a largely concealed belt of deformed Paleozoic rocks that borders the southern edge of the Central Stable Region of North America in the same way that the Appalachian system defines the eastern margin. Results of that effort were published by the Bureau in 1961 as part of the University Series publication. Flawn was senior author with co-authors August Goldstein, Philip King, and C. E. Weaver. And Flawn was to initiate work in northern Mexico with a paper on geology and geophysics of the Sierra del Carmen of Coahuila, Mexico. His love of Mexico and its metal mineral resources was a long-time affair. He became fluent in Spanish in 1964 while a Visiting Professor of Geology at the Instituto de Geología, Universidad Nacional Autónoma de México, where he was appointed vice president for academic affairs and in 1972 rose to Executive vice president at UTB before being appointed the president of The University of Texas at San Antonio (UTSA) for five years. When he arrived at UTSA, there were a few planners and administrators of the state’s University. Five years later, UTSA was a beautiful 600-acre campus, with 300 faculty, 8,800 students, and all infrastructure in place. His university was started in 1975 under Flawn’s watch.

Peter returned to Austin in 1977 for a research leave 19 years in the making, but in short order he was serving as acting director of the University of Texas Marine Science Institute and acting chairman of the Department of Marine Studies. In 1979 he was appointed president of The University of Texas at Austin, a position he would hold until 1985. Early on as president, Peter declared a “war on mediocrity,” which would earn him a piece in Doonesbury. He was later to admit to only one vice—a passionate addiction to Donniesbury, saying that he had quit smoking (Rot-Tan cigars and a pipe) in 1985. Early on as president, Peter declared a “war on mediocrity,” which would earn him a piece in Doonesbury. He was later to admit to only one vice—a passionate addiction to Donniesbury, saying that he had quit smoking (Rot-Tan cigars and a pipe) in 1985. Early on as president, Peter declared a “war on mediocrity,” which would earn him a piece in Doonesbury. 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Committee, the Marine Science Computer Sciences Development Scientific Advisory Council, UT Austin Research, the Texas National Research Regulatory Advisory Committee on and its Center for Nuclear Waste Foundation for Research and Education Board and the National Science Advisory Board, the Governor's Energy organizations as well. He served on 15 corporate boards of directors, some while president of UT, but most afterward. He was long involved in affairs of the university and the state and maintained close contact with Texas and university leaders, who frequently sought his counsel.

He served on 15 corporate boards of directors, some while president of UT, but most afterward. He was sought after by numerous noncorporate organizations as well. He served on the Advisory Board of the National Defense Fund, the Texas Nature Conservancy Advisory Board, the Governor’s Energy Council, the Governor’s Advisory Committee on the Superconducting Super Collider, the National Science Board and the National Science Foundation Advisory Committee, St. David’s Hospital Board, the Southwest Research Institute Board, as well as its Foundation for Research and Education and its Center for Nuclear Waste Regulatory Advisory Committee on Research, the Texas National Research Laboratory Commission, the Texas Scientific Advisory Council, UT Austin Development Board, Department of Computer Sciences Development Committee, the Marine Science Institute Advisory Council, the College of Natural Sciences Advisory Council, the UT Press Advisory Council, the McDonald Observatory and Department of Astronomy Board of Visitors, the Institute of Latin American Studies Mexican Center Advisory Committee, Laguna Gloria Art Museum Board, Yale University Council on Physical Sciences and Engineering, and the Foundations of the American Geosciences Institute and the Geological Society of America.

As if those activities did not fully occupy his time, in 1997, at age 71, Peter Flawn agreed to serve as President ad interim while UT began a search for a new leader. He resigned from the many corporate and nonprofit boards on which he was then serving and accepted a salary of $1. The only condition he made was that it be understood he was not going to mark time as a caretaker, as if anyone would ever imagine otherwise. He launched another capital campaign with the ambitious goal of raising $1 billion. He dealt with the fallout from the Hopwood v. Texas decision banning racial considerations in admissions. His wife called it his “second coming,” but Flawn called it “waiting for Larry.” Flawn recalled that when Larry Faulkner walked into the President’s Office, he was pleased to be able to deliver to him an institution without the burden of unmade decisions. Of Peter Flawn’s wide interests and involvements, he was a geologist at heart, and he kept his dedication to the geological professional societies and to UT geology, in particular. He long served on the Geology Foundation Advisory Council, of which he was an honorary member, as well as the Bureau of Economic Geology Visiting Committee. He worked closely with his good friend Jack Jackson, and after Jack’s bequest was received and the Jackson School of Geosciences formed, Peter chaired the Jackson School Vision Committee, created and formed by President Larry Faulkner. Fundamental recommendations were made to the president and accepted by him. The School owes its existence to Flawn’s direction of that critical committee.

Peter was always involved in the professional geological societies, serving as president of the Association of American State Geologists, the Geological Society of America, the American Geosciences Institute, and the first president of the Austin Geological Society. Appropriately, Peter was honored by his professional peers. He was elected to the National Academy of Engineering and The Academy of Medicine, Engineering and Science of Texas. He received an honorary doctorate from Oberlin and a Presidential Citation from UT. He received the Cross Medal from Yale, the Parker Medal from the American Institute of Professional Geologists, the Lamar Medal from the Association of Texas Colleges and Universities, the Campbell Medal from the American Geosciences Institute, and the Santa Rita Award from The University of Texas System. Flawn received the Condecoración de la Orden del Sol del Perú. He held the Barrow Chair in Mineral Resources and the Regents Chair in Higher Education Leadership at UT.

Perhaps his greatest achievement was convincing the engaging and vivacious Priscilla Pond to marry him in 1946 and be his life’s companion and counselor for 70 years. She was the First Lady of UT, and he would be the first to understand he was not going to mark time. She was his life’s companion and counselor for 70 years. She was the First Lady of UT, and he would be the first to say that without her he would have accomplished but a fraction of what he did. When he lost her a year before his own death, he was never quite the same. Peter lost his youngest daughter, Dr. Laura Flawn, in a tragic car accident in 2001. He is survived by his oldest daughter, Tyrrell Flawn, and a host of grandchildren and great-grandchildren. It will be long before we see the likes of Peter Flawn again.

—William L. Fisher
Professor and Leonidas T. Barrow Centennial Chair in Mineral Resources

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