THE UNIVERSITY OF TEXAS AT AUSTIN • JACKSON SCHOOL OF GEOSCIENCES • 2013 NEWSLETTER

JSGeo Travel Program

Scotland

August 23 - September 3, 2014

Experience varied geology, natural beauty and diverse fossils with JSG geoscientists and UT Alumni.

Scotland is a country rich in geological history. From the discovery of plate tectonics to theories about the formation of rocks, Scottish geologists and non-Scots working in Scotland have played an important role in the development of the science. Join us as our own Scotsman, Dr. Ian Dalziel, leads us on an exciting tour of his home country.

Limited space, so register early!
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Questions? Contact ktucek@jsg.utexas.edu or 512-471-2223.

The *Newsletter*, a tradition since 1950, is published annually for friends and alumni of the Jackson School of Geosciences at The University of Texas at Austin.

EDITOR AND DIRECTOR OF COMMUNICATIONS: J.B. Bird

ASSOCIATE EDITOR: Marc Airhart

CONTRIBUTING WRITERS: Mark Blount, Tim Green, Timothy Oleson, Tim Rowe, Dennis Trombatore, Emily Underwood, Joshua Zaffos

MAGAZINE DESIGN: J.B. Bird

PHOTOGRAPHY: Rose Cahalan, Sasha Haagensen, Joe Jaworski, David Stephens, Stephen Ramirez, Marcy Davis, Marc Airhart

SEND COMMUNICATIONS TO:
Newsletter Editor
The University of Texas at Austin
Jackson School of Geosciences
2225 Speedway, Stop C1160
Austin, TX 78712-1692

PHONE: 512-471-6048
FAX: 512-471-5585
E-MAIL: communications@jsg.utexas.edu
WEB: www.jsg.utexas.edu

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On the cover: While his geoscience colleagues were smelling petroleum outcrops nearby, petroleum engineering student Kyle Yuhao Sun snapped this photo through the floating ice along the coast of Svalbard, Norway. See more images from Statoil's student field trip to the Arctic on pages 42-43.

WELCOME

Members of the Jackson School community on the JSG-GSA expedition to Antarctica and the Scotia Arc in January.

Dear Alumni and Friends,

We've had another great year of research and educational achievements at the Jackson School, which I am excited to share with you in this edition of our *Newsletter*.

One of our goals at the Jackson School is the pursuit of "big science," projects with a major societal impact. Big science was much in evidence this year.

At the urging of Terry Quinn, director of the Institute for Geophysics, a rapid response team from the Institute conducted a marine survey off Long Island in January (p. 46) to assess the crucial system of barrier sediments that protect the coast. The Jackson School funded this post-Sandy, rapid response mission, and we are looking for ways to shore up funding for more of these nimble, rapid response missions in the future.

Under the leadership of Scott Tinker, a team at the Bureau of Economic Geology completed the best assessment to-date of natural gas reserves in the Barnett Shale formation (p. 50), with plans to roll out similar assessments for three other U.S. shale basins this year. The Bureau has been deluged with interest in the assessment, which has significantly boosted global confidence in the longevity of shale gas as an energy resource.

In addition to these major "big science" projects, our scientists contributed advancements to the understanding of small seismic events as they relate to oil and gas exploration (p. 58), they advanced development of "e-rocks" to measure sediment transport (p. 64), and they pulled off a trifecta of major Antarctic studies this summer (p. 3). Contributions to our understanding on Mars (p. 54) and the Deepwater Horizon spill (p. 60) rounded out another fascinating year of high-profile science.

Our faculty, research scientists, and students continue to take home major awards, including a UT Regents Outstanding Teaching Award for Jay Banner (p. 38) and the London Geological Society's coveted William Smith Medal for Martin Jackson (p. 35).

This year marks the retirement of two highly distinguished faculty members, Jim Sprinkle and Paul Stoffa (pages 29-30). We will miss their full-time contributions but look forward to continue working with them as members of the Jackson School community.

We had two noteworthy field trips to the ends of the Earth this year — an Arctic expedition for students and scientists to the Svalberg Islands that was generously funded by Statoil (p. 42) and our alumni trip to Antarctica (p. 94), which I was able to enjoy personally.

Your support makes all of this possible. We are truly blessed to be part of such an outstanding school and extended geoscience community. Thank you.

Sharon Mosher
Dean

RESEARCH HIGHLIGHTS

See this edition's feature articles for additional coverage of research highlights.

UTIG's Antarctic Trifecta

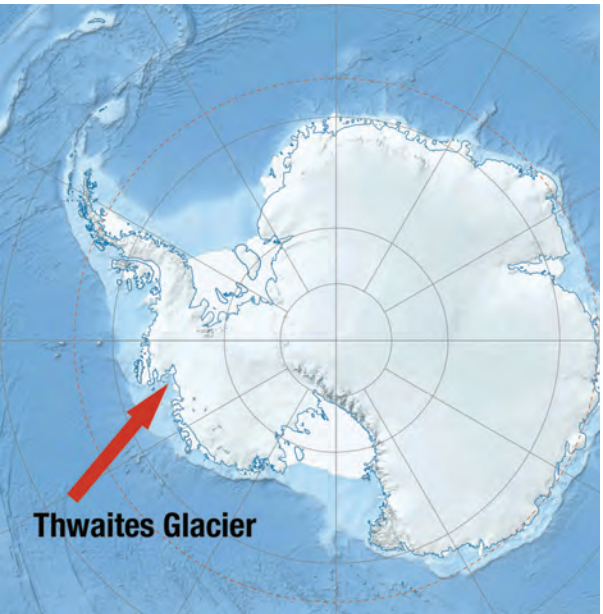
July 2013 was a big month for Antarctic research at the Institute for Geophysics. Three research teams published papers in three different journals—*PNAS*, *Geology* and *Scientific Reports*—with implications for the stability of the West Antarctic Ice Sheet, the origins of the continent's ice sheets millions of years ago, and the permanence of permafrost in the McMurdo Dry Valleys.

Breaking Through the Ice

Dusty Schroeder and Don Blankenship used an innovation in radar analysis to accurately image the vast subglacial water system under West Antarctica's Thwaites Glacier. Using the new technique developed by lead author Schroeder, a doctoral candidate at the Institute, the team revealed a swamp-like canal system several times as large as Florida's Everglades lying under the deep interior of the ice sheet, shifting to a series of mainly stream-like channels downstream as the glacier approaches the ocean.

As a result of this change in slipperiness, the glacier's massive conveyor belt of ice piles up at the zone where the subglacial water system transitions from swamps to streams. This transition forms a stability point along a subglacial ridge that holds the massive glacier on the Antarctic continent.

"This is where ocean and ice sheet are at war, on that sticking point, and eventually one of them is going to win," said co-author Blankenship, a senior research scientist from the Institute.



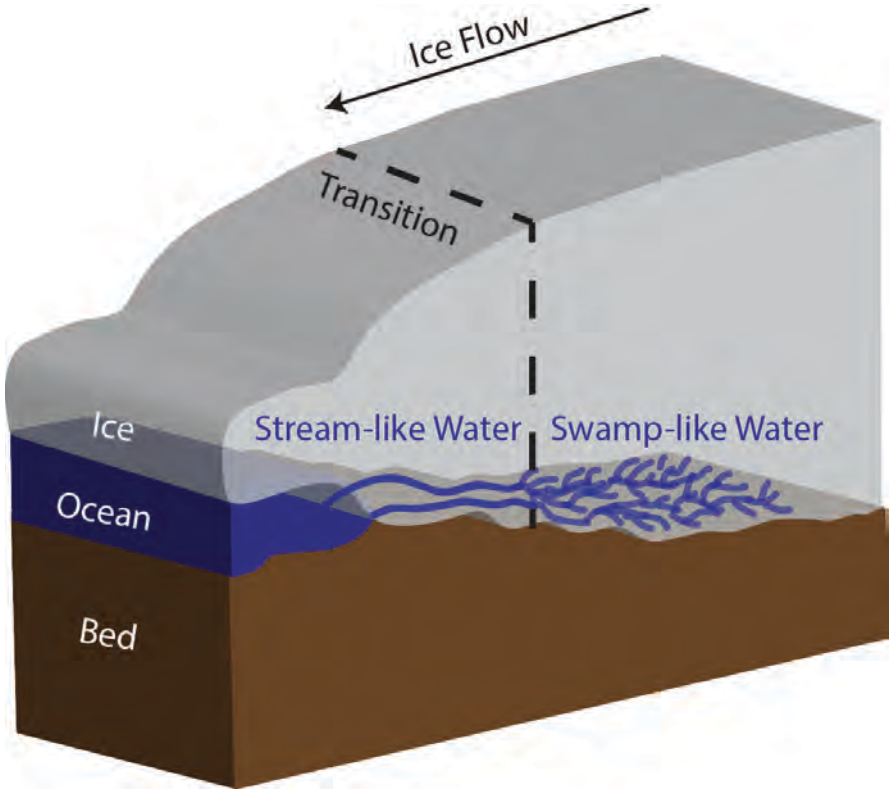


Figure showing transition from swamp-like water to stream-like water beneath Thwaites Glacier, West Antarctica. University of Texas Institute for Geophysics.

Observations of the subglacial stream-and-swamp dynamic and the sub-ice topography suggest that Thwaites Glacier is stable in the short term, holding its current position on the continent. However, the large pile of ice that has built up in the transition zone could rapidly collapse if undermined by the ocean warming or changes to the water system. Current models predicting the fate of the glacier do not yet account for these dynamic, subglacial processes.

Circumpolar Mystery

Ian Dalziel, research professor at the Institute and professor in the Jackson School of Geosciences, and his colleagues found geologic evidence that casts doubt on one of the conventional explanations for how Antarctica's ice sheet began forming.

The Antarctic Circumpolar Current (ACC), an ocean current flowing clockwise around the entire continent, insulates Antarctica from warmer ocean water to the north, helping maintain the ice sheet. For several decades, scientists have surmised that the onset of a complete ACC played a critical role in the initial glaciation of the continent about 34 million years ago.

Now, rock samples from the central Scotia Sea near Antarctica reveal the remnants of a now-submerged volcanic arc that formed sometime before 28 million years ago and might have blocked the formation of the ACC until less than 12 million years ago. Hence, the onset of the ACC may not be related to the initial glaciation of Antarctica.

These rock samples are distinct from normal ocean floor lavas and geochemically identical to the presently active South Sandwich Islands volcanic arc to the east of the Scotia Sea that today forms a barrier to the ACC, diverting it northward.

The research team also includes Larry Lawver and Marcy Davis at the Institute, among others.

The Ross Sea Ice Sheet in Garwood Valley, Antarctica. In recent years, despite stable tempeartures in the region, the deltaic sediment cap covering the ice sheet has absorbed greater amounts of solar radiation causing a significant increase in melt rates. Photo courtesy of Joseph Levy, Institute for Geophysics.

You Call This Permafrost?

Joseph Levy documented for the first time an acceleration in the melt rate of permafrost, or ground ice, in a section of Antarctica where the ice had been considered stable. The melt rates are comparable with the Arctic, where accelerated melting of permafrost has become a regularly recurring phenomenon, and the change could offer a preview of melting permafrost in other parts of a warming Antarctic continent.

Tracking data from Garwood Valley in the McMurdo Dry Valleys region of Antarctica, Levy, a research associate at the Institute, showed that melt rates accelerated consistently from 2001 to 2012, rising to about 10 times the valley's historical average for the present geologic epoch.

In contrast to glaciers and ice sheets, which sit on the ground, ground ice sits in the ground, mixed with frozen soil or buried under layers of sediment. Levy and his co-authors attribute the melting to an increase in radiation from sunlight stemming from changes in weather patterns that have resulted in an increase in the amount of sunlight reaching the ground.

If Antarctica warms as predicted during the coming century, the melting could become that much more dramatic as warmer air temperatures combine with sunlight-driven melting to thaw ground ice even more quickly. Ground ice is not the major component of Antarctica's vast reserves of frozen water, but there are major expanses of ground ice in the Dry Valleys, the Antarctic Peninsula and the continent's ice-free islands.

Garwood Valley could tell the story of what will happen in these "coastal thaw zones," says Levy.

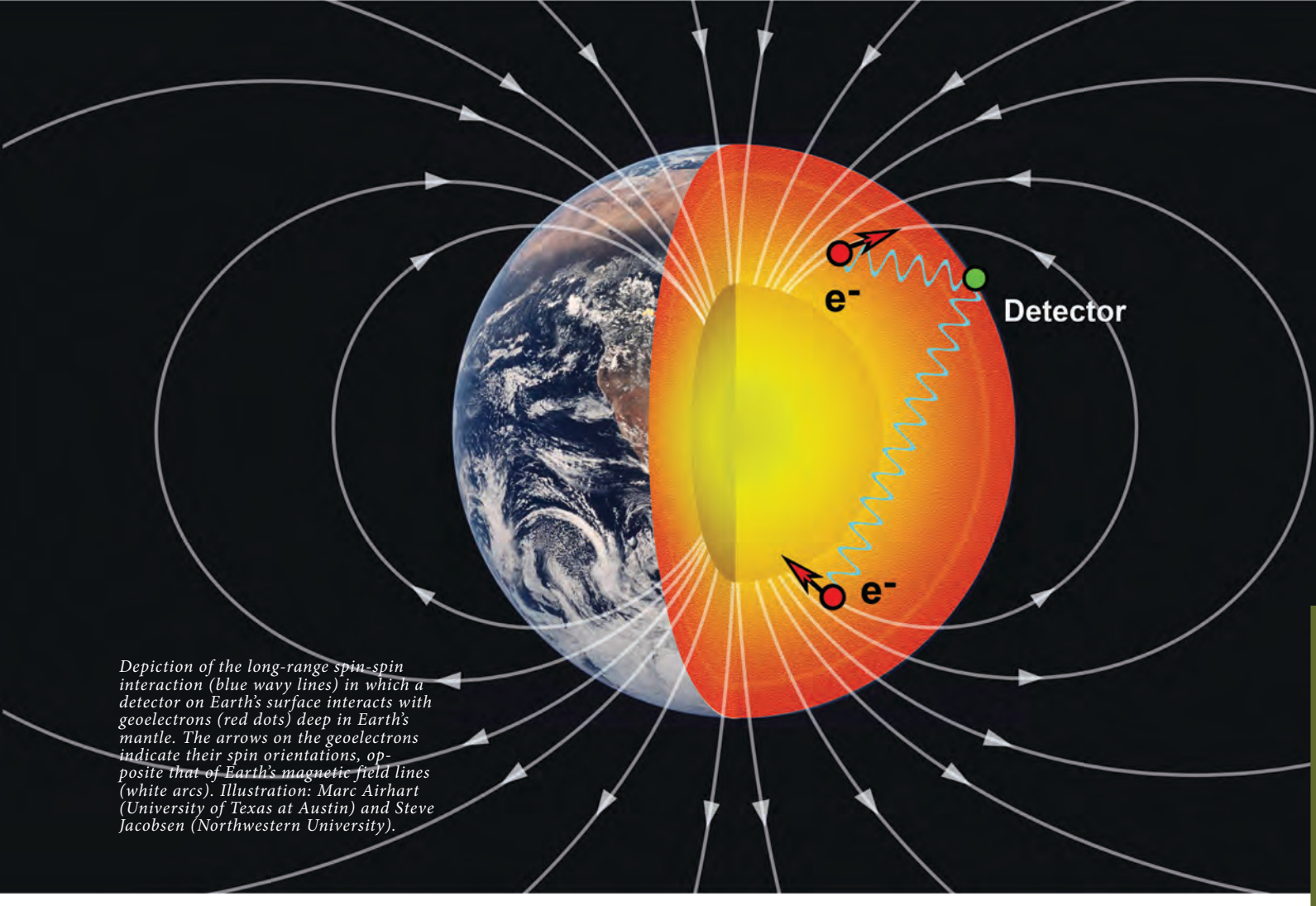
"There's a lot of buried ice in these low-elevation coastal regions, and it is primed to melt."

Small is Beautiful

In summer 2012, a team of scientists from the Bureau of Economic Geology and Institute for Geophysics completed the first of a series of expeditions in the Gulf of Mexico surveying potential offshore storage sites for carbon dioxide (CO_2). In the process, they tested out a new type of seismic instrument designed to reveal geologic layers and structures below the seafloor at shallower depths than those typically surveyed by the oil and gas industry. This additional information is critical, they say, to ensure the CO_2 won't escape back to the seafloor.

The team is currently focusing on a possible geologic storage site in Texas state-owned lands off the southern tip of Galveston Island, about 2 kilometers below the seafloor. Their primary goal is to find sites that can begin to safely and economically store industrial scale volumes of CO_2 in the near term. This project is seen as an important step towards what

Scientists from the Jackson School deploy a paravane that helps pull seismic streamers into the right configuration using an innovative new seismic tool, part of the first study in the U.S. to investigate the potential for underground storage of CO_2 in offshore formations.



Depiction of the long-range spin-spin interaction (blue wavy lines) in which a detector on Earth's surface interacts with geoelectrons (red dots) deep in Earth's mantle. The arrows on the geoelectrons indicate their spin orientations, opposite that of Earth's magnetic field lines (white arcs). Illustration: Marc Airhart (University of Texas at Austin) and Steve Jacobsen (Northwestern University).

might be the first offshore carbon storage demonstration project in the U.S.

To peer deep below the seafloor, oil and gas explorers troll the oceans aboard ships towing streamers several kilometers long to pick up the echoes of air guns off geologic features below. The Norwegian-designed P-cable marine seismic acquisition system features much shorter streamers (just 25 meters long), in a tighter formation. The result is high resolution 3D seismic imagery in a region extending from the seafloor down to about 1500 meters, shallow by industry standards. By stacking the new shallow data on top of existing industry data from deeper intervals, they plan to reconstruct a history of fluid migration in the region.

"Oil and gas have migrated through these sediments for millions of years," says Tip Meckel, research scientist at the Bureau and principal investigator for the project. "If we can tell the story of what happened to those buoyant fluids historically, we think we will be able to tell the story of what will happen to the injected CO_2."

This study, the first in the U.S. to investigate the potential for permanent underground storage of CO2 in offshore geologic formations, is made possible by a $10 million grant from the U.S. Department of Energy's National Emissions Technology Lab and the Texas General Land Office.

Probing Deep

Researchers from Amherst College and The University of Texas at Austin have described a new technique that might one day reveal in higher detail than ever before the composition and characteristics of the deep Earth.

There's just one catch: The technique relies on a fifth force of nature (in addition to gravity, the weak and strong nuclear forces and electromagnetism) that has not yet been detected, but which some particle physicists think might exist. Physicists call this type of force a long-range spin-spin interaction. If it does exist, this exotic new force would connect matter at Earth's surface with matter hundreds or even thousands of kilometers below, deep in Earth's mantle. In other words, the building blocks of atoms—electrons, protons, and neutrons—separated over vast distances would "feel" each other's presence. The way these particles interact could provide new information about the composition and characteristics of the mantle, which is poorly understood because of its inaccessibility.

"The most rewarding and surprising thing about this project was realizing that particle physics could actually be used to study the deep Earth," says Jung-Fu "Afu" Lin, associate professor in the Jackson School of Geosciences and co-author of the study appearing in the journal *Science*.

This new force could help settle a scientific quandary. When earth scientists have tried to model how factors such as iron concentration and physical and chemical properties of matter vary with depth — for example, using the way earthquake rumbles travel through the Earth or through laboratory experiments designed to mimic the

intense temperatures and pressures of the deep Earth — they get different answers. The fifth force, assuming it exists, might help reconcile these conflicting lines of evidence.

The Secret Lives of Fish

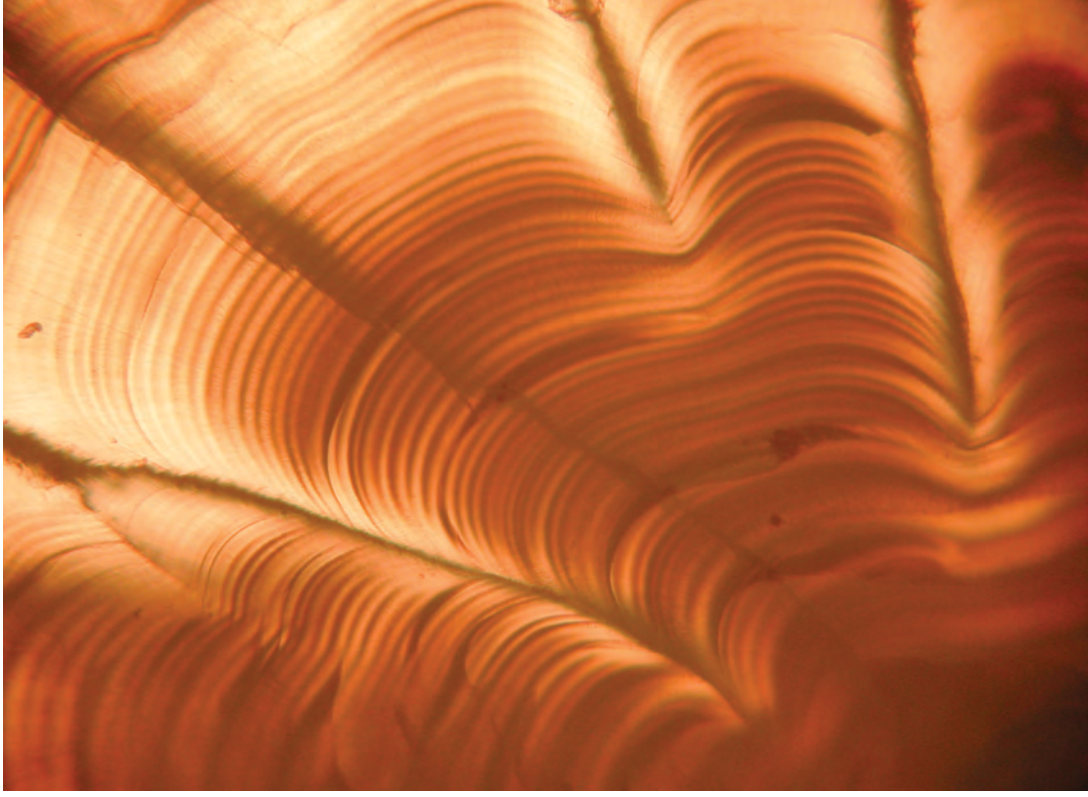
There's a problem for scientists trying to understand why populations of southern flounder have been in such decline in the waters of the Texas Gulf.

"They live underwater," says Benjamin Walther, assistant professor of marine science in the College of Natural Sciences. "We can't just follow them from birth to death. You can tag a fish with acoustic or satellite tags when it's an adult, but typically the young are too small and fragile. So you're missing that whole big piece of the story. And without that there are a lot of very important ecological questions we can't answer."

That's where the Jackson School's geochemical facilities come in.

All vertebrate animals have calcium carbonate crystals in their inner ears that help in balance and orientation. In fish, the crystals form solid rock-like otoliths, or earstones, that continue to grow throughout the fish's lifetime. They do so in layers, like tree rings, and therefore provide time-separated information. And certain elements and isotopes are incorporated into those layers that reflect the composition of the water the fish was living in.

"The otolith is like a flight data recorder," says Walther. "It's continually recording information from the environment, and we can use that to learn where a fish has been."



The Southern flounder's otolith, or earstone (shown in cross section), is helping geochemists decode the animal's migratory history.

Walther has been able to make use, in particular, of the equipment operated by Nate Miller, Laser Ablation and ICP Mass Spectrometry (ICP-MS) Lab manager and lecturer in the Jackson School, to do his analysis.

"They have all of the instrumentation and lasers to allow us to probe these structures at a fine scale," he says. "They've been great to work with."

With the help of Miller, Walther has learned that southern flounder don't just follow one migratory pattern as ecologists once thought. This new understanding has important implications for managing the habitats the fish rely on.

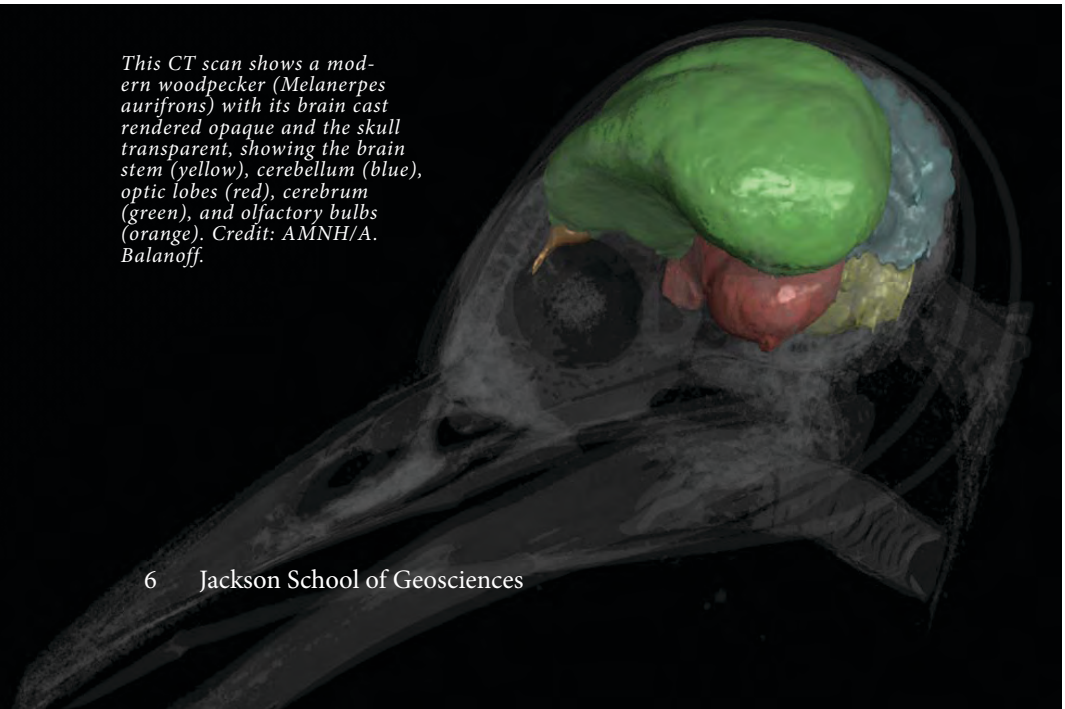
Brains Before Take Off

A team of researchers led by Amy Balanoff (B.S. '00, M.S. '03) concluded that some non-flying dinosaurs evolved the large brains necessary for flight long before dinosaurs actually began flying.

Using scanners at UT Austin's High-Resolution X-ray Computed Tomography Facility (UTCT) and elsewhere, the researchers created digital reconstructions of the brains of modern birds, the early bird *Archaeopteryx*, and closely related non-avian dinosaurs. Surprisingly, some of the non-avian dinosaurs had enlarged brains like *Archaeopteryx* and modern birds. The research was published in the journal Nature in July 2013.

"*Archaeopteryx* has always been set up as a uniquely transitional species between feathered dinosaurs and modern birds, a halfway point," said lead author Balanoff, a research associate at the American Museum of Natural History (AMNH) and a postdoctoral researcher at Stony Brook University. "But by studying the cranial volume of closely related dinosaurs, we learned that *Archaeopteryx* might not have been so special."

Study co-authors include Tim Rowe, co-director of the UTCT, Gabe Bever, assistant professor of anatomy at the New York Institute of Technology, and Mark



This CT scan shows a modern woodpecker (Melanerpes aurifrons) with its brain cast rendered opaque and the skull transparent, showing the brain stem (yellow), cerebellum (blue), optic lobes (red), cerebrum (green), and olfactory bulbs (orange). Credit: AMNH/A. Balanoff.

The Reservoir Characterization Research Lab, one of the first two industrial associate programs at the Bureau of Economic Geology, celebrated its 25th anniversary at the October 2012 annual review meeting in Austin, TX and Carlsbad, NM. Over 100 people from 28 companies attended. A remote controlled hexicopter took this aerial photo of the sponsors, researchers and students at a special dinner in Austin.

Norell, chair of the division of paleontology at AMNH.

Compared to living reptiles, birds have relatively large brains relative to their body size, which provides better vision and coordination for flying. This latest study adds to a growing list of features once considered unique to modern birds, such as feathers and wishbones, that now seem to have first appeared in non-avian dinosaurs.

Longhorns in Space

Scientists at the Institute for Geophysics helped develop a blueprint for a possible future NASA lander mission to Europa, an icy moon of Jupiter that has a global ocean covered by an ice shell. With its large reservoir of liquid water, many experts believe Europa to be the most likely place in our solar system besides Earth to host life today. The proposed mission is designed to assess the moon's habitability by studying its surface composition, ice shell, ocean and geology.

Don Blankenship, senior research scientist at the institute, is part of the science definition team commissioned by NASA to draft the report, which appeared in the August 2013 issue of Astrobiology. Blankenship and two colleagues — Krista Soderlund, postdoctoral fellow at the institute; and Britney Schmidt, formerly a postdoctoral fellow at the institute, now assistant professor at the Georgia Institute of Technology — developed a part of the mission scenario that would use sound waves to study the moon's icy shell, deep ocean and possible shallow lakes.

The Texas team has long been at the forefront of developing the capacity to explore Europa. Blankenship is part of a team developing NASA's Europa Clipper mission concept, which would conduct remote reconnaissance of the moon and help identify possible landing sites for a subsequent Europa lander mission such as the one outlined in this latest study. Blankenship and Schmidt are building an autonomous underwater robot with engineers at Austin-based Stone Aerospace as a prototype for a cryobot that could one day explore Europa's ocean or lakes. They plan to test it under an ice shelf in Antarctica in 2015.

The Texas team has also used existing data to expand our understanding of the Jovian moon. Using imagery from the Galileo mission, Schmidt and Blankenship found evidence for large lakes of water embedded near the surface of Europa's ice shell, which might provide a habitat for life. The discovery re-energized scientists searching for life on Europa.

Europa

Bureau of Economic Geology Publishes Interactive Map of Texas Mineral Resources

In the wake of the state's oil and gas resurgence, could another boom be just around the corner, this time in mineral resources?

Dr. Brent Elliott, economic geologist and lead scientist for the Bureau of Economic Geology's Texas Mineral Resources group, certainly thinks so. "There are lots of mineral prospects out there," he says. "Mineral deposits in the state need more attention. Similar productive ore deposits across the border in Mexico and New Mexico could potentially exist here in Texas. We're working on the means to narrow down the possibilities of where those valuable mineral deposits could be."


Brent Elliot

To that end, Elliott worked with the Bureau's Aaron Averett to create an interactive map of Texas' mineral resources.

"So much has changed in science in the last 25 years," Elliott adds. "We have a lot more detail now, and we can answer questions that we couldn't answer then. Many of these ore deposits and old mineshafts haven't been fully explored or researched."

The Bureau is uniquely positioned to conduct that kind of minerals research and exploration. One method involves using the Bureau's aerial lidar (light detection and ranging) surveying equipment to fly over rough terrain and identify faults and other possible mineral trapping features in the geology. Individual features are then overflown with the BEG's chiroptera, a device that uses hyperspectral imaging to detect the individual reflective signature of specific minerals. In this way, mineral resources can be pinpointed and identified for further assessment and possible mining opportunities.

"Our mapping and research ability can really cut costs for the mining industry, and make exploration a lot more efficient" Elliott asserts.

The Bureau's chiroptera research is partially funded by the State of Texas Advanced Oil and Gas Recovery (STARR) Project. Another program funded by STARR hopes to add to U.S. national security through exploration for rare earth elements, which are vital to the electronics and defense industries. – *Mark Blount*

Special Volume Honors Late Wann Langston, Jr.

Colleagues and former students of Wann Langston Jr., an internationally renowned vertebrate paleontologist at UT Austin who died in April 2013, have produced a special volume honoring his work collecting, preparing and describing ancient reptiles. The collection, which includes current research and a biography of Langston, appeared online in September and will be published this fall in a print edition of the journal *Earth and Environmental Science Transactions of the Royal Society of Edinburgh*.

Ernest Lundelius, professor emeritus in paleontology at UT Austin, conceived of the volume to honor his friend and colleague. Bill Parker, vertebrate paleontologist at Petrified Forest National Park, recruited authors, located a publisher, and served as one of several guest editors.

"Unfortunately, Wann passed away before the volume was published but last December progress was far enough along that we were able to put together a booklet with all of the paper titles and abstracts," says Parker. When presented with the booklet, Langston was reportedly overjoyed. "He also took the opportunity to make editing suggestions and sent the edited version back to us," says Parker. "This is the spirit of the man we are trying to honor, whose career spanned decades and influenced several generations of vertebrate paleontologists."

Papers in the volume focus exclusively on vertebrate paleontology, especially from the Mesozoic Era, where Langston's work was concentrated. Some of the papers were presented in a special symposium honoring Langston at the South-Central Section meeting of the Geological Society of America held in Austin, Texas in April 2013.

The special volume is titled "The Full Profession: A Celebration of the Life and Career of Wann Langston, Jr., Quintessential Vertebrate Paleontologist."

Professor Emeritus Wann Langston takes Newt Gingrich, former speaker of the U.S. House of Representatives, on a tour of the Vertebrate Paleontology Lab. By all accounts Gingrich, an impassioned amateur paleontologist, felt like he was in the presence of a

Marcia McNutt

SPEAKERS & LECTURERS

Tips from a Pro: Communicating Science

At a time when a third of young Americans can't find the Pacific Ocean on a map and even Harvard graduates struggle to explain the origin of the seasons, U.S. science literacy appears to be in a depressing state.

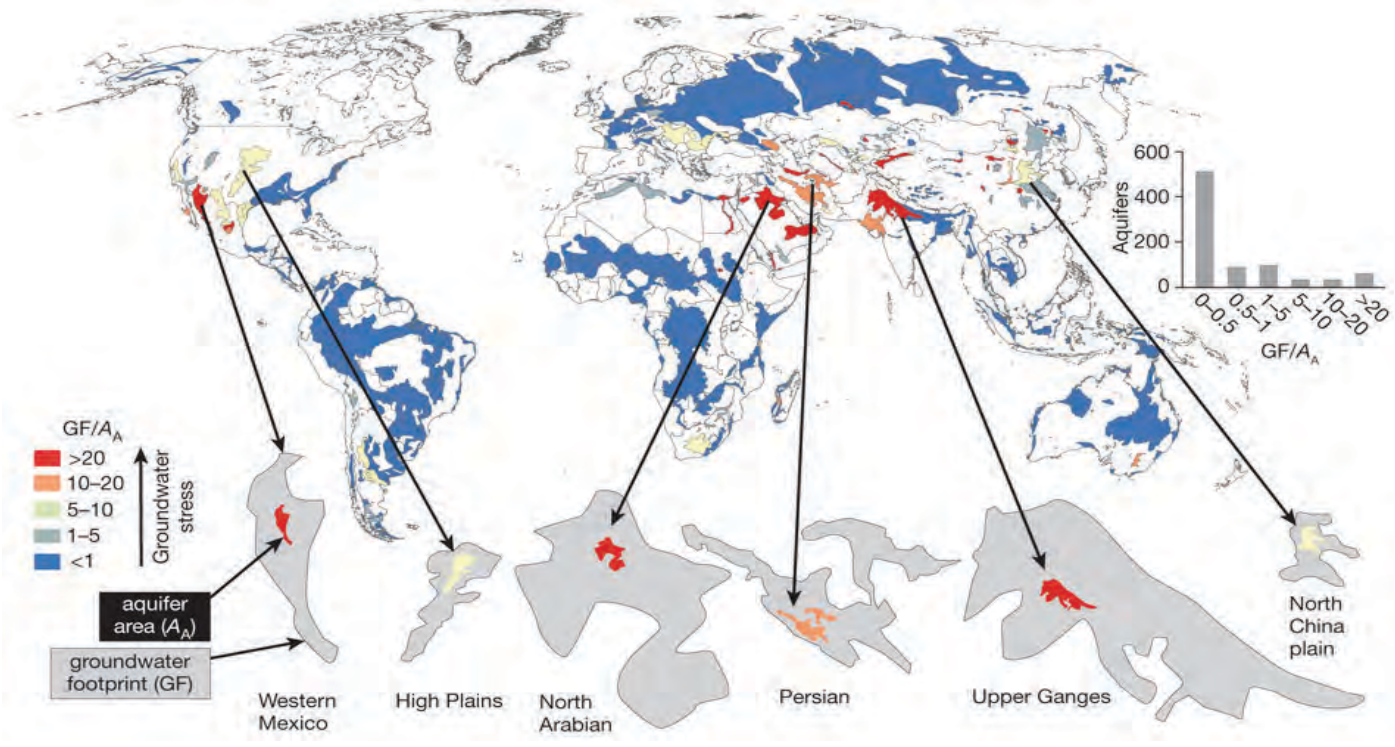
Scientists might find it easy to blame the situation on government cutbacks or poor educational standards, but "the fact is, scientists need to do all they can to help," said Marcia McNutt, the former director of USGS and newly installed editor-in-chief at *Science* magazine,

McNutt addressed the Jackson School community in the first annual UTIG Eminent Scholar Lecture. Focusing on how to communicate science, she offered 10 tips that alternately cajoled and inspired her audience.

In tip number two, "Be authoritative and informed but not arrogant," McNutt held up the well-known character of Sheldon from the television series The Big Bang Theory as an excellent example of how not to communicate.

"As in any profession, scientists are most helpful when they know their stuff, but we can be insufferable when we think that makes us better than everybody else," said McNutt.

Tips number three and four, "Stick



Tom Gleeson, in his Oliver Distinguished Lecture, showed how groundwater footprints (GF) of aquifers significant to global agriculture are significantly larger than their geographic areas. At the bottom of the figure, the areas of the six aquifers (Western Mexico, High Plains, North Arabian, Persian, Upper Ganges and North China plain) are shown at the same scale as the global map; the surrounding grey areas indicate the groundwater footprint proportionally at the same scale. The ratio of GF to aquifer area (AA) indicates widespread stress of groundwater resources. Credit: T. Gleeson.

to the facts" and "Be fair," offered sound advice for navigating the shoals of talking about controversial issues, such as hydraulic fracturing and climate change. Reminding her listeners to check their biases and prejudices at the door, McNutt advised them to steer clear of offering personal opinions and prescriptions while presenting scientific facts.

Thanks to their reputation for being unbiased, scientists always rank in the top ten most admired professions: "Lobbyists are never in the running."

To bolster their credibility still further, scientists should, when discussing controversial issues, go the extra mile and fairly restate the most credible alternative explanations, while explaining why those may not be their preferred interpretations, based on scientific evidence.

Several of McNutt's tips challenged colleagues to be more proactive in their public outreach, but she assured them the rewards were worth the effort.

Scientists, she said, might resist developing the kind of brief "elevator speeches" that entrepreneurs use to pitch their ideas. And yet a brief compelling argument is often the best way to make people care enough to invest public funds in your research, a fact she learned well in her time at USGS.

Likewise, scientists may resist taking calls from the media, especially on basic subjects that they can explain but that might not be their exact area of specialization. This can be a major mistake, advised McNutt, who said scientists ought to relish the chance to "be responsive" to the often last-minute requests of both the media and government offices. Lawmakers and reporters often need expert guidance on basic questions, and while the science may not seem exciting, these are often the moments when the public most clearly sees the value of science.

When the calls come, McNutt reminded colleagues to avoid jargon, treat everyone with respect, and not to fall into the trap of allowing "incomplete understanding to be an excuse for inaction." In their research, scientists pursue certainty, but certainty is almost always a luxury for public policy decisions. When advising the public on science issues, McNutt suggested her colleagues follow the approach used in medicine, where decisions are made every day on the best available information, with the goal of doing no harm.

In a twist at the end of her speech, McNutt asked her colleagues not to propagate the perception that "science is hard." Based on the odds of landing a job, she pointed out, it's much harder to go from college athletics to the pros. Less than two pecent of men's NCAA athletes land jobs in their fields, but almost 95 percent of the graduates of the Colorado School of Mines or Jackson School of Geosciences can find work in science and engineering, making these far easier ways to earn a living.

Groundwater Depletion and Cocktail Parties

Groundwater depletion is a massive problem worldwide, but aside from hydrogeologists and farmers, how many people are aware of it?

This year's Oliver Distinguished Lecturer, Tom Gleeson of McGill University, wants to make sure both the problem and its potential solutions are well understood—so well understood, they can even be explained at a cocktail party.

Jay Famiglietti

"If nothing else, I would like for you to come away from this lecture with at least two or three interesting facts about groundwater that you could use in a conversation at a cocktail party," he quipped. To make it easier, several of his slides had a little picture of a cocktail glass next to an interesting fact or figure. For example, did you know it takes 140 liters of water to grow a cup of coffee? Or that 99 percent of the fresh, unfrozen water on the planet is groundwater?

Gleeson's cocktail party facts underscore a looming crisis. According to Gleeson, about 1.7 billion people rely on groundwater resources that are being used faster than they are being recharged.

In a *Nature* journal article last year, Gleeson and his co-authors coined the term "groundwater footprint" to refer to the area required to sustain groundwater use and groundwater-dependent ecosystem services of a region of interest. In the case of an aquifer, it's how large the aquifer would have to be to sustainably support the actual human use and ecosystem services that rely on it. They found that 20 percent of the world's major aquifers are smaller than their groundwater footprints, including the High Plains Aquifer (U.S.), the Western Mexico Aquifer, the Upper Ganges Aquifer (India and Pakistan), and the North Arabian Aquifer (Saudi Arabia).

Gleeson offered four possible solutions for groundwater depletion:

1. Think multi-generationally, but act on a political time scale. Gleeson said we should have a long-range plan to ensure water availability, but be aware that decision makers don't like to think ahead more than a few years. So set a goal for the water table height you'd like to have a century from now and then use a simple hydrologic model to "backcast" and figure out what actions you would need to take over the next 5 to 10 years to get on the right path toward that goal.

2. Let the locals take charge. Gleeson said water management should be integrated, adaptive, inclusive and local. He described a group of farmers in a drought prone region of India who formed a committee to monitor rainfall, water table height and water pumping rates and who then set pumping limits on themselves accordingly.

3. Value groundwater differently. "Some commodities are too precious to be valued merely economically," said Gleeson. For example, he noted that groundwater provides an important buffer against climate change-induced drought, something that's hard to put a dollar amount on.

4. Decrease net groundwater use. Use it more efficiently, set limits on pumping, harvest rainwater, and artificially recharge aquifers during times of excess surface water.

"The take home message is that groundwater is a large, valuable reservoir of clean water and we're depleting it," he said. "But there are real solutions and tools to stop or reduce depletion."

Select Speakers, 2012-2013

Edwin Kite, Caltech • "Sedimentary Record of Ancient Climates on Mars"

Michael Manga, Univ. of California • "Earthquakes and water (and why the Lusi mud eruption in Indonesia was not caused by an earthquake)"

Paul Goodfellow, Shell; Kate Galbraith, Texas Tribune; Tad Patzek, UT Austin • Rational Middle Energy Project

Gavin Schmidt, NASA • "Can We Make Paleo-Climate More Useful for Future Projections?"

Jay Famiglietti, UC Irvine • "Geodetic Remote Sensing and Potential Applications to Water Management: Examples from California"

David Pyles, Colorado School of Mines • "Hydrodynamic Fractionation of Minerals in Submarine Fans: Results from physical experiments and the stratigraphic record"

Jim Markello, ExxonMobil • "A New Depositional Model and New Sequence Stratigraphic Architecture for the Lisburne Wahoo Reservoir (Early Pennsylvanian) North Slope Alaska, USA"

Michael Mann, Penn State • "The Hockey Stick and the Climate Wars: Dispatches from the Front Lines"

Art Saller, Cobalt Energy, AAPG Distinguished Lecturer 2013 • "Diagenetic Evolution of Porosity in Carbonates during Burial"

Erik Sperling, Harvard • "Oxygen, ecology, and the Cambrian radiation of animals"

John Dewey, Natural History Museum, London • "Transtension in the Eastern California Shear Zone"

Jeffrey May, EOG Resources, AAPG Distinguished Lecturer 2013 • "Mudrock Reservoirs – Why Depositional Fabric & Sequence Stratigraphic Framework Matter"

Douglas Foster, ConocoPhillips • "Amplitude Interpretation of Seismic Reflections"


Gavin Schmidt

Jackson School Hosts Run of Society Meetings

The Jackson School helped host four sectional and national society meetings in Austin over 2012-2013 — the American Meteorological Society, the Association of American State Geologists, the South Central sectional meeting for the Geological Society of America (GSA), and the Gulf Coast Association of Geological Societies.

Associate Professor Liz Catlos, who chaired the GSA sectional, shared some thoughts on the value of the experience.

What was most gratifying about organizing the event at UT?

I received many emails from researchers and students throughout the U.S. South Central region who felt the meeting was useful, well-run, and beneficial for their education. We tried to make the program appeal to a large range of geoscientists. The aim was to provide a forum for those in the region to disseminate their results and meet those in the section who are doing similar research.

Was the event a good showcase for the Jackson School?

Absolutely. Many students in the Jackson School and elsewhere participated and volunteered and had a chance to relay information about their projects. The Jackson School had an opportunity to showcase the depth and breadth of the research that is being conducted here and our students had a chance to shine in terms of presenting their results. In addition, we organized many sessions for educators, which highlights the outreach efforts that School makes.

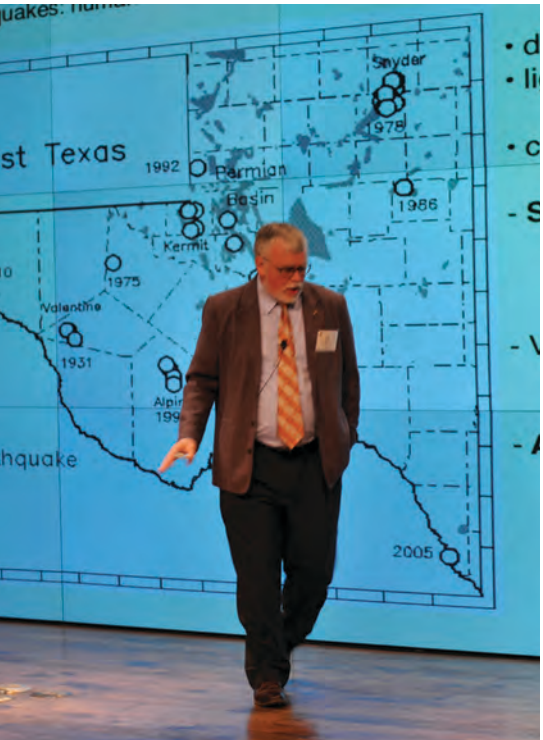
Would you single out any field trips as especially successful?

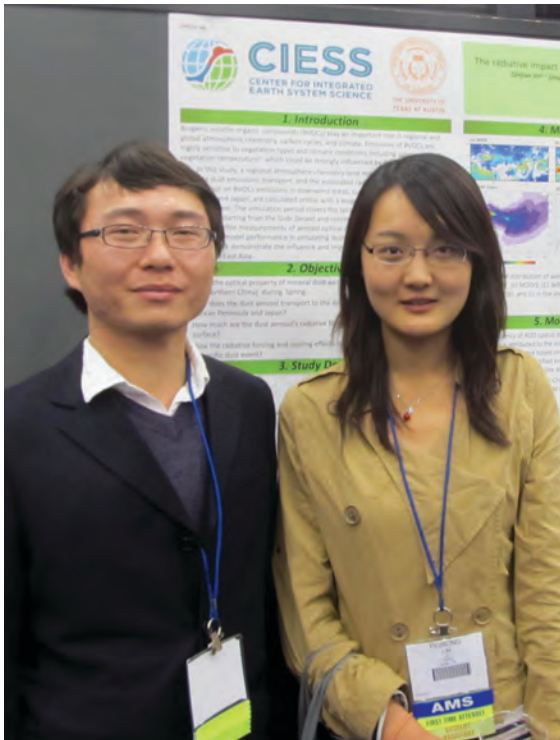
I cannot choose a single event. We had a number of keynote speakers (Cliff Frohlich, John Dewey, and Derek Briggs) who were excellent and provided talks that appealed to a broad audience. Of course the reason to go to section meetings is to attend field trips, and we had a number organized—to explore for fossils in Friesenhahn Cave and sites in north Texas, to see the geology and geomorphology of Enchanted Rock, a visit for teachers to the Llano Uplift, and numerous trips to explore the geology and hydrology around Austin. Brian Hunt and I edited a field guide that is available through the GSA Bookstore. We had a number of theme sessions dedicated to geologists who made significant contributions, including Leon Long in Geoscience Education, Wann Langston in Paleontology, and William. Muelhlberger in Tectonics.

Who helped out?

We had many outstanding volunteers from the Jackson School, including faculty, staff, and students. The school was a major sponsor of the event, along with the Austin Geological Society, the Barton Springs Edwards Aquifer Conservation District, Subaru, the Oklahoma Geological Survey, and Edwards Aquifer Authority. We were very grateful for all their support. ✶

Top to bottom, L to R: Adjunct Faculty member and Jackson School Ph.D. 2009 Marcus Gary leads a field trip near Jacob's Well in Wimberley for Hydro Days, a companion event to the GSA Sectional; Cliff Frohlich delivers the GSA keynote kecture on Texas earthquakes; Dean Sharon Mosher introduces Frohlich; Peirong Lin (left) was one of scores of JSG graduate students who took part in the AMS meeting in Austin.





Student-Led JSG Research Symposium

In February, the Graduate Student Executive Committee and ConocoPhillips hosted the second installment of a new tradition, the annual Jackson School Research Symposium. The goal is to stage an AGU-style poster competition with students presenting their research. Faculty and research scientists serve as judges. This year's contest was an even larger success than the first, creating a great training ground for the professional presentation of science.

Best Posters for 2013

Undergraduate: 1st Place: Aaron Hantsche, 'Rare Earth Element Analysis of Anhydrite Veins and Source Magmas from the Ertsberg Mining District, Papua, Indonesia.' 2nd Place: Marissa Vara, 'Investigating ENSO Variability in the mid-Holocene using a Fossil Coral from the South Pacific.'

Early-Career Graduate: 1st Place: Lauren Becker, 'Analysis of fracture-related seismic attenuation and scattering: insights gained through numerical modeling.' 2nd Place: Jake Jordan, 'Shock and Rarefaction Waves in a Heterogeneous Partial Melt.'

Late-Career M.S.: 1st Place: Jessica Kopp, 'The Effects of Varying Tectonic Subsidence in a Fluvio-Deltaic System.' 2nd Place: Kerstan Wallace, 'Use of 3-Dimensional Dynamic Modeling of CO_2 Injection for Comparison to Regional Static Capacity Assessments of Miocene Sandstone Reservoirs in the Texas State Waters, Gulf of Mexico.'

Late-Career Ph.D. : 1st Place: Dusty Schroeder, 'Configuration of Subglacial Water and Sediments Beneath Thwaites Glacier, West Antarctica: Context for a Potential Melt-Water-Intensive Grounding-Line-Retreat.' 2nd Place: Paul Betka, 'The formation of a retroarc fold-thrust belt by the closure and inversion of a back-arc basin; Patagonian-Fuegian fold-thrust belt, Chile.'

Best Represented Group

1st Place: Marc Hesse. 2nd Place: Danny Stockli. ✷

Alison Mote in an immersion suit, a "mix between an astronaut suit and a Gumby costume" that, in the event of a disaster, keeps you dry, warm, and afloat.

OUTREACH

Teaching Graduate Shares Excitement of Discovery

Alison Mote (MS '04), a science teacher at the Ann Richards School for Young Women Leaders in Austin, Texas, was one of two education officers on an international scientific expedition to the Gulf of Alaska this past summer. She spent 60 days on board the JOIDES Resolution, a floating laboratory and drill rig operated by the International Ocean Drilling Program (IODP), sharing the excitement of field research with students, teachers and the general public.

Co-led by Sean Gulick, research associate professor at the Institute for Geophysics, IODP Expedition 341 was designed to collect sediments in the Gulf of Alaska and investigate the interactions between long-term global climate change and the simultaneous growth of mountain belts.

Mote and another education officer from New Zealand held live video broadcasts once or twice a day from the ship to classrooms and summer camps in the U.S. and New Zealand. They also broadcast to the general public in places such as the Carnegie Museum of Natural History, the Smithsonian Museum and a visitor's center in Anchorage, Alaska. With a tablet computer, they took viewers on a walking tour of the ship's labs and drilling operations and visited with scientists at work collecting and analyzing core samples. The scientists even fielded questions from the viewers.

"I think it's really valuable for students because they're seeing science happen live and they're talking with scientists from different backgrounds from all over the world," says Mote. "It lifts what they're learning in camp or class and shows them how it applies to the real world, how scientists are finding cool and interesting results."

She said the students also found it fascinating that the ship is a floating, state-of-the-art lab with the ability to do full chemical analyses, akin to a space station. She says most of the students who participated had never thought of a career in the geosciences. More than one later told their teachers they were interested in becoming geologists.

Mote also blogged about the scientists and their work on the IODP website, including photos and video interviews with scientists.

Before the trip she assigned her five eighth-grade engineering classes to research the scientists and the ship. Then from the ship she videoconferenced with them on their next to last day of school.

"They were amazing," she says. "They got to talk to the scientists they had researched and were really familiar with what was going on."

She's presented ocean drilling activities to her students before, but she says the total immersion of being on the ship has given her new ideas for teaching it more effectively in the future.

She says she'd also like to incorporate into her classroom videoconferences with experts or even with students in other countries.

"It's so easy," she says, "I don't know why I haven't done it before."

Bureau Industry Day Highlights Energy, Environmental Research

On March 22, Industry Day 2013 showcased the Bureau's researchers, students, and facilities at the Austin Core Research Center (CRC). More than 100 invited guests, including industry and government

Alison Mote (left) videos co-chief scientist Sean Gulick for a live broadcast from on board the JOIDES Resolution.

leaders and decision makers, toured the facilities, saw poster presentations covering the breadth of Bureau research, and met with student researchers. Bureau Director Scott Tinker delivered the luncheon keynote address highlighting the uniqueness of the Bureau, and visitors heard talks by Bill Mullican (water resource management) and Gregg Robertson (pictured at right, exploration of the Eagle Ford Shale Formation). Associate Director Michael Young, J.-P. Nicot, and Bridget Scanlon hosted a discussion exploring the potential for a new and timely Water-Energy Consortium. This year's theme was "The Confluence of Energy and Environmental Research," and participants were able to glean information from all of the Bureau's industrial consortia and key programs. Initial feedback suggests that the Bureau's guests at Industry Day will be pursuing a number of exciting new partnerships to better engage with our programs and research.

Gregg Robertson, second from left, examines cuttings from a 1952 well that led to his exploration of the Eagle Ford play, with James Donnelly (far left), Scott Tinker and Eric Potter.

NSF Funds Summer Teacher Training on Climate Science

For the second year in a row, the Jackson School hosted teachers on campus this summer for the National Science Foundation (NSF) EarthLabs Climate project. EarthLabs Climate includes curriculum development, teacher professional development, and research on student learning, all directed at high school teachers and students. The overarching goal is to encourage high school students to develop systems-thinking and scientific knowledge as the basis for climate literacy.

EarthLab modules address weather and climate not simply as atmospheric processes, but in the context of the interconnected Earth system — oceans, landmasses, biosphere, cryosphere, and atmosphere. This approach introduces teachers and students to a rich body of concepts and knowledge with which to understand the world around them.

The EarthLabs Climate teacher professional development program is a two-part effort. The first part involves working with a small group of exemplary teachers, known as EarthLabs "teacher leaders." The second part consists of a summer workshop at which the teacher leaders introduce high school teachers to modules they can use in the classroom. At present the project is active in two states, Texas and Mississippi.

In Texas, co-PI Kathy Ellins of the Institute for Geophysics invited teachers from the Texas Earth and Space Science (TXESS) Revolution, the six-year teacher, NSF-sponsored professional development project organized by the Jackson School to prepare high school teachers for a capstone course in Earth and space science.

Ellins and colleagues organized three weeklong EarthLabs summer workshops in the Jackson School drawing 75 teachers last year and again in 2013.

Science experts from the Jackson School gave talks about natural and anthropogenic climate change, glaciology, and carbon sequestration. Field trips to the Lady Bird Johnson Wildflower Center and the Bureau of Economic Geology tcomplemented the classroom learning.

"Teachers really benefit from the on-site learning opportunities at the Jackson School," said Ellins, who said teachers especially enjoyed meeting directly with researchers at the tops of their fields, like Tip Meckel at the Bureau and Kerry Cook in the Department of Geological Sciences. "One of the most highly rated segments ," she added, "was on science communication, working with the Jackson School communications team. The Jackson School is one of the new institutions that can combine such a depth of relevant information for teachers."

Jackson School scientists even communicated with teachers directly from the field, through ship-to shore videocasts from on board the Integrated Ocean Drilling Program (IODP) drillship JOIDES Resolution, which was operating off the coast of Alaska to investigate the link between climate and tectonic processes. The teacher-in-residence on the JOIDES resolution, Alison Mote, participated in the 2012 EarthLabs Climate workshop at the Jackson School.

Graduate Fellows Work with K-12 Teachers

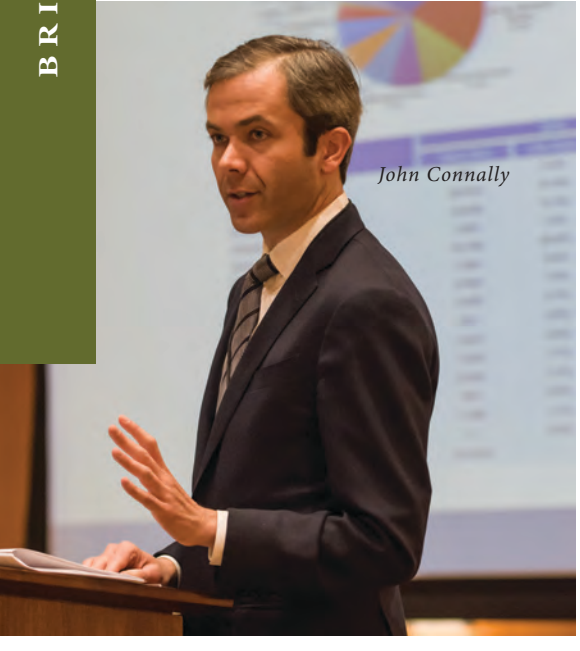
From 2001-2011, the National Science Foundation's GK-12 program at The University of Texas at Austin paired graduate student scientists and teachers from STEM disciplines in local school districts. The university's Environmental Science Institute (ESI), which receives support from the Jackson School and the College of Natural Sciences, has continued the program this year with a new twist. As of the spring of 2013, the GK-12 program has begun to provide prestigious fellowships and innovative training opportunities to graduate researchers interested in public outreach and environmental education. Two Jackson School graduate students are taking part in the program.

Kevin Befus is a Ph.D. candidate in Bayani Cardenas' lab in the Jackson School.

He studies the dynamics of groundwater as the water approaches the end of its time underground. Groundwater becomes ever-more influenced by changing surface conditions as it flows towards rivers, lakes, and seas, and that interaction between surface water and groundwater is the focus of Befus' research.

Befus sees his purpose as a GK-12 fellow as a way to share and foster the excitement of science with K-12 students. When possible, he plans to use water to explain science concepts to link class material to local and global issues related to water development, demand, quality, and quantity. Befus is working with an outdoor learning specialist and middle school science teacher in Round Rock, Texas.

Cassandra (Cassie) Browne, a geology Ph.D. candidate at the Institute for Geophysics, has been at the Jackson School for three years, and loves it more each year. She is interested in extensional tectonics on all scales, from micron-sized particle analysis to regional mapping. Specifically, she studies fault and fracture mechanics of oceanic basalt, which takes her all over the world.



John Connally

She has done field work in Iceland, Ethiopia, Cyprus, and the western US, experiences which have been incredibly valuable to her development as a scientist. Browne is working this year with science teachers at Travis High and Anderson High in Austin.

The Honourable Kevin C. Ramnarine (right), minister of energy & energy affairs for Trinidad and Tobago, talks Jorge Piñon about his country's exciting recent energy discoveries during the 2013 Latin American Forum.

Latin American Forum Goes Unconventional

Two themes dominated the 2013 Latin American Forum, the Jackson School's international gathering of energy and environmental ministers, industry leaders, and researchers: the impact of the shale gas revolution and the importance of sound governance.

Unconventional hydrocarbons have been a popular topic at the forum since its inception in 2005. In 2013, as the meeting returned to Austin after recent stints in Houston, Colombia, and Panama, shale gas surfaced in nearly every presentation.

Jason Bordoff, director of the Center on Global Energy Policy at Columbia University (and until 2013 the special assistant to President Obama and the National Security Council on energy and climate change), outlined global and hemispheric policy implications of the "transformational change" wrought by the shale gas revolution. Of particular note, he pointed out that countries like Russia, whose economies are under threat from rising global gas supplies, are often the loudest critics of hydraulic fracturing. Bordoff also observed that even though the European Union enacted a climate policy and the U.S. did not, it was the U.S. that actually reduced greenhouse gas emissions over the past decade, a fact scientists attribute largely to a rapid increase in natural gas production.

Richard Chuchla, South America new opportunities manager at ExxonMobil Exploration Company (and outgoing chair of the Jackson School Advisory Council), seconded Bordoff's point while adding a note on the importance of efficiency and technological innovation. Today, he pointed out, U.S. energy-related emissions are at their lowest level since 1992, even though the U.S. economy has grown 60 percent and energy consumption 14 percent over the same period.

Transparency and sound governance were as popular a subject as shale gas, with panels on resource nationalism and the Colombian model, and much speculation on future policy directions for Argentina, Venezuela, and Mexico. Phyllis Yoshida, deputy assistant secretary for Asia, Europe and the Americas in the Office of Policy and International Affairs at the U.S. Department of Energy, offered a close-up on U.S. energy policies, stressing areas of continuity between the Bush and Obama administrations and a focus on energy conservation.

Finally, wrapping up nearly all of the themes from the forum, the Hon. Kevin C. Ramnarine, minister of energy and energy affairs of Trinidad & Tobago, delivered an engaging, detailed presentation on his country's success with LNG, adaptation to changing natural gas markets, and efforts to resist the "Dutch Disease," or the so-called resource curse. One of his country's biggest challenges, Ramnarine explained, was retaining human capital, an area where he especially hoped to see ongoing collaboration with leading academic institutions in energy and the environment, like The University of Texas at Austin.

Switch Continues to Inspire New Thinking on Energy

Editor's Note: After its debut and successful run of festivals in 2011-2012, Switch*, the energy film and educational project created by Bureau of Economic Geology Director Scott Tinker and Austin filmmaker Harry Lynch, hit the road again this past year, reaching nearly 3 million viewers through television, movie theaters, and screenings on campuses. The movie continues to draw rave reviews, with write-ups in* The New York Times, Forbes *(see p. 19), and scores of major newspapers, while inspiring viewers to take a deeper look at energy. The op-ed below, written by Canadian professor Philip Walsh for the St. Thomas Times-Journal in Ontario, is an especially good example of the film's ability to advance the global conversation on energy.*

I sometimes tell my students that on the journey, knowing where you'd like to go is only half the challenge. Choosing the most strategic route can define success.

With recent headlines putting the energy debate front-and-centre, it made me think: How do we map out the future of Ontario's energy supply in a way that satisfies our need to respect the environment, while providing affordable energy to households for decades to come?

Ontario's reliance on coal is over. This is a good start. And with Kathleen Wynne taking her new post as premier, we are likely to see a continued emphasis placed on renewable energies such as wind and solar, which in 2012 accounted for about 3% of Ontario's energy needs.

This is a good next step, but can renewables alone provide the solution?

In answering that question, I was reminded of the documentary Switch, which recently screened as part of an event hosted by Ryerson University's Centre for Urban Energy.

Switch is an insightful new film about a road map for the world's energy future.

It's a lofty pursuit, to say the least. Consider that there are today more than 600 million people in India who don't yet have access to electricity and desperately need it -- the equivalent of Canada's entire population, 18 times over.

Switch's narrator, Dr. Scott Tinker, a professor at the Jackson School of Geosciences and director of the Bureau of Economic Geology at The University of Texas, hypothesizes that in a relatively short time (he manages to calculate the exact year), the world will "switch over" to relying predominantly on "energies of the future," those being renewables, natural gas and nuclear.

Ontario, like many regions in the world, has a mix of electricity sources, each bringing to the table its unique set of benefits and challenges.

Solar and wind can't generate electricity when the sun doesn't shine or the wind doesn't blow.

And since electricity must be generated in response to real-time demand, renewables need a reliable partner.

What is clear, as echoed in Switch, is that natural gas-fired electricity remains an essential element for the world's energy future.

This holds true in Ontario, despite last year's high profile gas plant cancellations and recent political headlines that could be used to influence a move away from this very important fuel. But let's not throw the baby out with the bathwater.

Natural gas is cleaner than other conventional fuels, producing only 45% of the emissions of coal and oil. It is affordable -- new discoveries of shale gas have driven prices down considerably, with forecasted affordability through to at least 2025.

Perhaps most importantly, it is reliable. It will be here when Ontario needs it to backstop intermittent renewables.

On both the coldest and hottest days of the year, when our heaters or air conditioners need to work overtime, natural gas picks up the slack. No other energy source can do that with the same efficacy and reaction time.

As Ontario ventures down a potentially new path in terms of our energy vision, it is important for policy makers to consider a road map that positions us for the longer term and provides Ontario with clean, reliable and affordable energy.

Knowing where we want to go is one thing. Ensuring we choose the right route is arguably even more critical.

— Philip Walsh is an associate professor with the Ted Rogers School of Management, Entrepreneurship and Strategy

IN THE NEWS 2012-13

Links to complete articles, streaming audio and video files, and current In the News items can be found on the news section of the JSG Web site.

Sunlight Not Behind Recent Warming

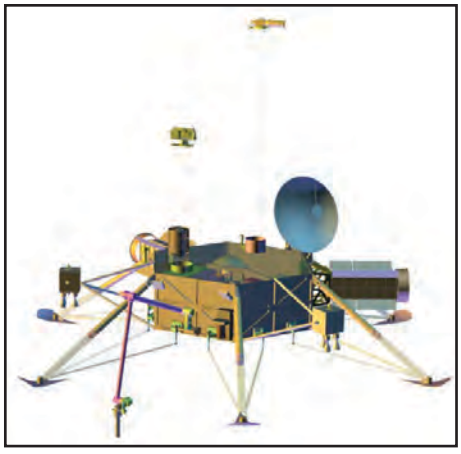
***Australian Broadcasting*, Aug. 27, 2013**

Variations in the rate of global warming since the 1970s were not caused by atmospheric changes that affect how much solar radiation reaches the Earth's surface, a new study says. Over the past century, rising greenhouse gas levels have caused global average temperatures to increase, climate scientists Kaicun Wang of Beijing Normal University and Robert Dickinson of the Jackson School write in the *Proceedings of the National Academy of Sciences*. "Our answer is no," says Wang. "Surface solar radiation can't be blamed for the strong warming rate during the recent decades, or the recent [lower] warming rate."

Tremors Tied to Extraction

***Wall Street Journal, Bloomberg, et al.*, Aug. 27, 2013**

Small earthquakes in South Texas' burgeoning Eagle Ford Shale probably result from producing lots of oil and associated water, rather than from hydraulic fracturing, says a new study by Cliff Frohlich, associate director of the Jackson School's Institute for Geophysics. That's in contrast to a study last year by Frohlich and colleagues at the Institute, which found that small earthquakes in the Barnett Shale were likely caused by injecting waste water deep underground. Much of that waste water is fluid that flows back to the surface after being used for hydraulic fracturing. "Although there is a considerable amount of hydraulic fracturing activity in the Eagle Ford, we don't see a strong signal associated with that and earthquakes," Frohlich said.



Artist's conception of a Europa lander: Caltech.

Scientists Map Out Europa Mission

***Houston Chronicle, Austin American-Statesman*, Aug. 7, 2013**

Researchers from the Jackson School's Institute for Geophysics (UTIG) are helping to make a case for exploring Europa, a moon of Jupiter that scientists believe has potential for sustaining life. Their research has contributed to a study that sets goals for a potential voyage to the Jovian moon and knocks more than $1 billion off previous cost estimates, which have hovered around $4 billion. UTIG's Don Blankenship had an important hand in recent NASA clipper and lander proposals for an expedition, while contributing to recent work on a proposed expedition reported in the journal *Astrobiology*.

New Ghawar in West Texas?

***Dallas Morning News*, July 25, 2013**

Pioneer Natural Resources, one of the country's largest independent oil and gas firms, is estimating the recoverable hydrocarbons in a single field in West Texas' Permian Basin at 50 billion barrels of oil and gas. At almost twice the estimated reserves in the Eagle Ford, that would make the field, named the Spraberry/Wolfcamp, the largest in the country and the second-largest in the world behind the Ghawar in Saudi Arabia. Oil was first discovered in what was then known as the Spraberry in the 1940s but had always produced at "relatively low levels," said Scott Hamlin, a researcher with the Bureau of Economic Geology. "That's changed in the last three years," he said. "With the development of increasingly efficient techniques, they were able to produce rocks that were previously not producible, like the Eagle Ford."

Spraberry field. Courtesy Pioneer Resources.

Antarctic Permafrost Melting Faster Than Expected

***Time, Los Angeles Times, et al.*, July 24, 2013**

Antarctica's Dry Valleys are home to some of the oldest ice on Earth. The first signs of the kind of massive thaw disturbing the Arctic's frozen ground have now appeared in one of these Antarctic valleys, melting a glacier buried since the last Ice Age. In a study published in Scientific Reports, Joseph Levy of the Jackson School's Institute for Geophysics found that coastal Antarctic

Robert Dickinson

Jim O'Connor of the USGS inspects a block of ice calved off the Garwood Valley ice cliff. Photo by Joseph Levy, UTIG.

permafrost, which unlike Arctic permafrost was considered to be stable, is actually melting much faster than scientists had expected. "That's a dramatic shift from recent history," said Levy.

Are Unconventionals Really Conventional?

***Platts*, July 22, 2013**

With exploration for so-called unconventional oil and gas resources becoming the rule, rather than the exception, the question arises: What are unconventionals? To Eric Potter, associate director of the energy division for UT Austin's Bureau of Economic Geology, the issue is chiefly one of permeability — how easily fluids can flow through rock. For unconventional rocks, the standard definition is permeability below 0.1 millidarcies, as opposed to more conventional hydrocarbon-bearing rocks that typically exhibit permeabilities many times that level, geologists say. Tight unconventional rocks need something more to pry out their oil and gas, says Potter.

Eric Potter

Switch Illuminates Energy Issues Without Lighting Faucets

***Forbes*, July 16, 2013**

Seen by nearly three million viewers in theaters and television screenings around the world, Scott Tinker's film Switch continues to draw rave reviews. Energy writer Loren Steffy of Forbes distinguished Switch from sensationalist "all-fossil-fuels-are-bad" entries in the energy film genre. Switch, writes Steffy, offers a more "scientific look at how we use energy and how difficult it's going to be to move away from fossil fuel." The movie outlines the prospect of a 50-year gradual transition from primary use of hydrocarbons to cleaner forms of energy. "If 50 years seems too long to wait for that portfolio of cleaner fuels to surpass oil, Tinker points out a way to accelerate it: conservation," notes Steffy, who praises the film for raising energy awareness and pointing out the massive numbers of gigawatts and dollars at stake in our global energy economy.

UTIG Scientists Win Renown for Antarctic Research

***Austin American-Statesman*, July 14, 2013**

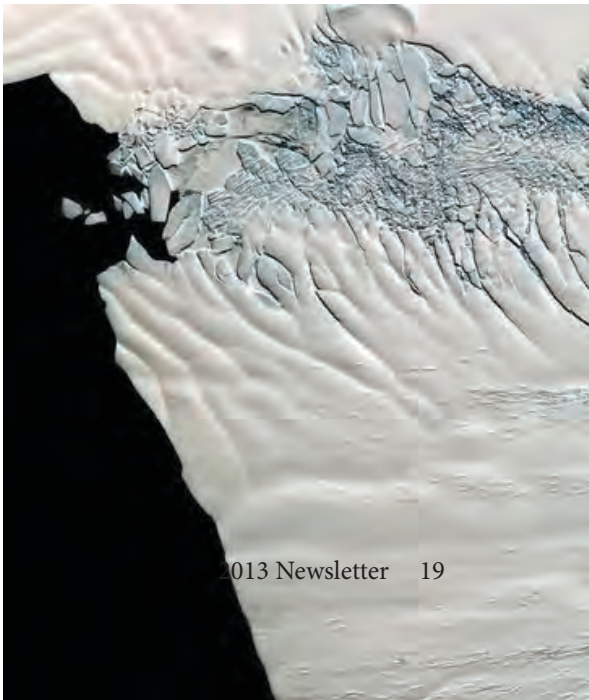
From a nondescript office at the J.J. Pickle Research Campus, sweltering in the midsummer heat like the rest of Central Texas, a cadre of researchers from the University of Texas Institute for Geophysics (UTIG) has become world renowned for its study of some of the coldest places on Earth — not to mention Jupiter's icy moon, Europa. Most recently, UTIG scientists Dusty Schroeder, Don Blankenship, and Duncan Young discovered a swamp-like system of water under an Antarctic glacier the size of New Mexico — a finding that might hold the key to how quickly the polar ice will melt and the seas will rise. This is just one of many accomplishments by UTIG scientists studying Antarctica.

Duncan Young

Ancient Undersea Volcanoes Hold Climate Secret

***Los Angeles Times*, July 13, 2013**

Ancient volcanoes discovered deep in the ocean off Antarctica may explain a climate mystery critical to predicting Earth's fate as humans pump more carbon dioxide into the atmosphere, according to Ian Dalziel of the Jackson School of Geosciences. Dalziel and colleagues from the University of Texas Institute for Geophysics dredged thousands of feet below the surface of the central Scotia Sea off the southeastern tip of South America, hauling up volcanic rock after their sonar mapping showed formations that looked uncannily like a sunken island chain. Their analysis suggests that volcanoes erupting from the ancient sea floor formed an island arc that blocked the formation of the Antarctic circumpolar current.



How to Handle New Cave in Williamson County?

***Fox 7 Austin*, July 10, 2013**

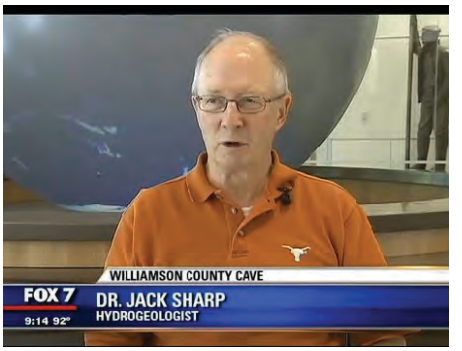
When a road crew discovered a large cave just a few feet below the surface along Highway 620, just west of Round Rock, Texas, authorities had to decide what to do with it. Professor Jack Sharp of the Jackson School weighed in on a proposal that the highway department fill in the cave. "The Edwards Aquifer, the caves are unique resources – they're really valuable to the area," said Sharp. "This new cave is something we should celebrate, not just fill in with concrete because it's inconvenient."

Hydraulic Fracturing Strains Rural Water Supplies

***USA Today*, July 9, 2013**

In a series on coping with climate changes across the U.S., USA Today explored contributing factors to Texas' water supply problems during the current drought. Exacerbating water worries in parts of Texas is water-intensive fracking, which is taking off in some of the state's driest areas. In Texas, water for fracking jumped 125 percent in three years and will continue to increase before leveling off in the 2020s, according to a UT Austin study this year by Bureau of Economic Geology (BEG) scientist Jean-Phillippe Nicot. The BEG study says oil and gas drilling accounts for less than 1 percent of water use statewide, and one-fifth of water used in fracking is recycled or brackish. But a similar 2011 study, also by Nicot, found it accounts for at least

J.P. Nicot



20 percent of water in some counties where fracking is big business.

Opinion: Grass Should Not Always Be Greener

***Wall Street Journal*, June 29, 2013**

In an opinion piece on misconceptions about water use, Rusty Todd cited the Bureau of Economic Geology's study of water used for hydaulic fracturing. Noting the BEG estimates fresh water for fracking in Texas will top out at about 23 billion gallons a year (in part since fracking water usage will continue to grow but will do so with brackish and recycled water), Todd noted this paled in comparison to water use for agriculture and conventional forms of power production. "Objections to the amount of water used in fracking verge on trivial given that electricity generation and irrigation account for more than 70% of water used nationwide ... Clearly, food and power production are where the conservation potential is."

Rising Seas Tied to Faster Melt

***Wall Street Journa*l, June 2, 2013**

Accelerated melting of polar ice sheets and mountain glaciers was the driving factor behind a rise in the global sea level of 16.8 millimeters, or about two-thirds of an inch, between 2005 and 2011, according to a study published in *Nature Geoscience*. The study resolves long-standing discrepancies that arose from different methods of measuring sea levels. "There was an increase in the melting rate in Greenland starting in 2005 and that is probably the underlying story why" a larger quantity of melt water has poured into the oceans in recent years, said Professor Clark Wilson, a geophysicist at the Jackson School and co-author of the study, which was based on data from the UT Austin-led GRACE satellite project.

Outlook Grim for Venezuela's Oil Industry

***Associated Press*, May 4, 2013**

Venezuela has the world's largest oil reserves, but production, earnings, and income from its national oil company, PDVSA, all appear to be on a downward slide, even as debts to its suppliers rose 35 percent. "The government of Venezuela today uses PDVSA as its petty cash box to lead populist social programs," said Jorge R. Piñon, associate director of the Latin America and Caribbean Program at the Jackson School. "Whatever capital is left in PDVSA is being mismanaged because they're just not focused on running the company. They're focused on building hospitals and schools."

New Eastern Fields Drive Rise in U.S. Gas Resources

***Energy Daily*, April 10, 2013**

An authoritative industry research panel, the Potential Gas Committee (PGC), said technically recoverable natural gas resources in the U.S. jumped by nearly 26 percent since the group's last estimate two years ago, with the increase driven primarily by discovery and rapid development of massive new shale gas fields, especially in the eastern U.S. A highly cited source for the estimate was "a recent study completed by the Texas Bureau of Economic Geology [showing] that even with declines, the Barnett has only produced perhaps a third of its productive potential," said John Curtis, professor of geology and geological engineering at the Colorado School of Mines and director of its Potential Gas Agency, which provides guidance and technical assistance to the PGC.

Sixth Century Cooling Tied to El Salvador Volcano

***The Canadian Press*, April 5, 2013**

American paleoecologist Robert Dull, a research scientists at UT Austin's Environmental Science Institute, believes he's

pretty much solved the mystery behind a catastrophic global climate change event from the sixth century. As the new History Channel Canada series "Perfect Storms" shows, Dull has found solid circumstantial evidence that an eruption at El Salvador's Lake Ilopango volcano was the cause of the so-called Dust Veil of AD 536, when a thick cloud of dust and ash over the Northern Hemisphere cooled parts of the Earth and led to millions of deaths.

Canada Winning LNG Race

***Bloomberg*, April 4, 2013**

Canada is pulling ahead of the U.S. in the contest to be the first exporter of liquefied natural gas from the North American shale bonanza to Asia's $150 billion LNG market. International energy giants from Exxon-Mobil to Malaysia's Petroleum Nasional are considering terminal projects in Western Canada to supply Asian utilities and factories paying more than four times the price of U.S. markets. "The smart money is going to Canada" to export LNG, said Michelle Foss, chief energy economist at the Center for Energy Economics at The University of Texas at Austin's Bureau of Economic Geology. "They don't have any objections to exporting gas and it's closer to Asia, which cuts down on shipping costs."

Drillship in Alaska Seeking Clues to Earth's History

***Petroleum News*, March 31, 2013**

Unlike most drilling shipts, the research vessel the JOIDES Resolution did not head for the Gulf of Alaska on an oil-hunting expedition. The JOIDES Resolution was scheduled to reach Valdez at the end of May, with Sean Gulick of the University of Texas Institute for Geophysics serving as co-chief scientist. Expedition 341 of the Integrated Ocean Drilling Program (IODP), titled "Southern Alaska Margin Tectonics, Climate and Sedimentation," sought through coring and downhole measurements to gather a sedimentary record from southern Alaska to examine the ties between tectonically driven orogenic processes, glacial processes, and north Pacific and global climate.

Crater lake at Ilopango Volcano in El Salvador. Nasa.

Co-Chief Scientist Sean Gulick gives a pre-site to the scientific party on IODP Expection 341. Credit: John Beck, IODP/TAMU.

Petrocaribe: Paying Beans for Venezuelan Oil

***Christian Science Monitor*, March 27, 2013**

Some 17 countries in the Caribbean region receive shipments of crude or refined oil products with preferential repayment terms under the Petrocaribe energy pact with Venezuela. But some nations fear oil shipments could stop post-Chávez. If that happens, everything from construction of new highways to the price of gas and electricity and tax rates could be affected in countries like the Dominican Republic, threatening to undermine their economy. "Any cut to Petrocaribe would be disastrous for countries" that receive Venezuelan oil under such deals, says Jorge Piñon, associate director of the Latin America and Caribbean Program at the Jackson School. "It's become an integral part of their economies."

Tectonic Plate Discovered Under California

***So. California Public Radio*, March 20, 2013**

A tectonic plate that disappeared millions of years ago has turned up in Central California and Mexico. New research from Brown University found that part of the Baja region of Mexico and part of central California near the Sierra Nevada mountains sit upon slabs of this long-lost plate. It's a big breakthrough in how we think

about California's 100-million-year-old geology. Sean Gulick, a geophysicist from the University of Texas at Austin's Institute for Geophysics, gives California radio listeners a brief lesson in plate tectonics to understand the discovery.

NG: Tiny Particles Enlisted

***EnergyWire*, March 15, 2013**

Can magnetic nanoparticles injected deep underground with hydraulic fracturing liquids reveal detailed dimensions of shale rock fractures and track movements of gas molecules? Can other particles — that change form when they encounter oil — be "interrogated" for clues about the amounts of oil in dense shale formations? Finding answers to these questions are among the goals of the Advanced Energy Consortium (AEC), headquartered at the Bureau of Economic Geology at the University of Texas, Austin.

Gas Boom Projected to Grow for Decades

***Wall Street Journal, NPR, Bloomberg Businessweek, et al.*, Feb. 28-Mar. 5, 2013**

The front page of The Wall Street Journal and scores of media outlets across the country reported that U.S. natural-gas production will accelerate over the next three decades, sustaining for at least a generation the energy boom that is remaking America. The conclusion is based on new research from a team led by Scott Tinker and Svetlana Ikonnikova of the Bureau of Economic Geology, who conducted the most comprehensive assessment to-date of the major unconventional shale basins in North America. In the first report, the BEG team forecasts gradually declining but steady production from the Barnett Shale. See related feature story in this edition of the Jackson School Newsletter.

Svetlana Ikonnikova

Researchers at the Advanced Energy Consortium, part of the Bureau of Economic Geology, inspect nanoparticles in solution. Photo by David Stephens.

Unparticle May Lurk inside Earth

***LiveScience, Boston Globe, Physics World*, Feb. 21-22, 2013**

Evidence of a miniscule force that could exist between two particle spins over long distances could be lurking in magnetized iron under the Earth's surface. That is the conclusion of a new study by physicists Larry Hunter and colleagues at Amherst College in Massachusetts, together with Jung-Fu "Afu" Lin of the University of Texas at Austin's Jackson School. The team has used our planet's vast stores of polarized spin to place exacting limits on the existence of interactions mediated by hypothetical particles, which include the existentially evocative "unparticle."

Loss of Venezuelan Oil Could Cause Cuban Exodus

***CNN*, Jan. 22, 2013**

Will Venezuela continue to subsidize Cuban oil supplies post-Chavez? "The impact of Cuba losing that arrangement would be disastrous," said Jorge Piñon, an energy expert at the University of Texas' Center for International Energy and Environmental Policy.

In Wake of Sandy, Scientists Map Sea Floor

***NPR*, January 29, 2013**

Congress has now agreed to give some $60 billion to states damaged by Hurricane Sandy. A lot will go to Long Island, one of the hardest hit areas. Besides damages to homes and businesses, its system of protective barrier islands and beaches were partially washed away. Scientists are trying to find out where that sand and sediment went, and whether it can be used to rebuild Long Island's defenses. NPR's Christopher

Joyce went on a radio expedition with the team from the Jackson School's Institute for Geophysics as they searched for sand.

How to Build a Smarter Rock

***Science*, Dec. 14, 2012**

Joel Johnson of the Jackson School has crafted metal rocks to mimic a natural stone's shape and density, and then inserted custom-made electronics to measure and record the faux rock's movements in real streams and rivers. The mission: to better understand how waterways move tons of rock and other sediment downstream. Improving sediment transport models means getting down to small details, including better measurements of dozens of variables ranging from large-scale channel slopes and water velocities to minute interactions between a single grain of sand and the water flowing around it.

Was Sandy Connected to Climate Change?

***KXAN TV*, Oct. 31, 2012**

Hurricane Sandy was dubbed a "super storm" and even a "Franken-storm" for its unusual formation. Kerry Cook, a climate scientist at the Jackson School, calls it a "hybrid" that was "drawing energy from the warm tropical Atlantic, but also from strong temperature gradients associated with the jet stream and the cold front." Cook cautions against making any direct connection between this individual storm and climate change, but she said the factors that led to Sandy are things we can expect to see more of. "It is exactly the kind of thing we expect to happen more under global warming," said Cook.

DOE Likely Won't Cap LNG Exports, Say Experts

***Natural Gas Intelligence*, Oct. 1, 2012**

Assuming the U.S. Department of Energy (DOE) decides to allow export of U.S. liquefied natural gas (LNG), the agency will likely leave it up to markets to determine how much LNG is sent abroad, according to industry veteran Michelle Foss, chief energy economist in the Bureau of Economic Geology at The University of Texas at Austin. "DOE people are certainly cognizant of potential market impacts of an export wave, if that really materialized," Foss said. "However, they also know that the market itself is a governing mechanism. If prices rise enough so that Henry Hub is no longer cost competitive for liquefaction and export, the LNG export developers themselves are in trouble."

Joel Johnson

BRIEFS

As part of a series of ads on researchers whose work has major societal impact, UT Austin featured Bridget Scanlon in the April 2013 edition of Texas Monthly highlighting her pioneering research on sustainable water for global agriculture.


Bob Hardage

AWARDS & HONORS 2012-2013

Common Abbreviations:
AAPG = Amer. Assoc. of Petroleum Geologists

AIPG = American Institute of Prof. Geologists
AGS = Austin Geological Society
GCAGS = Gulf Coast Assoc. Geological Societies
GSA = Geological Society of America
HGS = Houston Geological Society
SEG = Society of Exploration Geophysicists

Faculty & Researchers

Jay Banner
Oustanding Teaching Award, UT Board of Regents; Research Groundwater Stewardship Award, Barton Springs/Edward Aquifer Authority

Robert Baumgardner
A.L. Cox Poster Award, SW Section, AAPG

Don Blankenship
Outstanding Research, JSG; Director's Circle of Excellence, UTIG

Bayani Cardenas
Kohout Early Career Award, Hydrogeology Division, GSA; Fred Holmsley Moore Distinguished Lecturer, U. of Virginia; Faculty Science Performance, Associate Professor, DGS

Ginny Catania
Director's Circle of Excellence, UTIG

Elizabeth Catlos
Notable Paper, Mineralogical Society of America

Mark Cloos
G. Moses and Carolyn G. Knebel Distinguished Teaching Award, Undergraduate, DGS

Ian Dalziel
Career Researcher Award, UTIG

Robert Dickinson
Honorary Member, American Meteorological Society

Peter Flemings
Director's Circle of Excellence, UTIG

Robert Folk
Legend of Sedimentology Award, HGS; Dedication of 2012 GCAGS Transactions, GCAGS

Sergey Fomel
Top 30 Presentation, SEG Annual International Meeting, SEG; Sergey Fomel, Outstanding Educator, JSG

Bill Galloway
Doris Malkin Curtis Medal, GCSSEPM; Best Paper, 2012 GCAGS Journal, GCAGS

Patricia Ganey-Curry
Best Paper, 2012 GCAGS Journal, GCAGS; Outstanding Support Staff Award, UTIG

Omar Ghattas
Walter Excellence Award, JSG

Gürcan Gülen
USAEE Senior Fellow Award, U.S. Association for Energy Economics

Sean Gulick
Director's Circle of Excellence, UTIG

Scott Hamlin
A.L. Cox Poster Award, SW Section, AAPG

Bob Hardage
Outstanding Service, JSG

Marc Hesse
1st Place, Best Represented Research Group, JSG Research Symposium, JSG; G. Moses and Carolyn G. Knebel Distinguished Teaching Award, Graduate, DGS

Jack Holt
Director's Circle of Excellence, UTIG

Brian Horton
Faculty Research Assignment, UT Austin; Director's Circle of Excellence, UTIG

Michael Hudec
A. I. Levorsen Memorial Award, AAPG; 1st Place, Thomas A. Philpott Excellence of Presentation Award, AAPG

Charles Jackson
Director's Circle of Excellence, UTIG

Christopher Jackson
Bigsby Medal, Geological Society of London

Martin Jackson
William Smith Medal, Geological Society of London

Rich Ketcham
Exceptional Reviewer, GSA Bulletin, GSA


Bob Folk

Wonsuck Kim
Faculty Science Performance, Assistant Professor, DGS

John Lassiter
G. Moses and Carolyn G. Knebel Distinguished Teaching Award, Intro Course, DGS

Luc Lavier
Director's Circle of Excellence, UTIG

Robert Loucks
2014 KWI Karst Award, Karst Waters Institute; Top Ten Poster at AAPG Convention, AAPG

Jerry Lucia
Top Ten Poster at AAPG Convention, AAPG

Earle McBride
Dedication of 2012 GCAGS Transactions GCAGS

David Mohrig
Faculty Science Performance, Full Professor, DGS; G. Moses and Carolyn G. Knebel Distinguished Teaching Award, Graduate, DGS

Robert Reed
Third Place, Gordon I. Atwater Poster Award, GCAGS

Jack Sharp
2012 President's Award, International Association of Hydrogeologists; Distinguished Lecturer, Edwards Aquifer Authority

Britney Schmidt
Outstanding Young Researcher Award, UTIG

John Snedden
Best Published Paper, 2012 GCAGS Journal, GCAGS; Distinguished Service Award, SEPM (Society for Sedimentary Geology); Director's Circle of Excellence, UTIG; Outstanding Researcher Award, UTIG

James Sprinkle
3rd Place, Thomas A. Philpott Excellence of Presentation Award, GCAGS

Danny Stockli
2nd Place, Best Represented Research Group, JSG Research Symposium, JSG

Scott Tinker
Outstanding Contribution to Public Understanding of Geology, AGI; John T. Galey, Sr., Memorial Public Service Award (2013), AIPG; Among 16 Best Geoscientists in "Texas Top Producer" Survey, Texas Independent Producers and Royalty Owners Association, Texas Monthly & Best Companies Group

Ramon Treviño
Distinguished Service Award, GCSSEPM

Duncan Young
Director's Circle of Excellence, UTIG

Harm van Avendonk
Director's Circle of Excellence, UTIG

Tim Whiteaker
Best Published Paper, 2012 GCAGS Journal, GCAGS

Laura Zahm
Distinguished Service Award, AAPG

Staff

Dennis Trombatore
William B. Heroy Award for Distinguished Service, AGI

Lynda Miller
Picard Excellence Award, UTIG

Laura Zahm

Kara Scott
Thelma Lynn Guion Library Staff Honors DGS

Nicole Raney
Thelma Lynn Guion Library Staff Honors, DGS

Patty Romano
Staff Excellence, JSG


L to r: Scott Tinker, Zong-Liang Yang, Omar Ghattas, and Charles Jackson.

Leadership Positions

Bayani Cardenas
Editor, Geophysical Research Letters, AGU & Wiley

Elizabeth Catlos
Chair, Annual Meeting (2013), South-Central Section, GSA; Chair, Management Board, South-Central Section, GSA; Councilor, GSA; System Standing Review Board, NASA-Mars Organic Molecule Analyzer, NASA

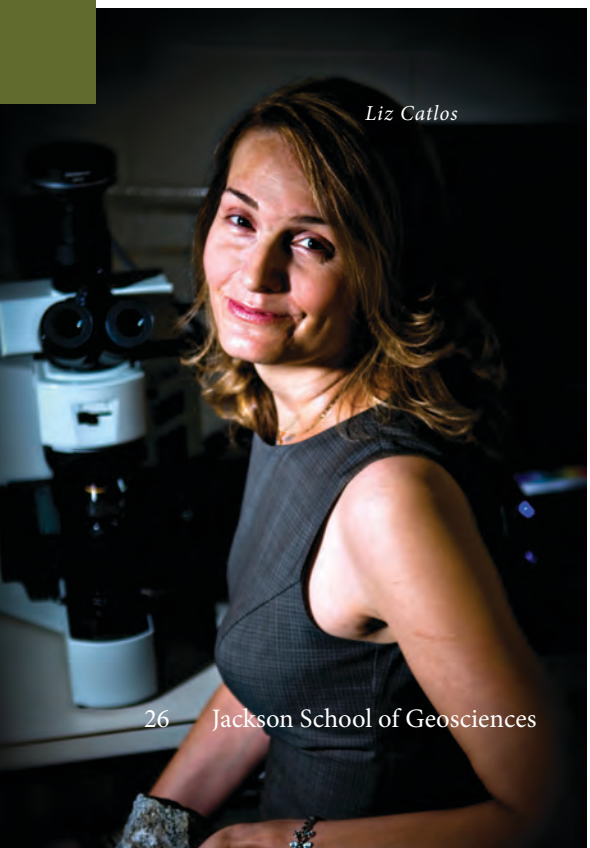
Kathy Ellins
Chair, Education and Outreach Subcommittee (2013-15), EarthScope; Member, Steering Committee (2013-15), EarthScope

Rong Fu
President-elect, Global Environmental Change Focus Group, AGU

Wonsuck Kim
Associate Editor, Journal of Geophysical Research - Earth Surface, AGU & Wiley

Carey King
Special Projects Chair, ASME Energy-Water Nexus Interdisciplinary Council, American Society of Mechanical Engineers

Sharon Mosher
President (2013), AGI


Liz Catlos

Suzanne Pierce
Board Member (Dec. 2012-2016), U.S. Chapter, Intern. Assoc. of Hydrogeology

John Snedden
Board Vice Chair (2012-14), SEPM Foundation

Promotions

Ginny Catania
Associate Professor, JSG

Philip Guerrero
Graduate Program Administrator, JSG

Nicholas Hayman
Research Scientist (Sep. 2013), UTIG

Richard Ketcham
Associate Dean for Academic Affairs, JSG

Jung-fu "Afu" Lin
Associate Professor, JSG

John Snedden
Senior Research Scientist, UTIG

Students

Gabriel Aguilar
GSA South-Central Section Meeting Award, GSA SC Section

Trisha Alvarez
SPIRIT Scholarship, ConocoPhillips

Veronica Anderson
Graduate Research Grant, GSA

Dan Arnost
Outstanding Mention, GSA

Khushboo Arora
1st Place, Gulf Coast Challenge Bowl, SEG; Khushboo Arora, Ike Crumbly Minorities in Energy Named Grant, AAPG

Lauren Becker
2nd place team, Gulf Coast Section, Imperial Barrel Award, AAPG; 1st Place, Early M.S. Student, JSG Research Symposium, JSG


Rich Ketcham

Rich Ketcham Becomes Associate Dean for Academic Affairs

Effective August 31, 2013, Rich Ketcham became the Jackson School's new associate dean for academic affairs. Ketcham has been an associate professor at the Jackson School for five years, serving as undergraduate advisor for most of that time and winning the Knebel Distinguished Teaching Award in 2011. Prior to that he was a senior research scientist, overseeing the UT Austin High-Resolution X-Ray CT facility.

"Rich brings wide experience to this position," said Dean Sharon Mosher. In addition to his recognition for teaching excellence, he is an outstanding researcher with one of the Jackson School's highest citation rates (h-index).

Ketcham earned his Ph.D. in geological sciences at UT Austin in 1995 after graduating with a B.A. in geology and computer science from Williams College.

He will serve halftime as associate dean for academic affairs, continuing as an associate professor in the Department of Geological Sciences for the other half.

Ketcham replaces outgoing Associate Dean Phil Bennett, who returns to the faculty full-time.

Paul Betka (right) making his case to judge Luc Lavier.

Paul Betka
2nd Place, Ph.D. Student, JSG Research Symposium

Kevin Bone
Mineralogical Society of America Award, MSA

Benjamin Byerly
JSG Best Graduate Paper, JSG

Ryan Cahalan
Outstanding Student Poster Award, 2012 AGU Fall Meeting, AGU

Amanda Calle
Marta Sutton Weeks Named Grant, AAPG

Kuldeep Chaudhary
Collaborative Research Award, Norway

Sarah Coyle
2nd place team, Gulf Coast Section, Imperial Barrel Award, AAPG

Julie Ditkof
1st Place, Poster Competition, UT Austin Energy Forum; Julie Ditkof, 2nd place team, Gulf Coast Section, Imperial Barrel Award, AAPG

Dallas Dunlap
Technical Sessions Best Speaker, M.S., Spring, DGS

Dan Eakin
Outstanding Student Paper Award, 2012 AGU Fall Meeting, AGU

Rania Eldam
Outstanding Student Oral Presentation, 2012 AGU Fall Meeting, AGU; Rania Eldam, Undergraduate Research Fellowship, UT Austin; Fellowship for Outreach Development, Young Women's Alliance

Emily Hernandez Goldstein
Diversity in the Geosciences Minority Research Grant Award, GSA; Student Research Grant Award, GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division

Menal Gupta
2nd Place, Gulf Coast Challenge Bowl, SEG; Best Graduate & Ph.D. Resume, JSG

Aaron Hantsche
1st Place, Undergraduate, JSG Research Symposium; Undergraduate Field Scholarship, Austin Geological Society; Austin Geological Society Award, AGS

Nicole Hart
Arthur A. Meyerhoff Memorial Grant, AAPG

Jessica Hudock
Ed Picou Fellowship Grant, GCSSEMP

Allan Jones
Outstanding TA, DGS

Jake Jordan
2nd Place, Early M.S. Student, JSG Research Symposium, JSG

Jessica Kopp
1st Place, Late M.S. Student, JSG Research Symposium, JSG

Jenna Kromann
Research Grant, GSA

Han Kyul (Kyra) Kim
Undergraduate Research Fellowship, UT Austin

Nicole Kurka
Austin Geological Society Award, AGS

Maureen LeVoir
GSEC Student Service Award, GSEC

Vishal Maharaj
Research Grant, SEPM

Damian Markez
Statoil Fellow, Statoil

Maren Mathisen
2nd place team, Gulf Coast Section, Imperial Barrel Award, AAPG; Outstanding TA, DGS; Maren Mathisen, James E. and Elloie B. Wilson Memorial Grant, AAPG

Renas Mohammed
Graduate Research Grant, GSA; Ronald K. DeFord Field Scholarship, JSG

Lindsay Olinde
Outstanding TA, DGS

Nicholas Perez
Graduate Research Fellowship, NSF; Bruton Fellowship, UT Austin; Graduate Research Grant, GSA

Maxwell Pommer
2nd Place, Grad Student, Folk/McBride Petrography Award, DGS

Joshua Poncik
Top 10 Finalist, Student Employee of the Year, UT Austin Human Resource Services

Jonathan Warden

Edgardo Pujols
Jay M. McMurray Memorial Grant, AAPG

Timothy Prather
Estwing Hammer Award, DGS

Natalie Raia
Best Freshman/Sophomore Resume, JSG; Outstanding Student Volunteer, JSG

Sebastian Ramirez
Pre-Expedition Award, Integrated Ocean Drilling Program

Robert Reece
Technical Sessions Best Speaker, Ph.D., Fall, DGS

Migdalys Salazar
Ed Picou Fellowship Grant, GCSSEMP; Peter Warren Gester Memorial Grant AAPG; Jesse L. Brundrett Memorial Endowed Presidential Scholarship, UT Austin

Jason Sandford
Fred M. Bullard Prestigious Graduate Fellowship, JSG; Ed Picou Fellowship Grant, GCSSEMP

Eugenio Santillan
Technical Sessions Best Speaker, Ph.D., Spring, DGS

Dustin Schroeder
1st Place, Ph.D. Student, JSG Research Symposium; Technical Sessions Best Speaker Ph.D., Spring, DGS

Jeffrey Senison
Outstanding TA, DGS; Jones-Amsbury Research Grant, South Texas Geological Society

Rachel Simon
Technical Sessions Best Speaker, M.S., Fall, DGS

Rebekah Simon
2nd place team, Gulf Coast Section, Imperial Barrel Award, AAPG

John Singleton
Best Published Student Paper Award, *Journal of Structural Geology*

Jeffrey Sitgreaves
Best Undergraduate & Junior/Senior Resume, JSG

Benjamin Smith
1st Place, Undergrad Student, Folk/McBride Petrography Award, DGS

Spencer Seman
1st Place, Grad Student, Folk/McBride Petrography Award, DGS

Tim Shin
Outstanding Mention, GSA

Xiaolei Song
Best Student Poster, SEG

Colin Sturrock
2nd Place, Undergrad Student, Folk/McBride Petrography Award, DGS

Dolores van der Kollk
Alexander Sisson Award, GSA

Nataleigh Vann
Best Master's Resume, JSG

Marissa Vara
2nd Place, Undergraduate, JSG Research Symposium

Kerstan Wallace
2nd Place, Late M.S. Student, JSG Research Symposium, JSG

Lichun Wang
Frank E. Kottlowski Memorial Grant, AAPG

Jonathan Warden
John and Colleen Silcox Named Grant, AAPG

Logan West
Kenneth H. Crandall Memorial Grant, AAPG

Stephanie Wood
3rd Place, Poster Competition, UT Energy Forum; William Dow Hamm Memorial Grant, AAPG

Jie Xu
Ed Picou Fellowship Grant, GCSSEMP

Lei Yin
Earth and Space Fellowship, NASA

Kuldeep Chaudhary

Renowned Invertebrate Paleontologist, Jim Sprinkle, Retires

Jim Sprinkle, the First Mr. and Mrs. Charles E. Yager Professor in the Department of Geological Sciences, has retired after 42 years of teaching and conducting research at the University.

His research focused on Paleozoic marine communities and especially on early (and now mostly extinct) echinoderms. Echinoderms are marine invertebrates with protective calcite spines and plates. Some, like the blastoids and ctenocystoids (which he named with Dick Robison in 1969), are now extinct. Others, such as starfish, sea urchins, and crinoids, have survived in the oceans to the present day.

He produced over 180 publications and supervised 8 master's theses and 9 Ph.D. dissertations. Seven of these former graduate students now have academic careers, while others went into industry.

"Jim taught me that the most important things in science are creativity and attention to detail," says Colin Sumrall (M.S. '91, Ph.D. '96), assistant professor of paleontology at the University of Tennessee in Knoxville. "Jim has always been a really great sounding board for some of my more unconventional views of echinoderm evolution, always poking around the edges and uncovering holes in my ideas."

Sumrall says Sprinkle has been the key person helping him define and refine the directions of his research career. He also noted that his thoroughness and tenacity have led to big advances in our understanding of echinoderms.

"Jim's taxonomic descriptions are simply the finest in the echinoderm field in terms of seeing and documenting all of the aspects of the organisms regardless of perceived importance," he says.

Now an emeritus professor, Sprinkle plans to complete a large number of research projects left over from his many years of teaching. Most of these involve naming and describing previously unknown fossil echinoderms, and trying to work out their evolutionary relationships.

It's hard to pinpoint exactly when Sprinkle's career documenting the life and evolution of echinoderms began while he was growing up in a suburb of Boston. There were the fossil collecting trips across the border in New York State with junior high science teachers. There was the summer job at Harvard's zoology museum. And there was the high school science fair project in which he identified and described some castoff fossil blastoids from the museum and others he'd bought from collectors. He shared first prize in his school and went on to an honorable mention at the state fair in Boston.

What probably sealed the deal was a chance discovery while taking a summer field geology course at Indiana University's Field Station in southwest Montana after his sophomore year at MIT. On one of his mapping projects, he noticed blastoids weathering out of some limestone slabs. He brought chunks of this rock back to camp and put them in Styrofoam cups with bubbling acid to dissolve away the surrounding limestone.

"By the time I was done, I got 25 or 30 blastoids out, which was more than anybody had ever found in that part of Montana," he says.

Ray Gutschick, a Notre Dame paleontologist doing field work in the area, was excited and enlisted Sprinkle to work as a field assistant over the next two and a half summers, during which they collected 1500 blastoids from all over western Montana. It took them 25 years, however, to describe the specimens, including two new genera and eight new species, in Harvard's Museum of Comparative Zoology Bulletin.

He notes that 15 out of 20 classes of echinoderms that have ever lived are now extinct, including blastoids.

"So there are no living representatives from those groups," he says. "If you're going to know about them, you've got to go to the fossils and work out what's going on-how they lived, how they're related to each other, how much diversity there was, things like that."

He says fossils are also critical for understanding where the living echinoderms such as starfish came from. That's because echinoderms rapidly diversified 500 million years

ago, near the beginning of the Paleozoic.

"Just looking at living animals will only get you so far," he says. "You get some ideas of where things join up going into the past, but that's got a lot of problems with it. You're too removed from when the interesting things were going on."

Geophysics Legend Paul Stoffa Retires

Paul Stoffa, professor and Shell Distinguished Chair in Geophysics, has retired after 30 years of service to the University of Texas at Austin.

As a leader of geophysical research for 40 years, he has inspired colleagues, fellow geophysicists, and a long succession of graduate students, including over 50 Ph.D.s. He has published over 100 research articles in peer-reviewed journals.

His geophysical research began at Lamont-Doherty Geological Observatory, and continued at Gulf Research and Development, before his appointment in 1983 to his present position at UT Austin. He was director of the university's Institute for Geophysics from 1994 to 2008 and a member of the Steering Committee charged with forming the Jackson School of Geosciences. During this time, he was actively involved in the Ocean Drilling Program and served as chairman of its Board of Governors.

"Paul has a wonderful imagination and is able to create new methods to acquire and process geophysical data," said Anton Ziokolwski, professor at the University of Edinburgh. "He has developed major acquisition and processing techniques in exploration geophysics that have made a huge contribution to our understanding of how to investigate the Earth's interior."

At Lamont-Doherty, he developed a new technique for processing multichannel seismic reflection data that was eventually adopted by industry. He and his colleagues also improved the process of seismic data collection, allowing them to image deep crustal structure and the deep continental margin. In 1989, Stoffa edited the groundbreaking book *Tau-p: A Plane Wave Approach to the Analysis of Seismic Data*.

At UT Austin, Stoffa and Mrinal Sen, professor and Jackson Chair in Applied Seismology, introduced genetic algorithms and very fast simulated annealing to geophysics and in 1995 published Global Optimization Methods in Geophysical Inversion. The second edition was published in 2013.

Building on this experience, as director of the Institute, Paul started a climate research program which used a Bayesian approach to estimate the uncertainties of climate models. In the late 1990s, the G. Unger Vetlesen Foundation contacted Stoffa to ask whether the Institute had any climate projects that they could fund.

"It was clear to Paul that we didn't do it, but we could be good at it," said Cliff Frohlich, associate director and senior research scientist at the Institute. "It was also clear that universities of the first class should do that and he was in the vanguard of making it happen."

Many of his colleagues at the Institute credit Stoffa with the clout and persistence that ultimately led to the establishment of a permanent home on a University of Texas campus in 2007 after many years in Galveston and at off-campus sites in Austin. The financial gifts of John Jackson and others cemented the construction of the new building.

Stoffa also won praise for his ability to teach and mentor graduate students, conduct advanced research, and be an effective administrator.

"He was devoted to his students," said Eleanor Picard, former assistant to Stoffa. "They all just loved him."

"He was a scientist with real ability and an administrator with skill," said Jamie Austin, senior research scientist at the Institute. "Yet he never lost sight of his work as a faculty member. It takes a smart man to cover all those bases. He did that extremely well and for a long time."

Stoffa also balanced the needs of the university with the larger academic research community. In 2003, he was asked by the National Science Foundation to build the management infrastructure for a new, international deep sea drilling program. Stoffa, with help from Austin, worked for two years to create IODP Management International, Inc. Now after several years of operation, the Integrated Ocean Drilling Program (IODP) has racked up an impressive list of research cruises throughout Earth's oceans.

In 2011, he received the Career Researcher Award from the Institute and in 2013, he was awarded Honorary Membership in the Society of Exploration Geophysicists.

Jackson School Inducts Four Legends into Hall of Distinction

In March 2013, the Jackson School inducted four geoscience legends into its Hall of Distinction. They were selected for their high-level accomplishments in academia, industry or government, as well as a strong affiliation with the Jackson School.

David S. "Scotty" Holland, Sr. was an integral part of UT's geosciences community for a number of decades. He served as a member of the Geology Foundation's Advisory Council for over 25 years, chairing the council from 1991 to 1993. The Jackson School's new Student Center that serves as the central hub for the UT geosciences community bears his name. His and his wife Jacque's strong belief in our community led them to also create a student geosciences excellence fund. In his professional life, he was an industry leader. He spent his early career as an exploration geologist in Midland, Texas with Marathon Oil Company and Pennzoil Company. He went on to serve in a number of leadership roles at Pennzoil, including President and Chief Executive Officer, before retiring in 1990. He died in January 2013.

John C. Maxwell was a pioneering researcher in the field of plate tectonics, contributing valuable scientific papers and thought leadership at a time when the new theory was widely debated within the petroleum industry. John was elected president of the American Geological Institute in 1971, and president of the Geological Society of America in 1973. He also served in a leadership capacity for a number of domestic and international scientific bodies, such as the National Science Foundation. During his career, John received numerous awards, including a Fulbright Research Scholarship and Guggenheim Scholarship for international studies. He believed deeply in supporting UT geosciences students. He and his wife Marian established an undergraduate geosciences scholarship in 2001. Additionally, as the William Stamps Farish Research Chair in Geology at UT, John supervised graduate students in completing 11 PhD dissertations and 3 Master's theses. He died in 2006.

Yosio Nakamura is a renowned geophysicist with special interests in seismology both here on Earth and on the Moon. He was a pioneering researcher for the Apollo Lunar Landing project in the 1970s, helping to advance our understanding of the Moon. More recently, he is finding new information about the interior of the Moon and assists younger scientists in planning future lunar missions. Yosio has made a tremendous impact upon the UT Institute for Geophysics, developing new ocean bottom seismometer instruments for improved underwater data collection. He has collaborated in cutting-edge research projects all over the globe, including the Gulf of Mexico, the Antarctic, western Australia and, more recently, a joint U.S.-Chinese project to study Taiwan's continent-collision zone. In addition to these feats, Yosio has been an invaluable colleague and a mentor to younger generations of scientists, helping to build the Jackson School's leadership in geophysics.

Chuck Williamson started his career at California-based oil company Unocal after graduating from UT Austin in 1978. Chuck went on to set the template for successful corporate mergers in the oil and gas industry, eventually advancing to become Chairman and CEO of Unocal and leading the company during the famous but unsuccessful purchase bid by the Chinese National Oil Corporation in 2005. He currently serves in executive roles for a number of Fortune 500 companies. Throughout the various phases of his career, he has remained steadfastly committed to the University of Texas and the Jackson School. He even serves the UT geosciences community through his passion for wine, recently leading a wine weekend in Sonoma for Jackson School supporters. As a member of the Geology Foundation Advisory Council, he is a prime example of the ties that bind us all.

To nominate someone for the Hall of Distinction, contact Karen Cochran (kcochran@jsg.utexas.edu) in the Development Office of the Jackson School of Geosciences.


David "Scotty" Holland


John Maxwell


Yosio Nakamura


Chuck Williamson

LIBRARY REPORT

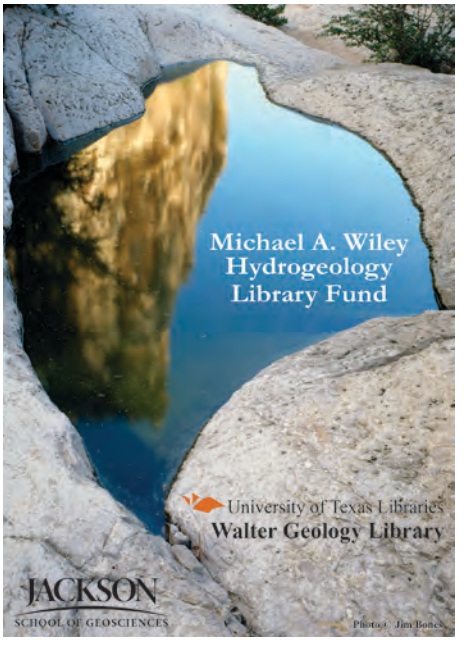
By Dennis Trombatore

The past academic year rushed by, as they all seem to do in hindsight, and the Walter Library continues to confront issues and opportunities. This year, we acquired a couple of very nice pieces of technology to make life easier: a brand new 40-inch Contex sheet map scanner and a BookEye book scanner that can quickly scan pages and assemble PDFs. The book scanner has been a particularly useful addition to our arsenal, as it gives users the ability to quickly produce PDFs on a flash drive for anything from course notes to book chapters (great for taking the relevant literature with you to the field!). At the end of the year, students also requested large mobile whiteboards for group study, and two of those have been received and are ready for use in the fall.

Another change we are implementing this summer is the consolidation of the Texas topographic map collection into the Perry-Castaneda Map Library. This move is due to the ready availability of these maps online, coupled with a real need for space to incorporate the large number of maps from the UNOCAL gift, which we have reviewed and are now processing for the collection. This will also better rationalize the map collections in the UT Libraries, with ALL topographic and bathymetric maps at the PCL map collection, and only geology maps in the Tobin Collection. Several staff in the libraries are getting basic training in GIS, and the UT Libraries are working on starting a GeoPortal as part of a multi-institution consortium. We hope to make further progress in this area in coming years.

The original donor to the Library Hydrogeology Fund, Mike Wiley, died in 2011, and we were informed that his estate left $367,000 to that fund, which has been renamed the Michael A. Wiley Hydrogeology Library Fund in his honor. We are having a bookplate designed, which will go in print volumes and on the library catalog records online for purchases made with this fund. The earnings on this fund will allow us to add substantially to the Walter Library in all areas of the water sciences.

This year's digitization news is focused on theses and dissertations. As the opportunity presents, we have been asking alumni to grant permission to digitize their Master's and Doctoral theses for our UT Digital Repository, which is the home of the official copies of new graduate theses. (See http://repositories.lib.utexas.edu/.)To date, there are 317 geology theses in the repository, of which between 100 and 200 pre-date the repository, representing only about 10 percent of the historic thesis collection. This process is especially important for the geology titles, which often include loose maps and glued in photographs, and are more and more difficult to preserve. Since the copyright of a thesis belongs to the author, we need individual permission to post the files, so if you would like to be included, please contact us at georequests@lib.utexas.edu.



We continue to process large volumes of gift materials – this year we have been working through a number of boxes from the Bureau of Economic Geology, and this summer we are receiving 30-plus cartons from the Edwards Aquifer Authority in San Antonio. We already own many of these items, but they have to be reviewed so that new materials can be added to maintain the legacy of research results from local agencies. Over the past several decades, most of the local Earth science collections have been either closed or downsized, so the Walter Library is the last and most comprehensive source for Earth sciences research in the region. We continue to store lesser used materials offsite, but our storage facility is also almost full, so space will be an increasing issue in the future. With the staff losses in the UT Library system, it is also becoming more difficult to acquire and process new materials for the collection, as the work is labor intensive and there are many fewer hands than there used to be. We continue to acquire internationally, using our many friends and contacts locally and globally to track down and obtain materials through purchase, exchange or gift for the collection from around the world.

Our GRA, Kara Scott, completed her M.S. in Information Science over the summer and has accepted a position as a cataloger and metadata analyst at the Baylor Library. Rattanaporn Fong-Ngern, after working in the Tobin Collection reviewing UNOCAL maps, has passed her comps and is off doing field work in Romania. Meanwhile, Armando Pecina and Zarina Moreno are off for study abroad. Irina Azcona, Be Nguyen, Nicole Raney, and Raanan Robertson graduated this May, and are moving on with their lives. Thanks to them all for their years of service to the Walter Library! This year's Guion Award winners were Kara Scott and Nicole Raney.

In staff news, Calla Smith-Dowling, unit manager and webmaster, is taking over map cataloging in addition to her other varied duties. Dennis Trombatore is the president of the Austin Geological Society for 2013-14, and remains chair of the AGI / GeoRef Advisory Committee. Pat Dickerson, our lead GeoRef indexer, has two major publications out this year, both of long gestation, in an AAPG Memoir and a GSA Special Paper. Go Pat!

To better understand how modern corals like this Hawaiian specimen might be impacted by the current trend of global ocean acidification, Rowan Martindale studies ancient corals from the Triassic.

Extinction Detective:

ROWAN MARTINDALE INVESTIGATES THE FATES OF ANCIENT REEFS

Growing up amid the crisp, cold landscape of the Canadian Rockies, Rowan Martindale's family liked to vacation in tropical environs with warm waters. As a result, the high-country farm girl learned to snorkel and scuba dive and explored coral reefs at an early age. Now, through her studies of ancient reefs, Martindale, an assistant professor in the Jackson School of Geosciences, is helping us understand the potential effects of the looming environmental threat from ocean acidification.

"I like reef ecosystems because you're not just looking at one thing," Martindale says. "You have to understand how the organisms building the reef work. You have to understand the oceanography and the chemistry. You have to look at the whole ecosystem which I find really exciting."

Coral reefs are sometimes called the rainforests of the sea. The fragile underwater environments, composed of animals and plants encased in calcium carbonate skeletons, cover just a tiny fraction of the planet, yet provide habitat for one-fourth of all marine species. But ocean acidification – a drop in ocean pH caused by an increase in carbon dioxide levels – threatens reefs' ability to sustain and rebuild themselves, which can trigger a crash in these essential marine environments. Concerns over current ocean acidification, related to greenhouse gas emissions, have generated plenty of research of ongoing shifts in the seas, but Martindale is looking back in time to provide answers about acidification, reef extinctions, and other impacts.

"There's been a lot of research on modern ocean acidification and looking at how different organisms respond," Martindale says, "but when you go into the rock record, especially in really deep time, there are very few tools that you can use to say whether ocean acidification occurred."

Triassic Park

Martindale grew up just outside Calgary, Alberta, and was interested in Albertan fossils from an early age. At Queen's University in Kingston, Ontario, Canada, she studied biology, but her interests in big-picture questions about evolution and species extinction led her to pursue a major in geology. Her undergraduate research thesis looked at cool-water carbonates and sediments around the island of Tasmania.

Looking to bring together her experience and interests in carbonate sedimentology, reef ecology, and environmental science, Martindale went to work on her Ph.D. at the University of Southern California. With input from her adviser, paleoecologist David Bottjer, she decided to study reefs and carbonates dating from the Late Triassic period, over 200 million years ago. During the Late Triassic, the supercontinent Pangaea made up the planet's landmass, there was no Atlantic Ocean, climates were

Rowan Martindale on the Steinplatte Wide in Austria.

Triassic reef from Austria.

much warmer and dinosaurs were beginning to take over the land.

Researchers previously thought North American Triassic reefs mostly existed as deeper water, tropical coral systems, but Martindale says her study sites in British Columbia, Oregon, and Nevada show that the prehistoric reefs grew along a thermal gradient, in both warm and cool, shallow waters. In the temperate systems, Martindale found that microbes, small organisms, and sponges – often overshadowed by the visually stunning corals – played important roles in nutrient cycling and reef construction.

"Surprisingly little work had been done, especially in North America, on Triassic reefs, and I realized there was a lot more nuance to their ecology," she says. "When you look under the microscope, each reef is unique."

She conducted similar work in the Austrian Alps where "The Sound of Music" was filmed.

Mass Extinctions

While 200 million years separate the Triassic from current times, Martindale says the ancient reefs have important ties to the modern ocean. Specifically, the Triassic marks the appearance of the ancestors of today's coral species, which built reefs together with sponges, and algae, in a similar way to their modern descendants. By studying the prehistoric and present conditions and changes, Martindale says, "We can use the past to tell us about the present."

That connection is particularly significant since the end of the Triassic was marked by a catastrophic mass extinction 201 million years ago. One of the planet's five mega-extinction events, scientists believe about three quarters of the planet's species were wiped out at the time. The oceans, Martindale says, suffered "one of the biggest reef collapses and the most severe extinction of modern corals."

The most accepted cause of the Triassic-Jurassic mass extinction is a series of massive volcanic eruptions, which would have released a sudden "burp" of carbon dioxide and other greenhouse gases – like we're experiencing today. Some investigators have also suggested ocean acidification was a factor, but there's less consensus on that point.

"It's one of the few times in geological history," Martindale says of the Late Triassic event, "where we might have an analog for what's going on in the modern ocean."

As part of her doctoral research, Martindale and colleagues gathered findings from volcanologists, sedimentologists, and climatologists who have studied the Triassic-Jurassic event. By reviewing measurements of climate and carbon dioxide concentrations, ocean carbonate sediments, the timing and size of eruptions, and records of the land and marine species that went extinct, the scholars recognized a surprising drop in ocean carbonate sediments and organisms with a carbonate skeleton at the extinction. That led Martindale and her colleagues to conclude that ocean acidification likely occurred as a product of the volcanic eruptions at the Triassic-Jurassic boundary and is "a reasonable explanation for why the extinction was so severe."

After completing her Ph.D, Martindale landed a postdoctoral position working with Dr. Andrew Knoll at Harvard University following up on her studies of reef paleoecology. She comes to Austin having turned her attention to other extinction events, the impacts on reefs, and the connections with ocean acidification.

"There are still a lot of time periods where very little research has been done," Martindale says.

Martindale is now studying the Pliensbachian-Toarcian, a more moderate extinction event about 183 million years ago, during the Early Jurassic Period. As with the older Triassic mass extinction, geoscientists attribute the turnover to volcanic eruptions. Indeed, there is evidence of warmer temperatures, lower oxygen in the ocean, and reef collapse, yet fewer organisms and species were killed off.

"Our hypothesis is this may have been an ocean acidification event as well, but first we have to find evidence of acidification," Martindale says. "People have suggested it might be, but no one has gone in and done the legwork. We plan to look at the geochemical proxies and the ecology of the reefs to see how they changed through time."

Before settling in at the Jackson School, Martindale has been carrying out field research in Morocco, Slovenia, Italy, and even back in Alberta, Canada, to study early Toarcian sites. If her hypothesis holds up, Martindale will face another major research question: If it was an acidification event, why wasn't this a mass extinction and why did so many species survive?

With a research field that relies on disciplines from sedimentology to geochemistry, Martindale looks forward to pursuing her work in collaboration with fellow Jackson School colleagues. She plans to team up with UT Austin geochemists, paleontologists, sedimentologists, and other scientists, and, she adds, "It doesn't hurt that we have (almost) every instrument under the sun." Martindale also expects to study local Permian reefs in Texas, giving her a much older class of sites to explore.

Ultimately, her inquiries into reef paleoecology, carbonate sedimentology, and ocean acidification could inform how we understand – and prepare for – changes now occurring in the ocean.

"If you want to talk about predictions for our oceans, you don't want to have only a 'disaster' scenario," Martindale says. "You want to understand how we can help a reef system survive an acidification event, so that what we're doing to the ocean right now doesn't result in another mass extinction."

"It's really interesting because everyone's working on modern ocean acidification, but very few people have looked to the past, and there's a lot of information in the rock record," Martindale says. "It's certainly a wide open niche." — *Joshua Zaffos* ✶

Martin Jackson in the Himilayas.

Salt of the Earth:

MARTIN JACKSON RISES TO THE TOP OF SALT TECTONICS RESEARCH

When he came to the Bureau of Economic Geology in 1980, Martin Jackson was a hard-rock kind of guy. He grew up in what was then Rhodesia (today, Zimbabwe), prospected for minerals there and in South Africa and Namibia, studied the metamorphic history of Precambrian gneisses in the Forbidden Area of the Namib Desert and taught structural and metamorphic geology at the University of Natal in South Africa. The geology he knew in southern Africa tended to be old, hard rocks sampled and mapped in outcrops. Nothing about his background suggested he might become the world's leading expert in salt tectonics, the study of the structure and movement of salt. Then after ten years he came to Texas and it was back to basics.

"I was plunged into a subsurface world of very young, soft rocks," he says. "It was a major retooling when I got here."

His first project was evaluating Oakwood salt dome in East Texas as a possible federal repository for high-level nuclear waste. His part of the Department of Energy (DOE)-funded project was to determine whether the salt was tectonically stable or not. Would the waste stay where it was put after millennia? After a few years of research, the whole study became moot when Congress directed the DOE to stop work on salt domes and focus on Yucca Mountain in Nevada.

Not long after, Bill Fisher, director of the Bureau at the time, called Jackson down to his office.

"He said, 'Jackson, it's time to bring in the groceries,' meaning that instead of being part of a large funded team, I had to attract support to replace the DOE by starting something completely new," recalls Jackson.

So he hatched a plan to build a physical modeling lab, which he dubbed the Applied Geodynamics Laboratory (AGL), to investigate the poorly understood world of salt tectonics. No such lab existed in the U.S. To augment seed money from UT Austin, he visited 13 oil and gas companies and asked them to join a consortium which would become one of the first two Industrial Associate programs at the Bureau and a model for several more programs later created by others. Marcus Milling, associate director of the Bureau at the time, helped him make some of those early pitches. Happily, all 13 companies accepted the offer.

At the time, says Jackson, the field of salt tectonics was "moribund." An NSF program manager assured him in 1981 that "the NSF would never waste funds on such a dead topic as [salt] diapirism." (A salt diapir is a blob of salt that has pierced, or appears to have pierced, surrounding sediments and is typically shaped like a plug or a ridge.) Because salt is impermeable and can trap oil and gas, knowing the location and shapes of salt domes was useful in finding hydrocarbons, but that's about as far as geologists understood salt diapirs. Their interest was all very applied. Few geologists were interested in how salt domes got to be where they were or how they related to the overall evolution of continental margins.

Jackson imagined that the AGL, which began in 1988, would run for perhaps three or four years and then wind down.

Fast forward 25 years. The AGL now has 32 participating companies and is widely considered the world's preeminent salt-tectonics laboratory. The AGL has brought in nearly $20 million in research funding to the university. Jackson and his colleagues undoubtedly delivered the groceries.

Some of the hottest areas in the world for oil and gas exploration today are deepwater salt basins such as the Gulf of Mexico, the North Sea, the Persian Gulf, the Caspian Sea area, and offshore Brazil and West Africa. Petroleum companies are spending billions of dollars in these areas searching for the next giant field. It's hard to imagine that the salt frontier would have been cracked open without the string of key insights that have sprung from the AGL.

Jackson too has risen diapir-like to the top of his field.

"He's the number one person in the world by a goodly margin," says Michael Hudec, senior research scientist and co-principal investigator at the AGL. "His papers are universally regarded as the most authoritative on salt tectonics. And his name is associated with most of the major concepts in salt tectonics."

Jackson doesn't consider himself a petroleum geologist, yet his work has had such an impact on the field that the American Association of Petroleum Geologists has awarded him more technical awards than anyone else, including what amounts to a lifetime achievement award, the Robert R. Berg Award for Outstanding Research.

Dipping strata on the northern edge of the Great Kavir salt desert. Image: M. Jackson.

Likewise the Geological Society of London recently awarded him one of its highest honors, the William Smith Medal, which recognizes outstanding contributions to applied and economic aspects of geoscience.

Inspiration

The seeds of the AGL's success were planted near the end of the research project on a proposed east Texas nuclear waste repository. Even after four years working on a salt dome, Jackson realized he still didn't fully understand the mechanics of salt tectonics. So he headed to Uppsala, Sweden to work with the leading light on the subject, Chris Talbot.

"He has influenced my career in salt tectonics more than any other person," says Jackson. "He's one of these clever, creative and original thinkers. In the early 1980s he alone was advancing the frontiers of salt tectonics."

Talbot's lab, which was named after Hans Ramberg who started it, was considered the best tectonic modeling lab in the world at the time. At its center were two big centrifuges that whirled around fist-sized models generating thousands of times normal gravity. That meant you could use stiff materials to mimic rock, sediments and salts and they would flow easily under these high gravity forces, but when you took them out and cut them, they would maintain their shape and intricate structures like slices of marbled rye bread.

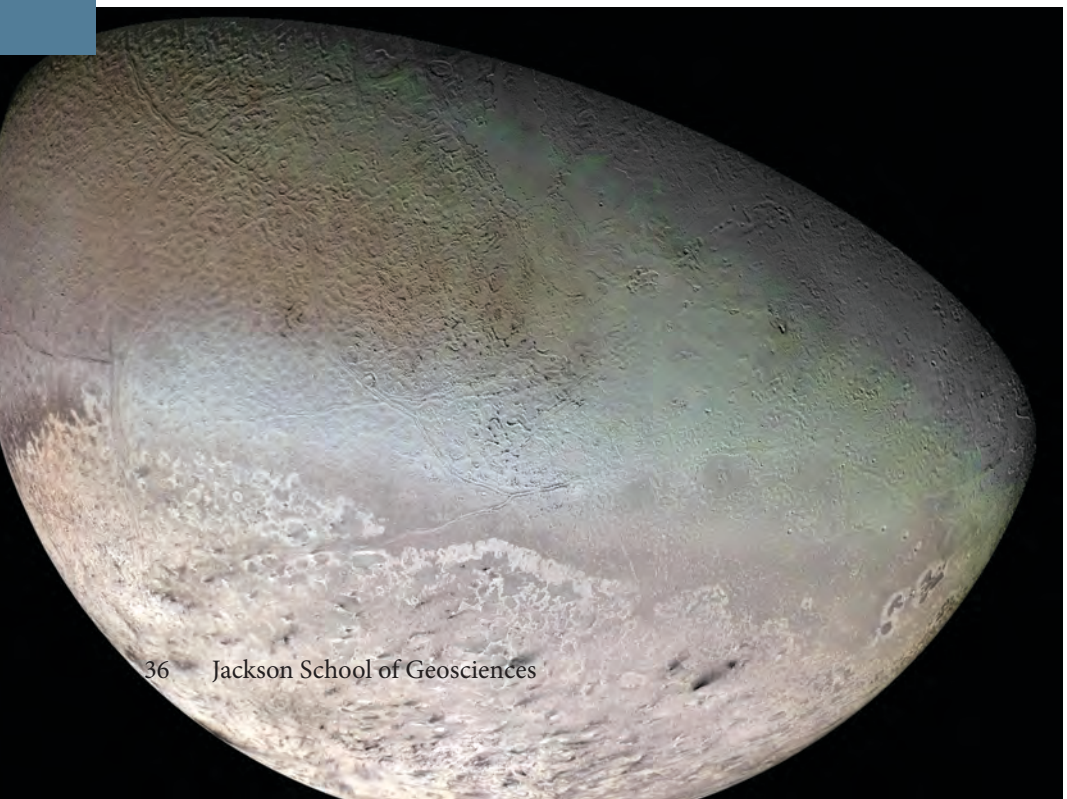
Together, with some of his remaining DOE funds, Jackson and Talbot created models of salt structures in the Great Kavir in Iran. The largest salt desert in the world, the Great Kavir looks like endless plains of mud flats studded with low hills. Those hills are the tops of salt diapirs. The researchers saw in their models an astonishing process: salt diapirs could coalesce near the surface, like individual trees merging into a high forest canopy. When they reviewed photographic and geologic evidence from the Great Kavir, they recognized similar structures to those they had modeled in the centrifuge. They dubbed the coalesced salt diapirs a salt canopy.

From above, a salt canopy looks like a single, huge, lobed mass of salt. Their key insight was that if salt diapirs were shaped like trees, there would be a lot of extra space around and between the trunks that wasn't filled by salt. Instead, there were sedimentary rocks and fluids, including maybe, just maybe, hydrocarbons. Within a short time, much larger salt canopies were found in great abundance by the oil industry in the northern Gulf of Mexico and later in basins such as offshore Angola and the Precaspian Basin of Kazakhstan.

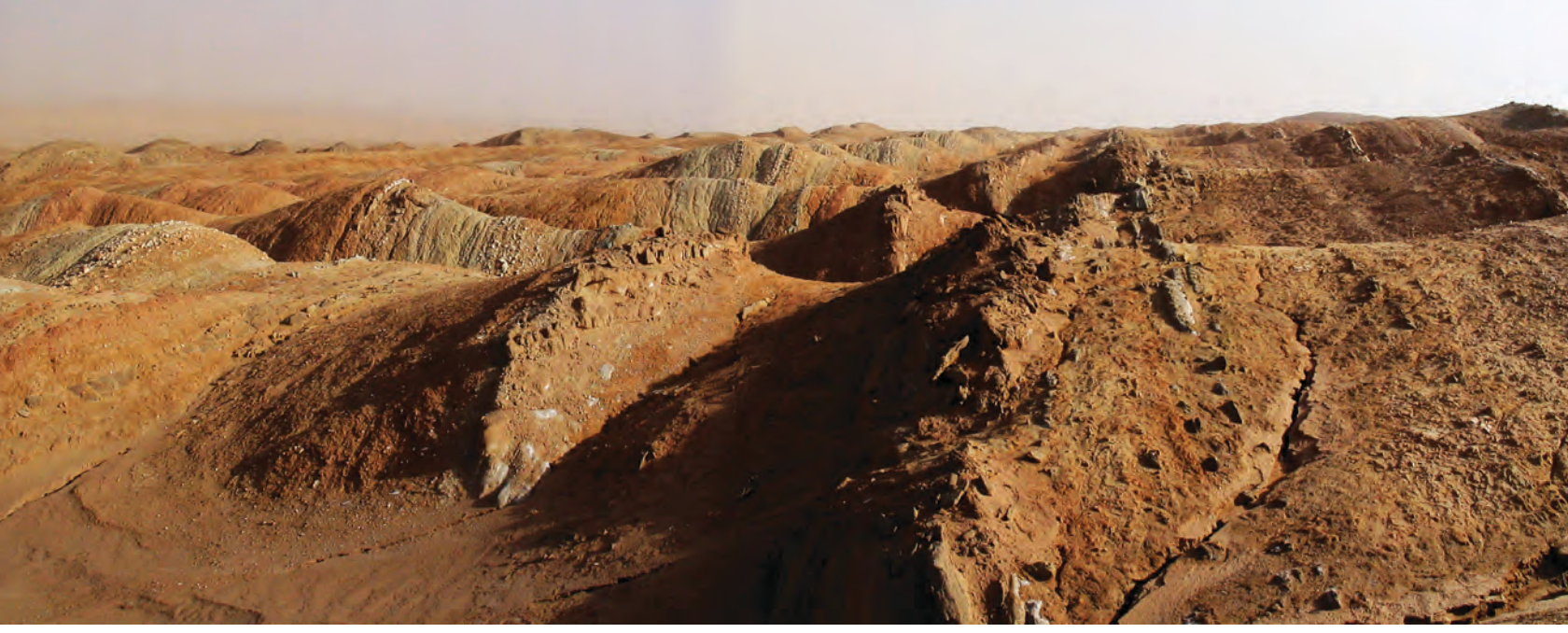
"Some of these canopies are very thin and if you drill past this salt, you pass into enormous thicknesses of sediment," says Jackson. "Here underneath the canopy, you might find subsalt treasure."

After two formative months in Talbot's lab, Jackson had his inspiration for a physical modeling lab at the Bureau.

"This was part of my initial sales pitch to the companies," says Jackson. "I'd say, 'Have you heard of a salt canopy?' And



Jackson helped explain the formation of cantaloupe terrain on the surface of Triton. Credit: NASA/JPL/USGS.



of course very few people had. They were intrigued to learn more."

A Great Ride

From its earliest days, the AGL has been fertile ground for salt tectonics research. In 1992, Jackson and his collaborator Bruno Vendeville published a set of papers that flipped the field on its head.

For 50 years, scientists had assumed that all of salt tectonics could be explained by treating salt bodies and the sediments surrounding them, called overburden, as stiff fluids. To make a physical model in the lab, you simply placed a denser fluid to represent the overburden on top of a less-dense fluid to represent salt. As the denser fluid sank, the buoyant fluid simulating salt was forced to rise as diapiric blobs through the sinking overburden. Along with scientists at Rennes University in France, Jackson and Vendeville believed this view was flawed because almost all overburden sediments are brittle and stronger than salt so that instead of flowing, the overburden tends to crack into pieces.

"It was thought that the salt would rise up like a fist from the deep, blasting its way through everything on top," says Michael Hudec. "In most cases, that's not true. Salt can only rise when sediment permits it to rise."

Unlike fluids, brittle materials can resist small forces, such as the buoyancy of less dense salt. As the deforming forces increase, the brittle overburden breaks as faults. And that allows salt to move.

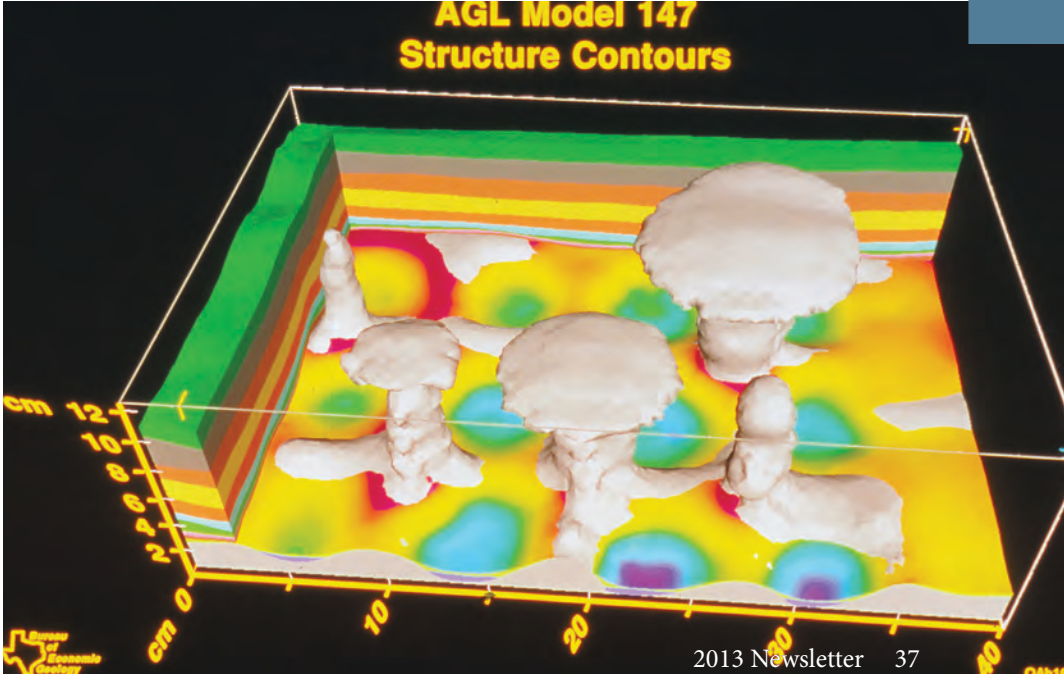
"Their insights changed the world," says Hudec. "Much of the literature became obsolete. For oil companies, every presentation that described how a salt structure grew had to change. You cannot work effectively in salt tectonics without reading Martin's work."

And the hits kept coming. Today, it's almost impossible to talk about salt tectonics without using terms and concepts developed at the AGL, including salt canopy, salt weld, allosuture, autosuture, reactive diapir, falling diapir, squeezed diapir, extrusive salt sheet, multidirectional extension, cryptic extension, and mock turtle.

One key to the AGL's success has been its ability to combine world-class physical models by colleagues Bruno Vendeville and Tim Dooley, numerical models especially by Dan Schultz-Ela and Maria Nikoulinaku, and industry seismic data exchanged through this industrial-academic consortium.

Following his boundless curiosity, Jackson has also hunted for signs of salt-tectonic activity on other planetary bodies. Applying what he's learned from lab models, seismic data and terrestrial field work, he explained how a puzzling canyon on Mars five times as large as the Grand Canyon likely formed as an enormous karst chasm, whose collapse triggered the rise of diapirs and outflow of a pale viscous material that may include salts. He also revealed a diapiric mechanism that makes parts of the surface of Neptune's icy moon Triton dimpled like the skin of a cantaloupe.

In 2008, Jackson and two colleagues,



A 3D computer image generated from a physical model shows mushroom-shaped diapirs rising through mildly deformed sediments. Physical model by Bruno Vendeville, 3D image generated by Giovanni Guglielmo, both of AGL/BEG.

David Roberts and Sig Snelson, published the AAPG Memoir Salt Tectonics: A Global Perspective, a definitive book on the subject.

In 2012, Jackson and Hudec produced the much-anticipated digital and paper atlas *The Salt Mine*, an interactive resource about salt tectonics. The most comprehensive collection of salt-tectonic images and animations ever assembled, the atlas contains more than 1400 images of salt structures around the world, including field exposures, seismic sections, geologic cross sections, conceptual sketches, animations and AGL's physical models.

Jackson and Hudec are now writing a textbook on salt tectonics. Even after decades of research, and writing over 100 scientific papers and three books, Jackson says the textbook project is revealing new aspects of salt tectonics he had never studied previously.

According to Hudec, there are three traits that make Jackson such an effective scientist: great people skills, healthy skepticism and openness to different viewpoints.

"First, he's a great guy, which means anybody and everybody wants to collaborate with him," says Hudec. "Second, he's very good at ignoring conventional wisdom when the data pointis in the other direction. And third, he doesn't insist on being right. Some people, when they become famous, become the authority beyond question. That's not Martin, he's still open to debate and changing his mind."

For his part, Jackson attributes much of his success to being in the right place at the right time. Petroleum exploration in the 1980s and 1990s was moving out into deeper and deeper water, where salt tectonics became more and more complicated. When he began, there was a vacuum of researchers and fundamental knowledge in salt tectonics even in much simpler settings.

"The whole salt tectonics thing could have worked out completely differently," says Jackson. "I could have been continuing to work in a field that I enjoyed but nobody was interested in and was of no practical use. And fortuitously, salt tectonics became of vital practical importance to industry. It was pure chance that I had a head start in understanding the topic when it began attracting so much interest." — *Marc Airhart* ✶

Jay Banner teaching an environmental science field course along a highway in Austin, Texas.

Four Keys:

JAY BANNER FINDS BALANCE IN TEACHING AND RESEARCH

When Jay Banner accepted his first faculty position, teaching was just something he had to do so he could do what he really loved—research. In particular, studying the processes by which ocean sediments become rock, tracing underground flow paths of water and using cave formations to reconstruct past climate. His first teaching assignment was an undergraduate course in sedimentary geology.

"I somehow felt compelled in those 15 weeks to teach them everything I had learned in 16 years [of post-secondary education]," says Banner, professor in the Jackson School of Geosciences and director of the university's Environmental Science Institute. "That works out to about four months per lecture. So I was talking non-stop at too high a level, about too much stuff."

His students got the last word, though, when it came time for evaluations. One comment has stuck with him through all those years: "Banner should be giving these lectures to the other faculty."

He took those harsh evaluations as a challenge. When attending seminars and lectures at the university and at professional conferences, he now found himself not just listening to the scientific results but also considering what made a speaker effective or not. Building on this insight for his next course, he put a more focused effort into planning each lesson. Eventually he realized he actually liked teaching.

He had discovered one of four keys to great teaching, which he sums up with the mantra "less is more." Instead of trying to fill students up with facts, help them develop critical thinking and problem solving skills. Those fundamental skills will last much longer than mere facts as they go on to work in the real world.

"Each semester I throttle back a little more," he says. "I think I'm finally getting there."

He recently received three of the university's highest teaching awards: a Board of Regents' Outstanding Teaching Award (2013), a Friar's Centennial Teaching Fellowship (2011), and membership in the university's Academy of Distinguished Teachers (2011). He's also won the Knebel Distinguished Teaching Award from the Department of Geological Sciences (three times) and the Outstanding Educator Award from the Jackson School of Geosciences.

Second Key: Get Them Out in the Field

As an undergraduate at the University of Pennsylvania, Jay Banner first majored in chemistry. But then after a couple of years, unable to see the applications of chemistry to real-life problems, he switched to geology.

Near the end of his bachelor's degree, he had to take a capstone field course designed to integrate what he'd learned throughout his degree and reinforce all those facts and textbook illustrations with concrete, so-that's-what-it-looks-like examples. His university didn't offer a capstone field course, so he headed to West Texas to join the group at Sul Ross State University. It was his first time both west of the Mississippi and in the desert.

The class would set out from the Sul Ross campus on trips to Big Bend National Park and other parts of Trans-Pecos Texas. One day, he came up over a hill and saw an igneous ring dike, a wall of magmatic rock standing above the surrounding land due to its resistance to erosion.

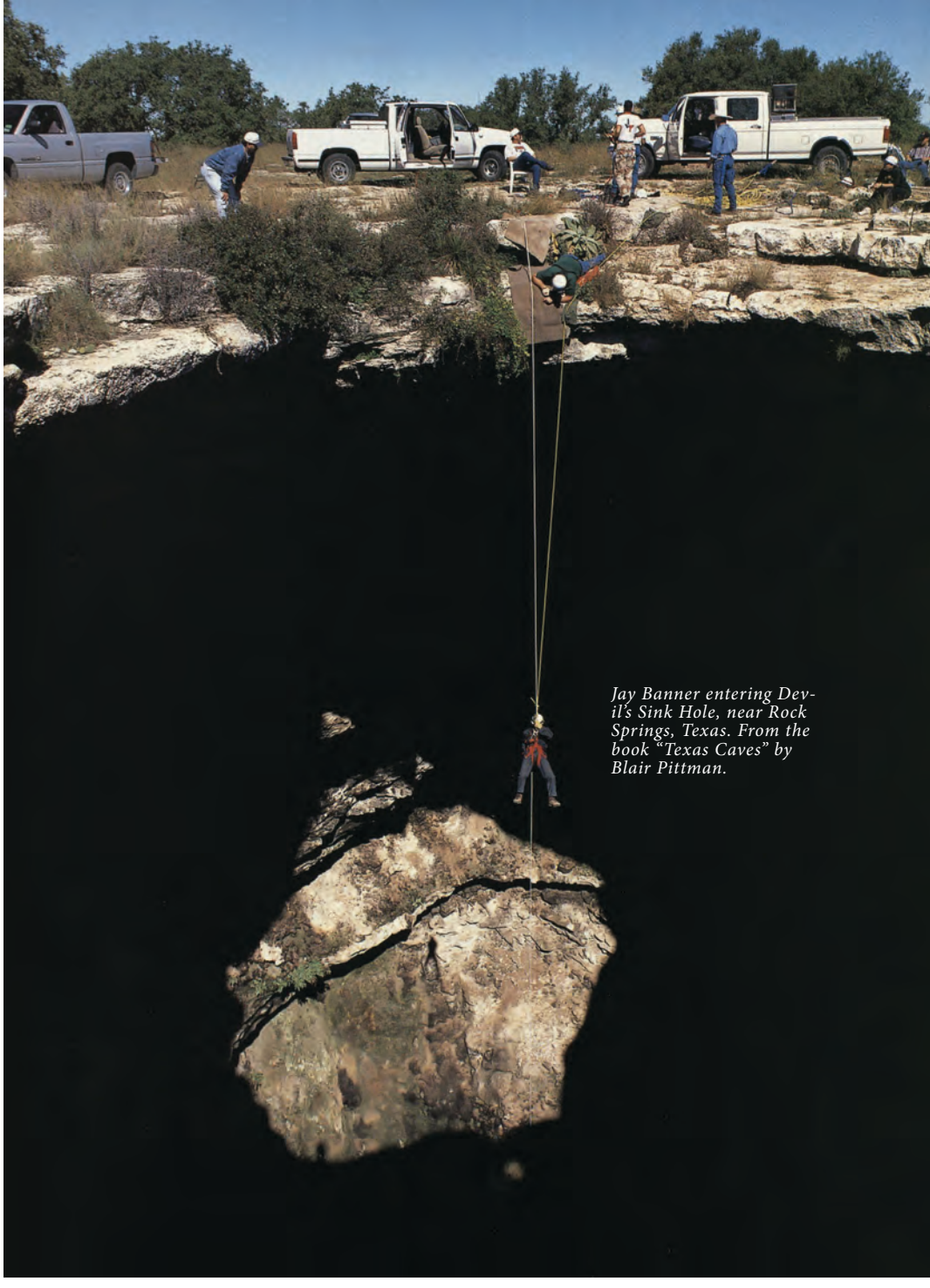
"I thought Holy Cow, it was a textbook just jumping to life," he says. He kept having these light bulb moments.

"Up until then, I wasn't convinced about my decision to switch to geology," he says. "After a couple of weeks, I had an epiphany. Oh yes, this is what I was meant to do."

Not only did it confirm his choice of major, it taught him the second key to great teaching: get students out in the field. By getting out of the classroom and engaging all their senses, students absorb the concepts more vividly and, if they're lucky, find their passion.

Many years later, Banner chaired the committee that drew up UT Austin's first degree plan for a B.S. in environmental science, which was approved in 2010. As part of the core requirements for that degree, he designed and now teaches an environmental field course taken in the second semester of college, not a capstone course taken at the end of the degree.

"The idea is that if you get students as jazzed as I was on my field course, but do it early in their career, it might serve them better so that when they're suffering through math and chemistry and physics, they'll understand why," he says. "They'll see the value of having those quantitative skills and the fundamental technological know-how."



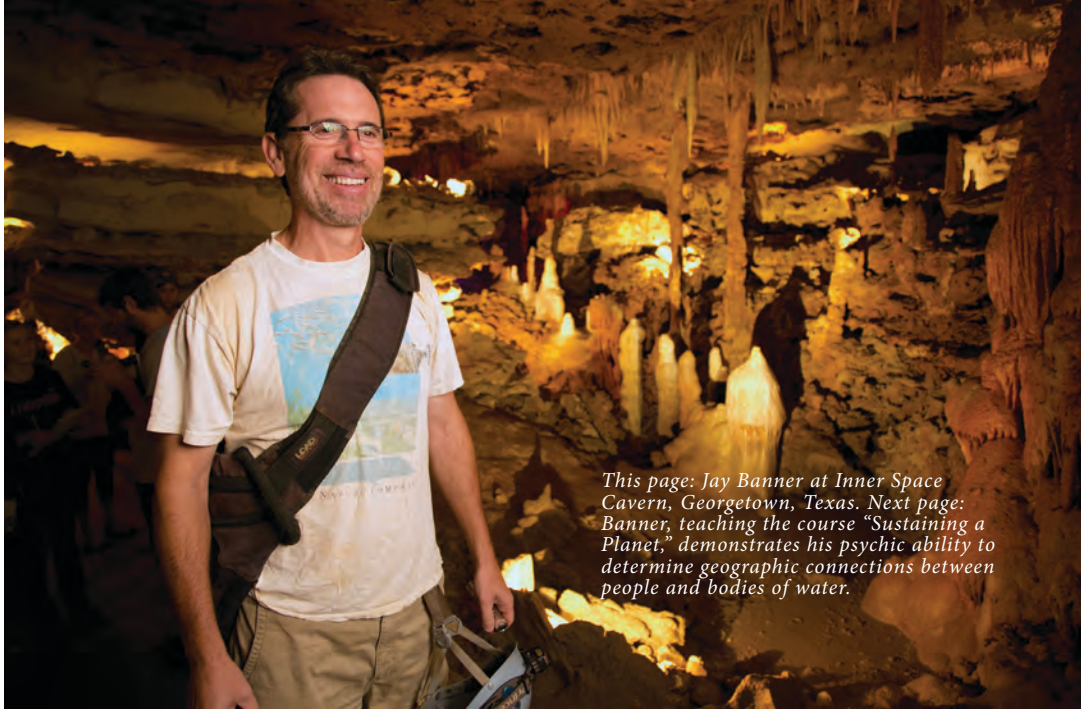
Jay Banner entering Devil's Sink Hole, near Rock Springs, Texas. From the book "Texas Caves" by Blair Pittman.

Time Machines

For his Ph.D., Banner used isotopic tracer techniques to study how ancient marine sediments are transformed through the process of diagenesis, from the time they are deposited as sediments, become buried, interact with fluids flowing through them, and eventually become carbonate rocks. He focused on Mississippian-age marine limestones deposited by an ancient interior ocean in present-day Iowa, Illinois, and Missouri approximately 350 million years ago.

Later, as a professor, he and master's degree student MaryLynn Musgrove, now a hydrologist with the U.S. Geological Survey, were surprised to discover that, based on isotopic analyses, water discharging from springs in Missouri had originated over a thousand kilometers away in the Front Range of Colorado. They also helped solve a long-standing mystery about why groundwater in that part of Missouri was nearly as salty as seawater.

Before coming to Austin to join the faculty in the Department of Geological Sciences, Banner spent part of his time as a postdoctoral researcher studying groundwater chemistry in a popular tourist cave in Barbados. His work was aimed at



This page: Jay Banner at Inner Space Cavern, Georgetown, Texas. Next page: Banner, teaching the course "Sustaining a Planet," demonstrates his psychic ability to determine geographic connections between people and bodies of water.

helping islanders better understand how their groundwater system worked, a system which provided the growing nation's only source of freshwater.

One day he was squatting in a low-ceilinged room in the cave collecting water dripping from the ceiling, being very careful not to bump into a stalagmite right behind him. Looking at the rocky tower that had grown upward over the millennia from the floor of the cave, he stared at the stalagmite and wondered, could this formation tell me something about past climate?

He suspected strontium isotopes might hold the key. He knew, for example, that the limestone rocks containing the caves had a different strontium isotope signature than the soils above and that rainwater usually has essentially no strontium. Just like your clothes when you walk through a room full of cigar smokers or a chocolate factory, water moving through the soil and limestone should pick up a whiff of the places it's been. Banner reasoned that during rainy periods, water moves quickly through the system and doesn't have time to get an imprint from the limestone, whereas during periods of low rainfall, water has time to pick up the limestone strontium signature.

He and his colleagues studied several Barbados speleothems, a catchall term for stalagmites and other cave formations. From their new way to apply strontium isotopes (limestone signature = dry; soil signature = wet), they interpreted changes in strontium isotope ratios as changes in wetness over time going back 5,500 years. It was the first time the technique was applied to speleothems.

They identified an extremely dry period about 1,200 years ago which coincided with other evidence of a major drought in the Mesoamerican tropics and which some experts have linked to the collapse of Mayan civilization.

"This is what got me started looking at speleothems and I've never looked back," he says.

See the Jackson School website (look for multimedia on the news page) for a video on speleothem research at Westcave Preserve.

An Eye on Texas Droughts

Since coming to Austin in 1990, Banner has extended his research with speleothems, and also with tree rings, to address one of the biggest concerns on the minds of Texans—drought. The state is still in the grips of a drought that began in fall 2010. The state experienced its worst single-year drought in 2011. Agricultural losses in that year alone were more than $7 billion. Rather than see their herds starve, cattlemen sold off their stock in record numbers. The water supply to rice farmers on the lower Colorado River was entirely cut off to save water for cities such as Austin.

Banner warns it could get a lot worse.

He and his colleagues used tree rings to reconstruct the history of Texas droughts for the past five centuries. Their study, in combination with others, found a number of droughts longer and more severe than the six-year 1950s drought, the worst multi-year drought in the historical record. Some droughts in the pre-historic tree-ring record lasted 20 or 30 years. Since the 1500s, droughts lasting a decade or more have occurred in Texas at least once a century. As if that weren't ominous enough, some climate models predict more frequent and severe droughts in Texas during the coming century.

At Westcave, a small cave about an hour from Austin, Banner and his colleagues are now trying to understand what triggers droughts and what turns an ordinary drought into a record-busting mega-drought.

Thanks to thick insulating rock walls and small openings to the surface, the air inside most Texas caves hovers around the same temperature year round. It's what makes them so refreshing on a hot summer day, but not very useful for gauging past temperatures. Fortunately, Westcave isn't like most caves. Because it's small and has big, wide open entrances, the temperature inside is always about the same as the temperature outside. That makes it one of the few caves in Texas where speleothems could possibly record real outside air temperatures.

Working with Banner, graduate student Richard Casteel, postdoctoral fellow Weimin Feng, and undergraduate student Ayla Heinz Frye have shown—using natural and experimentally-grown speleothems in the cave—that oxygen isotope measurements in speleothems from Westcave indeed record changes in air temperature over the past decade. Now, their objectives include going back thousands of years with high enough resolution to see not just individual years, but changes from season to season, and to

combine such a temperature record with drought records from tree rings to better understand whether severe droughts are driven more by heat or lack of rainfall

Hot Science

As a professor, Banner has managed to strike a balance between teaching and research without sacrificing either. As director of the university's Environmental Science Institute (ESI), he's also been at the forefront of public outreach from the university.

In 1999, he began organizing a series of public lectures that have become the most highly visible and successful of the institute's projects. The Hot Science - Cool Talks series invites K-12 teachers, their students and the general public to hear from scientists doing groundbreaking research.

Hot Science talks typically draw more than 400 people—occasionally reaching overflow crowds of 600 or more—an impressive turnout given that they're usually held on a Friday evening. The talks, held six times a year, are also webcast live for those who can't attend in person. Teachers receive free classroom materials that enable them to give their own lessons on the featured topic. So far, 83 events have been held and more are in the works.

Through the ESI, Banner is also the principal investigator for a National Science Foundation-funded project called Research Experience for Undergraduates (REU) in The Science of Global Change and Sustainability. The program brings about 10 students to UT Austin every summer and pairs them with faculty mentors such as Banner to work on 10-week research projects. Many of the students, such as Heinz Frye, come from smaller universities with few research opportunities and facilities.

Summer REU research projects address major societal challenges such as climate change, loss of biodiversity, and threats to water resources and food supplies. Students learn how to do research, design their own short research project, and present their results in a student symposium.

Banner notes that fewer and fewer students are choosing careers in science, engineering and math, a trend that does not bode well for the future of a country long seen as innovative in science and technology.

"If you can get students involved in research, they get excited about it and more of them choose to go into it," he says.

That's why he says a third key to great teaching is to give students a chance to do real research.

Fourth Key: Get Their Attention

So, class, let's review what we've learned so far about great teaching: keep it simple, get them out in the field and give them research experience. Last but not least, Banner says a fourth key is to make it vivid.

"When you're looking out at 240 faces, if all you're doing is standing still next to the PowerPoint and clicking through, eventually those faces are going to fade," he says. "They're not going to continue to pay attention."

You can see many of his strategies for making teaching more vivid if you drop by Sustaining a Planet, an interdisciplinary class he created with engineering professor David Allen in 2006. He continues to co-teach the class every year.

Banner enhances his presentations with videos, animations, and pop music, all designed to help reinforce concepts presented in a given lecture. He invites a student to run across the room and throw a football to demonstrate the Coriolis Effect. He models atmospheric circulation by heating a laundry bag full of air and letting it rise to the ceiling of a large lecture hall. He shows students clips of a psychic on the TV show Crossing Over and then demonstrates his own psychic ability to randomly pick students out of the lecture hall and reveal their relationships to bodies of water.

"I challenge them to use the scientific method to prove that either I have special abilities or I'm full of it," he says.

Sustaining a Planet was the first of the university's signature courses, interdisciplinary classes taught by engaging faculty as part of every student's core requirements. Many of the students do not have a background, or even an expressed interest in, science and the environment. While Banner's primary goal is to help students develop the ability to think critically about scientific concepts, it's just as important to him that he gets them fired up about science. He admits he's come a long way since that very first class in 1990, when he wanted to teach students everything he knew.

"I think what makes a good teacher is that you share with your students your excitement of scientific discovery, what gets you jazzed about science," he says. "If I can impart some of that to students, then I think I'm doing a good job as a teacher." — *Marc Airhart* ✷

Meet More JSG Scientists

Find profiles on our website of the more than 23 faculty we've hired since 2008, plus features on our research scientists and established faculty.

SUMMER FIELD CAMPS

From Austin to the Artic, Courtesy of Statoil

For the first time, Norwegian-based Statoil invited a group of students from a non-Norwegian university on the company's Svalex Arctic field trip. The seven-day field course takes place on Svalbard, an archipelago in the Arctic Ocean that is the northernmost part of Norway. Participants work in multidisciplinary teams drawn from geology, geophysics, drilling, and petroleum technology. Traditionally, the course brings together students from six Norwegian universities. In 2013, Statoil added 60 graduate students and 15 professors from The University of Texas at Austin.

"This year we expanded the expedition because of our long-term growth ambitions in the U.S. and our partnership with UT," explained Statoil's Brit Ragnhildstveit. As Statoil grows in the U.S., the company has placed a premium on partnerships with top-tier universities, with a particular focus on UT Austin, where Statoil recently signed a multi-year, mulit-million dollar agreement to sponsor scholarships and research projects.

Jackson School participants loved the field course. The geology in Svalbard is dramatic and varied, and highly exposed, offering a unique introduction to the the Barents Sea and the Arctic.

To learn more about the trip, check out the video recap on the Jackson School website and keep an eye out for the article in UT Austin's alumni magazine, *The Alcalde*, which was heading to press about the same time as this edition of the *JSG Newsletter*.

Photos by Rose Cahalan/*Alcalde*.

SUMMER FIELD CAMPS

Scenes from Geo 660, Hydrogeology, and Marine Geosciences & Geophysics Field Courses

Opposite page: Testing water quality at Gorman Falls in Colorado Bend State Park near San Saba, Texas and (middle left) at the Bureau of Economic Geology's Devine test site; Geo 660, Wyoming.

This page: Marisa Vara with the broom on the R/V Manta, with Dallas Dunlap and alumni Bobby Reece; Katie Bales checking data on board the R/V Manta; Geo 660 students mapping in Wyoming.

Photos courtesy of Marina Frederrik, Mark Helper, Kevan Moffet, Nancy Ford/Midden Media (MG&G).

In the wake of Hurricane Sandy, debris and destruction can be seen in and around the houses in Breezy Point, N.Y. Over 100 houses burned to the ground as flood waters isolated the community from firemen. Image: FEMA.

Right in Time

In Wake of Hurricane Sandy, UTIG Scientists Lead Rapid Response Assessment of Vital Barrier Sediments

By J.B. Bird

Even before Hurricane Sandy hit residents of the East Coast at the end of October 2012, the storm began to reach viewers with unprecedented scope and immediacy. Thanks to social media, and the simple fact that the storm hit a major center of traditional media, Sandy ranks with Hurricane Katrina as the most closely watched natural disaster in human history. YouTube videos showed its massive waves, television broadcasts emanated from flooded city streets, and Instagram photos from thousands of citizen-journalists showed us flattened towns and acres of swamped cars. On smart phones, computer screens, and televisions, millions of people watched the storm unfold virtually in real time.

All of this took place in the fast-paced timescale of current events, and the flood of images raised predictable post-disaster questions demanding quick answers: Are friends in New York and New Jersey safe? Will the state and federal governments respond effectively? Where will refugees find shelter and recuperate?

But while questions on the human time-scale were paramount, Sandy, like so many natural disasters, also reminded us of the geologic time-scale. Most natural disasters, after all, represent precise moments when long-range geologic processes, like the stress of tectonic plates or the gradual expansion of the oceans, burst into our daily lives. Suddenly, as nature wreaks havoc, processes that only geoscientists follow with regularity take center stage.

Geologic issues were almost immediately on the minds of a group working at the Institute for Geophysics who specialize in coastal processes. For them, the storm raised questions that, like

the material needs of the devastated inhabitants, needed to be addressed quickly—very quickly, in geologic terms.

"Some of the processes at play in major storms like Sandy and Ike are vital to our understanding of coastal geologic processes," said John Goff, a senior research scientist at the Institute who did ground breaking research on coastal damage after Hurricane Ike (2010). "Unfortunately, the signs these events leave can be highly ephemeral. You have to get out there quickly if you want to measure them."

Of particular interest after Sandy were the sediments offshore of New York and Long Island. While wind and waves destroyed structures on land, what was happening to the shifting structure of sand that creates the barrier systems just off the coasts? Understanding how the storm was reshaping these systems could help answer fundamental questions about the sedimentary record.

It could also be vital to coastal inhabitants. The sediments form the protective wall of sand that dissipates storm surges, protects millions of people in New York and Long Island, and shelters biologically diverse estuaries and ecosystems. In a heavily populated New York-New Jersey region, politicians will spare few expenses to restore the offshore barriers to pre-Sandy conditions.

But it's hard to restore a sedimentary system if you don't understand it—or, as occurred after Hurricane Ike hit Galveston, if you don't know where the sediments were dispersed after the Hurricane.

"As with Ike, we wanted to see after Sandy where the sand went as a result of the storm," said Goff. "With Ike, we found that the ebb of the storm surge moved a lot of beach barrier sand off shore."

The danger with any storm of Sandy's magnitude, added Goff's colleague at the Institute, Jamie Austin, is that "a lot of the sand gets pushed too far off shore, beyond the ability of normal processes to reincorporate it into the system that nourishes the barrier naturally."

When that happens, the only way to restore a sedimentary system may be to recover sand from new, offshore locations manually and deposit it where it was before the storm.

"The cost to society for these restoration projects can be huge," said Austin, "so we need to get the sediment budget details absolutely right."

Time to Move

As Sandy was lashing the Northeast, Terry Quinn, director of the Institute for Geophysics (and a professor in the Jackson School), quickly realized the importance of getting solid data on the region's coastal sediments. Quinn almost immediately contacted Goff and Austin to encourage them to put together a rapid response expedition to Long Island. The Institute for Geophysics has been a pioneer in rapid response geoscience. Partly at its urging, the Jackson School made rapid response a strategic priority in 2007. The school has since funded six expeditions (see sidebar) involving research scientists and faculty from across the school. Scientists from the Institute have led four of them.

"I knew right after Sandy that if we were going to continue to be a major player in rapid response geoscience," said Quinn, "this was a moment to answer the call."

With Quinn's encouragement, Goff and Austin got to work. They requested and obtained funding from Sharon Mosher, dean of the Jackson School, and then assembled as quickly as possible the local research partners and logistical elements to conduct a survey of the offshore sediments. Beth Christensen was enlisted from Stony Brook University in New York and Roger Flood from Adelphi University in New Jersey. Steffen Sastrup and graduate student Cassandra Browne of the Institute rounded out the team, with co-principal investigators Goff and Austin.

For conventional marine geoscience research it normally takes months, and sometimes years, to pull together all of the moving parts: funders, research vessels, technology, support staff, and scientists with complimentary objectives. In contrast, rapid response missions require immediate funding, highly focused research objectives, and a team that can take up and move on a moment's notice. Employing mainly full-time researchers who are not tied to the academic calendar, the Institute is in an ideal position to handle rapid response science, as Sandy demonstrated. By January 4, Goff, Austin, and the team were on the waters off Long Island.

Working with local partners was absolutely critical to moving

John Goff and Beth Christensen on the R/V Seawolf outside Manhattan shipping out to their offshore field sites.

Left to right: Brian Gagliardi, Steffen Sastrup, Beth Christensen, Cassandra Browne, and Jamie Austin (foreground) seek warmth in the cabin of the Stony Brook University's R/V Seawolf.

quickly, stressed Austin. The team required significant help lining up ships, equipment, and even basics like accommodation, which can be a major challenge when entering a disaster-torn region. They needed local scientific expertise. And they also had to have access to baseline data to make before-and-after comparisons.

With strong logistical support, particularly from Stony Brook, the team was able to secure two vessels and conduct 10 days of marine research with a primary goal of assessing the storm's impact on the seabed. The surveys included multibeam bathymetric swath mapping, compressed high-intensity radar pulse (CHIRP), and surface sediment sampling "to provide ground truth for the geophysical data," as the researchers reported in the September 24 edition of EOS.

By design, the offshore surveys covered regions that had been previously studied by Stony Brook and the USGS. The team also targeted the area offshore Fire Island where the storm opened up an inlet that appears to have become a conduit for transferring barrier island sediments offshore.

Favoring the Brave

For the first 10 days on Stony Brook University's R/V Seawolf, the research took place under conditions that were relatively benign for January in Long Island. But then the team switched to Stony Brook's smaller R/V Pritchard, "and our luck went all out the window," said Goff. The region experienced some of the coldest temperatures it had ever recorded in January. Between shifts on a treacherously icy deck, team members huddled for warmth inside the ship's small cabin, with winds outside howling at 30 knots.

"To work in places that have been effected by these storms can be a real challenge," said Goff.

Rapid response missions are often difficult, but as past Jackson School expeditions have shown, the chance to document the fleeting record of a major geologic event can make all of the rigors worthwhile.

The Institute team presents the results of their research at a Hurricane Sandy panel at the 2013 annual meeting of the American Geophysical Union (AGU). A few preliminary results were suggested in their September EOS summary. (By design, the EOS article reported on the process, not the results.)

Goff indicated three major takeaways from the research. The first involved mud. While swath-mapping the sea bed, the team was surprised to find a surficial mud deposit, a murky layer up to half a meter thick in places. The mud was gone later that winter, leading the Institute team to hypothesize that these were ephemeral deposits eroded by the storm and then rapidly dispersed. Geochemical investigation is ongoing to determine the provenance of the mud layer, which may have included churned up toxins.

"Another surprising observation," reported the scientists, "was the widespread occurrence of hummocky bedforms [in all surveyed areas] where none had been observed prestorm." As many stratigraphers know, hummocky bedforms are indicators of shallow, storm-dominated environments, but modern observations of the morphology are rare. "Sandy represents a remarkable natural experiment in the formation of this morphology, which could provide clues to offshore sediment transport during the storm," the team reported in EOS. The hummocky bedforms, like the mud, were also another highly ephemeral trace of the storm, the kind of evidence only a rapid response mission can detect.

In the area of greatest immediate concern to residents on the coast, the team found encouraging news. Preliminary results indicate that the big bed forms protecting the coast moved during the storm.

"The shore face responded the way it is supposed to," said Goff, who noted the difference from Ike, where barrier sediments were carried away.

As a result, Goff says, "We didn't see any widespread erosion on the shore face. The bedforms were basically a shield for the shore face." While the storm wreaked havoc on land, it did not do a lot of damage to the barrier system, which bodes well for long-term prospects in New York and Long Island.

In the Geologic Present

With a U.S. death toll of about 125 and U.S. property damages estimated north of $60 billion, Sandy was a devastating reminder of how human time is just a blip within the longer sweep of geologic time. Like the rising seas that have raised new questions about New York City's vulnerability to storms, geologic processes can quickly reshape human history.

Today we can follow a storm like Sandy in real time, but to understand it, we need sound science and a deeper understanding of the geologic forces at work over the long haul.

Paradoxically, one of the best ways to understand those long-term forces is to move quickly — to mount rapid response geoscience missions that will catch the fleeting traces of geologic processes that will help people prepare for the next big storm. ✷

Sandy breached an inlet on Fire Island that appears to be moving sediments offshore. Image: NOAA.

Getting Ready for the Next One: The Case for Rapid Response Geoscience

In its inaugural strategic plan, the Jackson School made rapid response science a strategic priority, noting that "a new paradigm is required to enable rapid collection of data when the urgency is greatest."

The idea bubbled up from scientists across the school, but particularly from the Institute for Geophysics, which has traditionally been a leader in research relating to natural disasters. Of course, research on disasters can help save lives, but it can also be valuable basic research, since major events often leave a profound mark on the geologic record. As a community, however, geoscientists have traditionally been hamstrung in their ability to make critical, time-sensitive observations of major transient events. The research is expensive, and generally geoscientists must write proposals well in advance to obtain funding – to study events that have already taken place.

The Jackson School made a strategic decision, therefore, to step in and attempt to fund a limited number of rapid response missions. Since 2007, the school has funded six such expeditions. From Haiti to the Solomon Islands, these high-profile missions have been highly successful at documenting precise, fleeting evidence of major disasters. The results have helped communities like Galveston cope with budgetary responses to disaster planning, while bolstering the voice for public policy based on sound science in Haiti, Chile, and other locations.

Rapid response science is expensive, but the Jackson School hopes to continue to pioneer this exciting new paradigm. Dean Sharon Mosher sees the research as an especially natural extension of the school's mission, to "advance understanding of the Earth for the lasting benefit of humankind."

"Rapid response requires extensive and diverse scientific talent and broad capabilities in technology and equipment," says Mosher. It also requires a cadre of scientists who have both the interest and flexibility to respond to breaking events. "We have the talent and capabilities across the school, and our research scientists at the Institute have the ability to get out into the field on short notice. All of this puts the Jackson School in a unique position to be a leader in rapid response," says Mosher.

From their own experiences documenting the impact of Hurricane Sandy, John Goff and Jamie Austin of the Institute see a benefit to rapid response that goes beyond the fundamental science.

> **"... because there is always a next one."**
> ***—Jamie Austin***

"Getting ourselves out there on the front line, meeting people and being seen by people who were affected by Sandy was very important," says Goff. The University of Texas at Austin logo, emblazoned on their research van, drew warm responses throughout the trip. "Everywhere, people wanted to know what we were studying, and they were grateful to learn that this science from Texas might help the region prepare for future storms."

"It puts a face on science and says we're going to help," adds Austin. "If we're going to be relevant, we have to be engaging our students, and engaging our colleagues and technical people in service to the public."

Like Mosher, Austin believes the Jackson School is uniquely positioned to succeed in rapid response because of its depth, breadth, and global reach. And the school, he believes, has a responsibility to lead.

"Rapid response science has to play a vital role in helping society prepare for the next one," says Austin, "because there is always a next one."

Fred Taylor (foreground), senior research scientist at the Institute for Geophysics, led the first rapid response mission funded by the Jackson School, to the scene of the tsunami that struck the Solomon Islands in April 2007. Alsion Papabatu, standing, assisted Taylor in his position as head of the seismology section of the Department of Mines, Energy, and Water for the Solomon Islands. His nephew, Fred Solomon, steers.

Boom Times

Bureau of Economic Geology Pioneers Major New Assessments of U.S. Shale Gas Basins

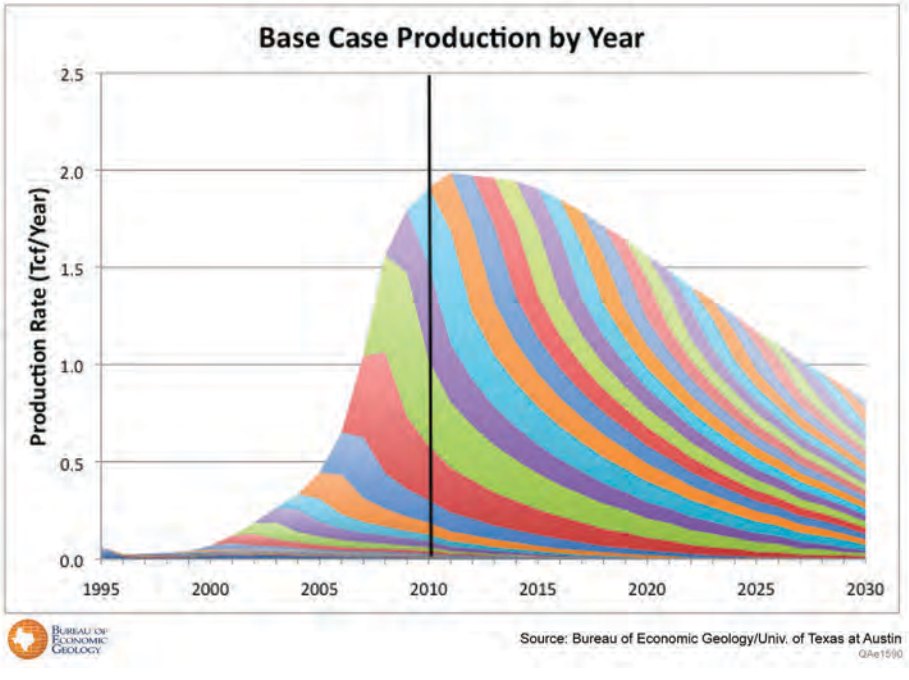
By J.B. Bird

International confidence in shale gas as a viable resource received a major boost this winter, thanks to new research from The University of Texas at Austin's Bureau of Economic Geology.

On February 27, 2013, energy correspondent Russell Gold reported on the front page of the *Wall Street Journal* that "U.S. natural-gas production will accelerate over the next three decades, new research indicates, providing the strongest evidence yet that the energy boom remaking America will last for a generation."

Within hours, scores of media outlets had picked up the thread. The headlines told the story: "U.S. Barnett shale to pump natural gas to 2050" (Reuters), "A Bounty of Natural Gas from Barnett" (CNBC), "Texas Study Points to a Longer Natural Gas Boom" (NPR), or as the Houston *Chronicle* added: "Get used to the energy boom. Drilling for natural gas in shale rock formations across the country likely will continue for decades."

The source for all this optimism was an innovative new assessment many months in the making, funded by the non-partisan Sloan Foundation and led by a team at the Bureau of Economic Geology. Today, the report is acknowledged by many as the most thorough assessment yet of the natural gas production potential of the Barnett Shale.



The Bureau study foresees slowly declining production from the Barnett through 2030 and beyond with total recovery at greater than three times cumulative production to date. The numerical model behind the assessment allows for scenario testing based on many input parameters, including price and pace of technological innovation.

"Ours is a very dynamic model that accounts for more drilling as prices go up, and pulls it back as prices go down," said Principal Investigator Scott Tinker, director of the Bureau of Economic Geology and acting associate dean for research at the Jackson School. In the assessment's base case, set at a price of $4 per million BTUs of natural gas (just a slight increase over recent prices), the study forecasts a cumulative 45 trillion cubic feet (TCF) of recoverable reserves from the Barnett, with annual production declining in a predictable curve from the current peak of 2 TCF per year to about 900 billion cubic feet per year by 2030.

This forecast falls in between some of the more optimistic and pessimistic predictions of production from the Barnett and suggests that the formation will continue to be a major contributor to U.S. natural gas production through 2030.

Though previous estimates from the U.S. Energy Information Administration (EIA), the U.S. Geological Survey (USGS), and others predicted loosely similar production levels, existing forecasts had not inspired robust confidence, in part because they were based on a top-down view of the Barnett that relied on estimates and extrapolations. Without a clearer picture of production from the world's first major shale gas play, predictions of shale gas reserves not just from the Barnett but overall had become a political football. People bullish on shale gas expressed confidence in sustained production, but skeptics, particularly critics of hydraulic fracturing, tried to suggest the forecasts were overly optimistic.

Apart from the political wrangling, investors also were seeking greater confidence in the production outlook for shale gas. As Gold noted in the *Wall Street Journal*, the gas boom has led to a reorientation of the U.S. energy economy. It has caused steep declines in consumption of coal for electricity

Chesapeake Energy facility just east of downtwn Fort Worth, Texas. (David Kent/Fort Worth Star-Telegram)

generation, while prompting "companies to announce or consider multibillion-dollar investments to export gas and build chemical, steel and fertilizer plants that will consume enormous quantities of gas." But what if shale production were to fall short of expectation? Prices for the fuel, which now accounts for 35 percent of U.S. electricity generation and 50 percent of home heating, might rise dramatically, with ripple effects across industries.

Wading into these uncertain waters, the Bureau research team, led by Tinker and co-PI Svetlana Ikonnikova, an energy economist, pioneered a comprehensive, bottom-up approach. Through partnership with IHS and DrillingInfo.com, the Bureau team was able to look at data from the actual wells in the Barnett—all 16,000 that had been drilled through mid-2011. No one had done this before. The result, coupled with the team's integrated approach incorporating engineering, geophysics, physics, geology, and economics, yielded an innovative and highly comprehensive assessment.

"There's been a lot of discussion about the future viability of the Barnett," said Tinker, "which this assessment directly addressed." Or, as Tinker told one journalist, "With shale gas, we are looking at multi-, multi-decades of growth."

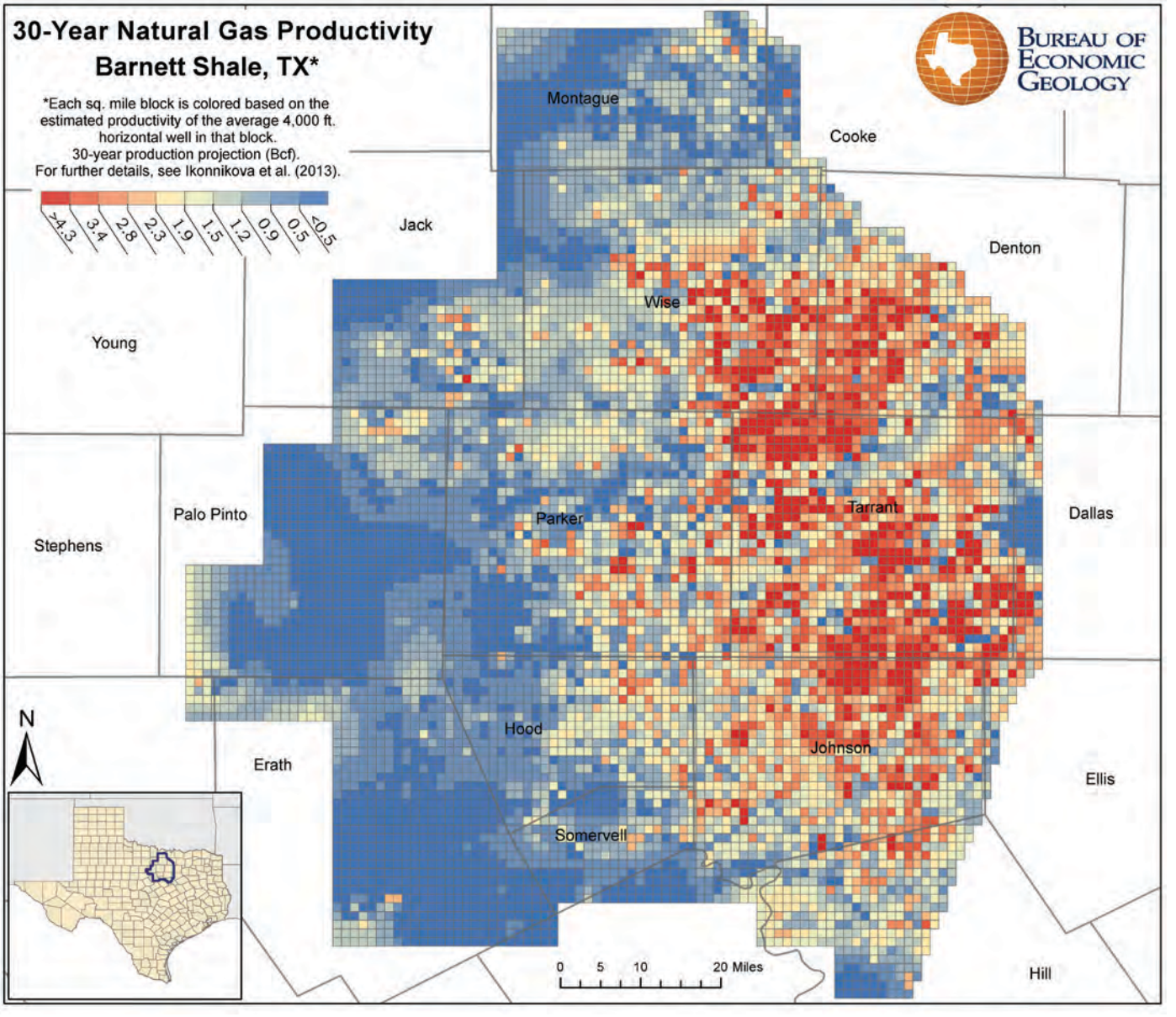
For the Bureau team, the Barnett assessment is only the first step. Assessments of three other major U.S. shale basins—the Fayetteville, Haynesville, and Marcellus—will follow this year, culminating in a review of all four basins at the April 2014 annual meeting of the American Association of Petroleum Geologists.

Model of Rigor

On the heels of the news coverage, requests came pouring in for permission to see the Barnett study. In a matter of days, the Bureau received over 100 requests from investment bankers, U.S. and foreign government agencies, academics, industry, and non-governmental organizations.

In response, the Bureau posted figures and some aggregate data on a dedicated website, which you can find by searching the keywords "bureau barnett assessment" or "sloan shale gas study." (Data on the individual wells from IHS and DrillingInfo.com remains proprietary—people can buy this data from the companies directly, but contractually the Bureau agreed not to distribute it.) The site includes links to two *Oil & Gas Journal* summaries of the research and peer-reviewed publications by members of the team.

The study offered many unique contributions. The team generated well-by-well analysis of production and calculated the estimated ultimate recovery (EUR) of each well. Tad Patzek, chairman of the Petroleum and Geosystems Engineering (PGE) Department at UT Austin, and graduate student Frank Male developed a new physics-based decline curve analysis that closely describes Barnett well declines. The team took a new approach to explaining drainage that helps account for the unique decline characteristics of shale wells as they mature. And in addition to predicting the economic life of each well, the model can adjust for changes in price, efficiency, and technological innovation.



Finally, the assessment took account of the great variability of productivity in the Barnett. The team geologically mapped porosity (PhiH, or pore volume per unit of area) and net pay-zone thickness across the entire play. With this information, and knowing the EUR and location for every well in the field, the team was able to divide the Barnett into 10 productivity tiers, analyzing well results in 1-square mile grids. As the team reported in the *Oil & Gas Journal*, the productivity tiers closely corresponded to the porosity map, "indicating that reservoir pore volume is a key driver of productivity." This correspondence led team members to call the PhiH map "a rock-quality map."

The productivity tiers (see illustration) reflect the by now well-known importance of finding the sweet spot in any shale gas play. The Barnett field has considerable heterogeneity, report the researchers, with better performance blocks interspersed with poorer blocks, but a clear pattern emerges, "with relatively low productivity where the reservoir thins to the west and south." Interestingly, the ground under Fort Worth appears to have high productivity potential, though it would be extremely challenging to develop.

To perfect their method, the Bureau team presented preliminary results and solicited valuable feedback before going public. They invited an independent review panel with members from government, industry, and academia to critique their research. At an open day for academics and industry scientists, 100 attendees were invited to offer additional feedback. Scientists and engineers from two of the larger producers in the Barnett — Devon Energy and ExxonMobil — offered critical feedback on the methodology during two in-house corporate review days. As a last step, the BEG hired a private consulting firm to individually critique the draft manuscripts and offer suggestions for improvement of the work.

Overall, the Bureau methodology won high praise. Even Art Berman, a petroleum geologist who writes about peak oil and believes most shale gas assessments are overly optimistic, conceded the strength of the Bureau approach, calling it "probably the most comprehensive study of the Barnett shale that will ever be done."

Staff at the U.S. EIA, who are tasked with making similar as-

sessments, were highly complimentary, and have been studying the new methodology. When the Bureau approached the Sloan Foundation about funding similar assessments of U.S. shale oil plays, a very senior EIA official wrote a strong letter of support. (As the *Newsletter* was going to print, the Bureau received news that Sloan is funding the shale oil study, based on unanimous approval from eight external grant reviewers.)

Here Comes the Boom

In addition to predicting estimated reserves that will be economically feasible to recover of 45 TCF, the Bureau assessment estimates technically recoverable resources in the Barnett at 86 TCF of free gas, which exceeds previous USGS and EIA estimates.

The second *Oil & Gas Journal* article offers a detailed look at the production forecast from the Barnett, but the Barnett is just the beginning. The Bureau team has almost completed research on the Fayetteville and Haynesville basins. When they release the assessment of the largest U.S. shale basin, the Marcellus, in the spring, Tinker plans to include a wrap-up on the four basins and the overall implications of the assessments. While Tinker is not ready to report any numbers, he acknowledges that "early looks at the Marcellus are considerably greater than the Barnett."

By itself, the Barnett assessment reaffirms the transformative, long-term impact on U.S. energy markets of shale and other unconventional reservoirs of gas. Assessments of shale oils, up next on the Bureau's docket, will even further deepen our understanding of America's revitalized position as the world's top energy producer.

Tinker compares the expansion of hydrocarbon reserves from shale gas to the expansion of global oil reserves from deep-water exploration that has happened in the past several decades.

"Drilling into unconventional reserves is potentially analogous to offshore oil in terms of impact," Tinker says.

The implications of sustained natural gas supplies, he points out, touch on a number of major societal questions. Should we export LNG? Reduce oil imports? Are planners comfortable with the natural gas resource base? All of these issues, Tinker notes, now hinge in part on our confidence over natural gas supplies.

And then there's the fascinating case of greenhouse gas emissions. In 2004, the U.S. produced more than half of its electricity from coal. As of April 2012, coal and natural gas were basically even as electricity source fuels at 35 percent each. Over that same eight year period, U.S. anthropogenic emissions of greenhouse gases dropped 10 percent, says Tinker, noting, "We're the only major industrial nation that did that." The biggest driver in the drop? The transition to natural gas.

The U.S., it should be noted, had no set policies over this period to curb carbon emissions. The European Union, which did enact a central carbon policy, experienced growth in emissions thanks to an increase in the use of coal for electricity generation.

Ten years ago, few would have predicted that the expansion in production of a hydrocarbon resource would lead the U.S. to reduce its carbon emissions. Moving into the future with a deeper understanding of the extent of our natural gas resources, Americans have the chance to make informed decisions based on sound science. ✷

Sloan Shale Gas Assessment Team

- Principal Investigator: Scott Tinker, Director, Bureau of Economic Geology (BEG)
- Co-PI: Svetlana Ikonnikova, Energy Economist, BEG
- John Browning, Petroleum Engineer, BEG
- Qilong Fu, Geologist, BEG
- Gürcan Gülen, Energy Economist, BEG
- Susan Horvath, GIS Specialist, BEG
- Frank Male, Graduate Research Assistant, Department of Petroleum and Geosystems Engineering, UT Austin
- Ken Medlock III, Energy Economist, Baker Institute, Rice University
- Tad Patzek, Chair, Department of Petroleum and Geosystems Engineering, UT Austin
- Eric Potter, Associate Director – Energy Division, BEG
- Forrest Roberts, Graduate Research Assistant, Jackson School
- Likeleli Seitlheko, Graduate Fellow, Baker Institute, Rice University

Prophetic Words

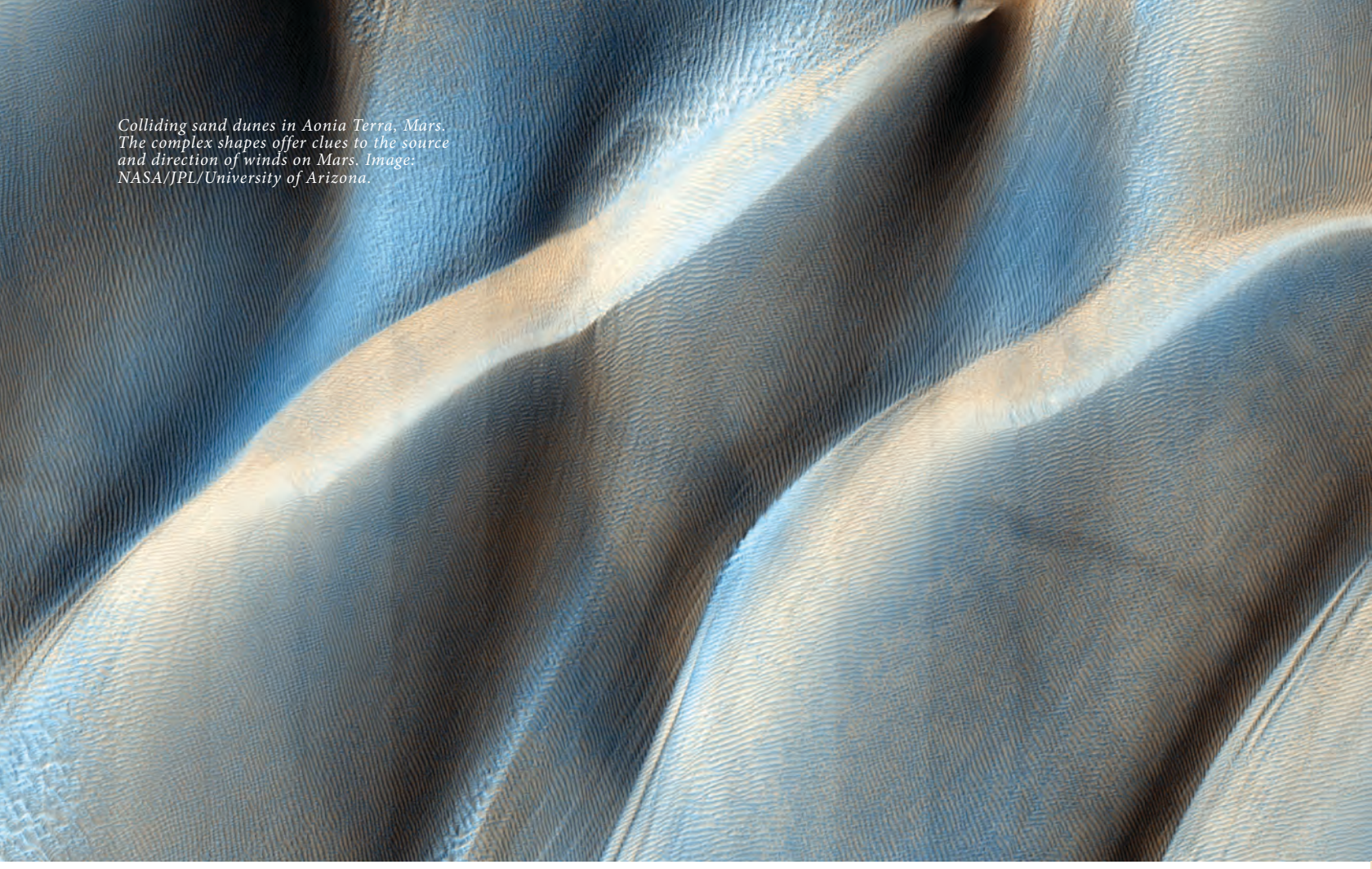
"The steadily upward progression of the trend line [in Texas natural gas production] … reveals the underlying impact of hydraulic fracturing technology and its strategic geologic deployment independent of price and incentives."

These would have been wise words ten years ago. Try 22. In 1991, Bill Fisher, the Leonidas T. Barrow Centennial Chair in Mineral Resources at the Jackson School, published these thoughts in "Future supply potential of US oil and natural gas," in *Geophysics: The Leading Edge of Exploration* (December 1991). Fisher has been in the public eye for predicting growth in U.S. hydrocarbon reserves since at least his time as Assistant Secretary of Interior for Energy and Minerals under President Gerald Ford. During the 1970s, his faith in the power of markets and technological innovations to drive increases in U.S. reserves clashed with prevailing fears of peak oil. By 1991, history was starting to prove Fisher right, even if his critics had not been paying attention.

In "Future supply," Fisher handily dismissed the "prevailing wisdom of the '70s … that the discovery and production of finite resources such as oil and gas would follow a symmetrical life cycle—increase exponentially, peak, and decline exponentially." Less than a decade after King Hubbert made this "peak oil" thesis famous, Hubbert's oil mean had been exceeded by 10 billion barrels of oil and his gas peak by 85 trillion cubic feet.

But far from rehashing the past, Fisher boldly predicted the future. Anticipating technological improvements in hydraulic fracturing, enhanced oil recovery, and geophysics, he was bullish on growth in U.S. reserves. "By far, the greatest potential lies in the complex reservoirs." As an example, he cited the Spraberry trend in the Midland basin as the kind of mature field that had resources in place and could benefit from innovations. Today, the Spraberry/Wolfcamp shale is considered the second largest field in the world, after Ghawar, in terms of recoverable resources.

Above all, Fisher advocated for the "aggressive pursuit of both advanced technology and the scientific capability to deploy it." He concluded that the idea the U.S. had to live with progressively declining domestic production was not valid, "unless through some self-fulfilling prophecy we make it so." He foresaw domestic sufficiency in natural gas "over the next 50-60 years," and stable oil production, with profound implications for long-term U.S. economic and national security. History is proving him right.



Colliding sand dunes in Aonia Terra, Mars. The complex shapes offer clues to the source and direction of winds on Mars. Image: NASA/JPL/University of Arizona.

Sand Gods

Aeolian Expertise Helps Curiosity Navigate the Shifting Sands of Mars

Mars might be named for the god of war in Roman mythology, but today it's ruled by Aeolus, who in Greek mythology had dominion over wind.

As other geologic processes have faded in impact, wind is the force that has the greatest current bearing on shaping geology on the planet where change has occurred slowly over the past three billion years.

This made Gary Kocurek, the J. Nalle Gregory Chair in Sedimentary Geology in the Jackson School of Geosciences, a likely choice to become a member of NASA's Curiosity rover mission to Mars.

He has studied aeolian processes, the effect of wind on geologic features, for three decades.

"Having aeolian expertise was one reason I was selected to be on the team," he said. "But, equally, they wanted some geologists who were not primarily planetary scientists and who could give the project a wider approach."

Windy Domain

Kocurek said the study of aeolian processes is driven by curiosity into the basics of how wind has shaped the Earth's surfaces—the fundamental research leads to greater understanding of how things work. More specifically, aeolian processes play a big role in land management in arid environments.

"For a geologist working with sub-surface strata, aeolian strata make great reservoirs for water, oil, and gas," he said. "Discover-

ing and producing hydrocarbons from aeolian strata, for example, requires an understanding of aeolian processes and the architecture of the strata they deposit."

The mission's principal purpose is to look for evidence that habitable environments might have existed on Mars.

Though the Curiosity rover's emphasis is not on wind or dunes, "everything on Mars is affected by the wind because the wind is so pervasive," he said. "That's where I come in."

The rover landed in Gale Crater on Mars in August 2012. Since then, it has covered about one-fifth of its five-mile journey to Mount Sharp, which rises 18,000 feet above the crater floor.

Kocurek has studied the Navajo, Entrada, and Page formations of the Jurassic period on the Colorado plateau and the interaction of wind and sand in places like the White Sands area of New Mexico and the Sahara Desert.

Curiosity is not his first experience with Mars. He's studied dune deposits that underlie the planet's north polar ice cap. He is one of about 18 Jackson School researchers who use geologic features on Earth to study Mars and other planets and moons in the solar system with similar features.

Long-Distance Science

As a member of the Curiosity team (about 450 scientists and engineers), Kocurek helps make sure the rover stays on a safe path as it wheels its way across the Martian landscape and studies features that might be interesting from the aeolian perspective.

Curiosity Rover's first picture shows the North Rim of Gale Crater. NASA/JPL.

"It's kind of like looking out the windshield of a car," he said. "You want to avoid craters, big rocks, and you don't want to go up or down slopes that are too steep."

To reach the mountain, the rover must deal with a dune field in its path. That's where the expertise of Kocurek and his aeolian colleagues on the rover team pays off.

"The rover has to get across or around the dune field," Kocurek said. "Because driving on loose sand is tricky, every effort is being

A thick stack of sedimentary debris stands in Gale Crater on Mars, looking southwest toward the crater's central peak, Mount Sharp. Image: NASA/JPL/Arizona State University, R. Luk.

The Ultimate Road Trip

Every road trip needs a destination and the destination of the Curiosity rover mission to Mars is Mount Sharp, a mountain that's five miles from the rover's landing site.

Towering 18,000 feet (five kilometers) above the surface of the Gale Crater, Mount Sharp offers researchers a wide range of Martian geological history to study.

"The reason Mount Sharp was chosen from all the other potential landing site was because it has a nearly 5-kilometer thick stratigraphic record that spans some of the most critical times of Martian history," said Gary Kocurek, the Jackson School sedimentary geologist on the Curiosity team.

He said satellite images show a wide diversity of rock types in the mountain.

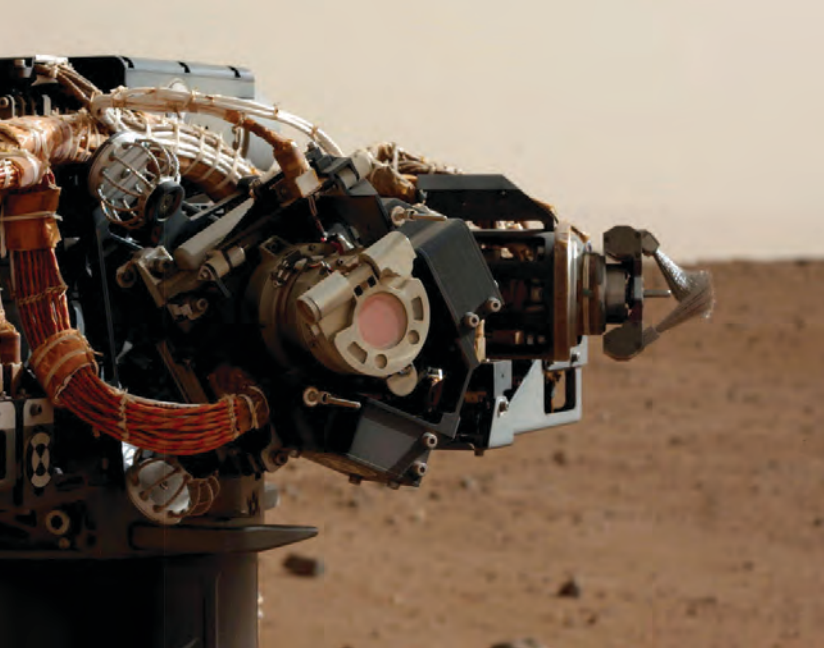
"Of particular note is the basal exposed strata, which almost certainly contain clay which is thought to reflect the presence of water," Kocurek said. "A major part of the MSL (Mars Science Laboratory) mission is to search for a record of past habitable environments, so areas with clay minerals are of particular importance given the connection between habitability and water."

One question of interest to aeolian investigators is how Mount Sharp, Curiosity's destination, was formed by wind or water.

Some scientists, using satellite data, have posited that wind was responsible.

Curiosity has a way to go before it reaches Mount Sharp, so it's still too early to judge. But so far, features observed by the rover seem to have been formed by water, Kocurek said.

"Nearly everything that has been seen thus far was deposited by flowing or standing water, such as rivers and ponds, from the rim into the crater," Kocurek said. "The main aeolian deposits have been surface small dunes and sand drifts. The surface is for sure heavily eroded by the wind, as most of Mars is."



Left: During the Mars mission, the left eye of Curiosity's Mast Camera took this image of the rover's arm, the Mars Hand Lens Imager: NASA. Kocurek with aeolian colleague Nick Lancaster in the Gran Desierto de Altar in the Sonoran desert of Mexico.

made to reduce the area of sand that needs to be crossed,"

Kocurek said that he and other members of the team have spent much time charting the path and gauging how the rover will be behave in loose sand.

"There are several people on the team who have expertise in sand dunes and aeolian processes," he said. "Especially the rover planners, the people who actually drive the rover. They have huge experience from previous missions in driving over all sorts of terrain."

While the sand is an obstacle, it's also an opportunity for geologists like Kocurek who study the interaction of wind and sand to witness wind moving sand across the dunes. That's known as a sand-transporting wind event.

"This would be significant because it has never been done before," he said. "The observations could be used to test a lot of the theory that predicts how sand transport should occur on Mars."

The rover could provide an up-close look at what happens when wind blows sand, an enticing prospect for someone who studies sand-transporting events.

Kocurek manages his Curiosity work from his office on the UT Austin campus. He examines images the rover sends back to Earth and participates in daily scientific meetings in which mission team members decide the rover's next moves.

"Every day I try to see what the rover is doing," he said. "You can look at the images and listen to the scientists' discussion. If there's something coming up in your area, it's up to you to jump in and do it."

Once the next day's activities for the rover are decided, NASA engineers at NASA's Jet Propulsion Laboratory program every single action the rover will take. Then the programming is uploaded across the millions of miles to the rover.

So far, his experience has been a "discovery as you go process," Kocurek said. "It's taking things as you see them and trying to understand them. Knowledge builds."

Martian Field Work

Kocurek is used to working remotely even with his research on Earth, where about three-quarters of his research is conducted through remote sensing. Kocurek and his students examine satellite data, including high-resolution images.

"My greatest research tool is Google Earth Professional," he said. "That's where all the images are. It's incredible."

He also employs other technologies such as LIDAR (Light Detection and Ranging), which provides precise topographic data for his research.

"We have a time series of images with LIDAR of White Sands," he said. "We have measurements of dune volumes, very precise dune migration rates, and changes after single sand storms."

He and his students do field work to see what is actually happening on the ground.

"There is still a big role for getting out and doing real-life measurement on the dunes," he said. "Looking at the rock, measuring the rock. Doing geology like we've done it for a hundred years."

Geology on Mars can be done like it's been done on Earth, but the geologist on Mars is Curiosity itself. The NASA project that built and operates Curiosity is called the Mars Science Laboratory (MSL).

For the big picture, Kocurek uses images from the High Resolution Science Experiment (HiRISE) aboard the Mars Reconnaissance Orbiter satellite.

Panoramic view of Curiosity Rover's surroundings in Gale Crate stitched together by Stuart Atkinson from NASA/JPL images.

"Just like doing geology on Earth, we would use satellite images for the context and then field work to see processes in action or examine the geomorphic forms or outcrops in detail," he said. "MSL is just like a geologist in the field, except that it carries around its own laboratory."

The tool that Kocurek mainly uses is the rover's cameras.

He uses images from the Mastcam, mounted on the rover's mast, for the wide angle and the Mars Hand Lens Imager (MAHLI) for an up-close view that provides sharp detail.

"You can see grains as you would looking at a rock with your hand lens on Earth," he said.

One question of interest to all investigators is how Mount Sharp, Curiosity's destination, was formed by wind or water.

Some scientists, using satellite data, have posited that wind was responsible.

Curiosity has a way to go before it reaches Mount Sharp, so it's still too early to judge. But so far, features observed by the rover seem to have been formed by water, Kocurek said.

"Nearly everything that has been seen thus far was deposited by flowing or standing water, such as rivers and ponds, from the rim into the crater," Kocurek said. "The main aeolian deposits have been surface small dunes and sand drifts. The surface is for sure heavily eroded by the wind, as most of Mars is."

For geologists, Mars offers the opportunity to study geological conditions that don't exist on Earth.

"You get to see early planet history, the first billion or two years," Kocurek said. "We don't see that on Earth anymore because all of those rocks have been destroyed. On Mars, they're still sitting there."

As the rover moves along Mars, Kocurek is interested in studying how the wind shapes dunes and how they are similar to and different from those on Earth.

"Because the boundary conditions are so different, the question is how does this affect the processes?" he said.

Boundary conditions are the environmental factors that affect dunes. They include: How much sand is available? How often does the wind blow? How strong is the wind? Is there water available?

"They're never going to be the same in any two places," Kocurek said. "Whatever you're looking at, they differ from place to place."

While dune fields on Earth have different boundary conditions from each other and from those on Mars, there are still fundamentals with which Aeolus rules.

"The beauty of this is that it's all fundamental physics and processes," Kocurek said. "Wind blows, sand moves, physical laws have to be obeyed. There are basic principles that govern it all." ✷

Field work on Mars? Sign Me Up

Whether you're in Pasadena or Austin doesn't make much difference when the object of your research is millions of miles away. Mackenzie Day is working toward a Ph.D. with Dr. Gary Kocurek in the Jackson School of Geosciences at The University of Texas at Austin and is a participating scientist on the Mars Curiosity rover mission to Mars.

She came to the university from the California Institute of Technology (Caltech), where NASA's Jet Propulsion Laboratory is located. JPL runs the rover mission.

Day's undergraduate advisor at Caltech was John Grotzinger, a sedimentary geologist and the project scientist of the Mars Science Laboratory aboard the Curiosity rover.

"He recommended that I apply to the Jackson School and from there things fell into place," Day said. "Professor Kocurek needed a student to join the MSL team and I was thrilled at the opportunity."

As a participating scientist on the rover mission, Day is not associated with a particular instrument.

"Instead I help with day-to-day operations as a member of the geology theme group," she said. "Each day team members discuss what in the vicinity of the rover is of most scientific interest, and how we should investigate it. When I work shifts in operations, I help develop these plans."

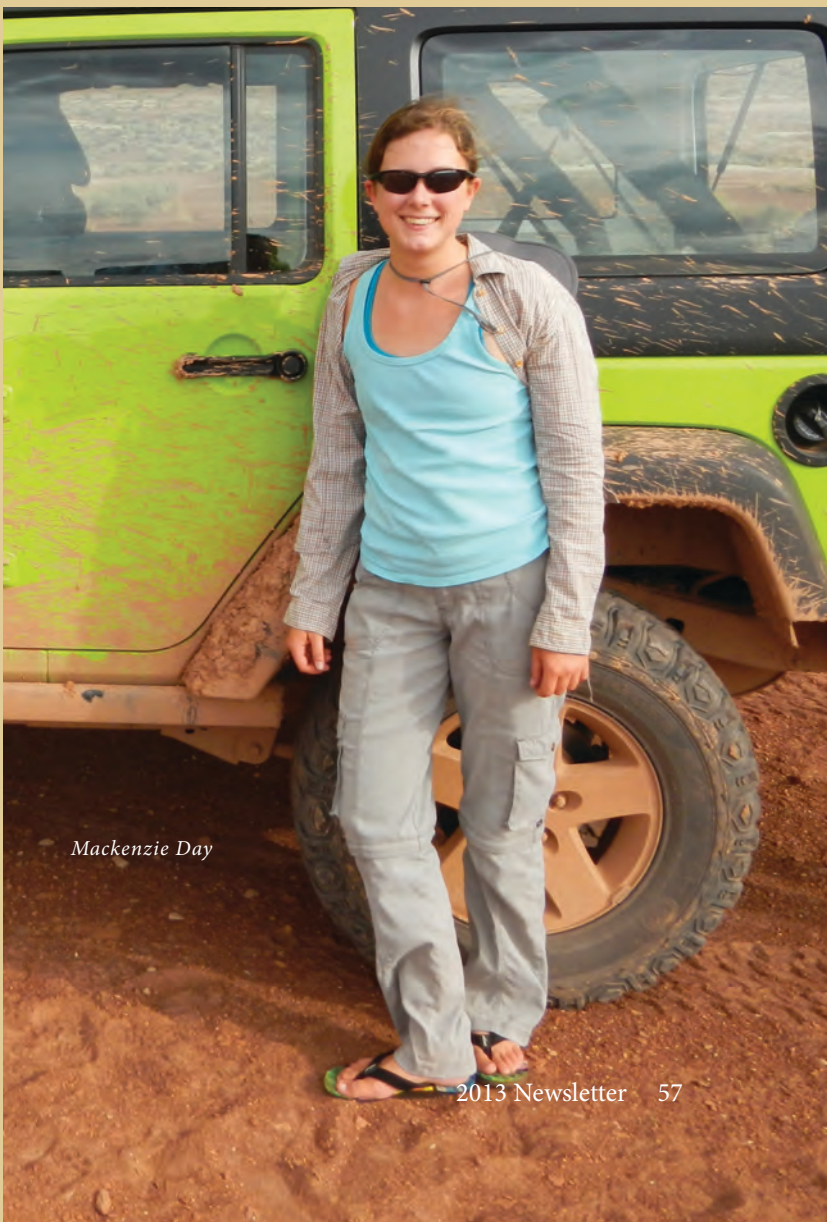
Day's research interests are in the sedimentary budget of Mars. She studies the dynamics between sand and dust on the surface and crater basins across the planet.

"Luckily for me, many members of the team also have similar interests, and an entire group is devoted to sedimentary processes," she said.

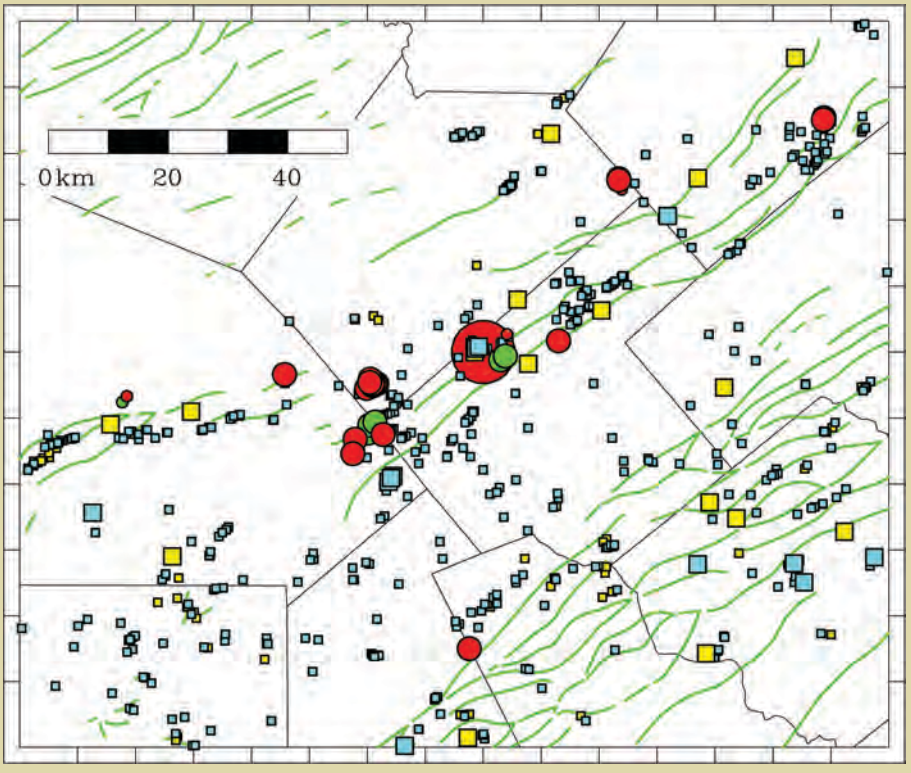
When she's not working with the MSL, Day's field work takes her to southern Utah and northern Arizona. She recently was on a field trip to Yellowstone National Park and Kane Cave in association with a course on geomicrobiology.

She would welcome the opportunity to do field work a bit further afield. It is her hope to apply to NASA's astronaut program.

"I would love the opportunity to do field work on Mars," she said.



Mackenzie Day



A map of the Fashing area of the Eagle Ford showing seismic events (circles), Class II injection wells (yellow squares), wells producing/extracting water (blue squares), and mapped faults (green lines). For seismic events, green circles have origin times during local daylight work hours (which might indicate quarry blasts); red circles occur at other times; and larger circles have more precisely estimated locations than smaller circles. For injection wells, small squares represent injection rates above 10,000 barrels of water per month (BWPM), large squares represent rates above 100,000 BWPM. Credit: Cliff Frohlich.

Rumblings

Study Shows Small Earthquakes in the Eagle Ford Region Triggered by Oil and Water Extraction

By Marc Airhart

Most of the small earthquakes in the Eagle Ford region of South Texas are probably triggered by the extraction of large volumes of oil and associated water, according to a recent study by Cliff Frohlich, associate director at the Institute for Geophysics.

No injuries or severe damage were reported from any of the quakes identified in the two-year study, although the two largest (magnitude 3.9 and 4.8) did cause noticeable shaking at the surface.

The results, appearing last August in an online edition of the journal *Earth and Planetary Science Letters*, show the Eagle Ford region contrasts sharply with the Barnett Shale region of North Texas, where Frohlich and colleagues reported last year that most small earthquakes were probably triggered by the injection of large volumes of waste water from hydraulic fracturing (see sidebar).

Small quakes in both the Barnett Shale and the Eagle Ford Shale have attracted attention since the boom in unconventional oil and gas production brought on by hydraulic fracturing began in each region. The Barnett Shale study and others have raised concerns that hydraulic fracturing or the subsequent injection of waste fluids associated with the practice can induce small earthquakes. However, this latest study found most small earthquakes in or near the Eagle Ford region were induced by fluid extraction, rather than fluid injection.

"Although there is a considerable amount of hydraulic fracturing activity in the Eagle Ford leading to a significant amount of waste fluid being injected in the Eagle Ford region, we don't see a strong signal associated with that and earthquakes," he says. "However, the earthquakes seem to be associated with petroleum production, as in the past. We can't say there aren't any earthquakes induced by injection, but we can say that it's just not the strong signal."

Though it might seem disconcerting that oil production can produce earthquakes large enough to feel at the surface, notes Frohlich, the long history of oil production helps put the risk in context.

"One way to look at this is that Texas is a huge laboratory," says Frohlich. "We've produced vast amounts of oil and gas since the 1930s, and since then a number of earthquakes have occurred in oil and gas fields without significant damage and the majority without ever being felt at the surface. So if producing petroleum was vastly dangerous, Texas would be famous for its constantly damaging earthquakes. Since we're producing petroleum in places that we

haven't been before, this is a phenomenon that we need to understand, but it's not appropriate to say it's vastly dangerous."

Frohlich analyzed seismic data collected between November 2009 and September 2011 by the EarthScope USArray Program, a National Science Foundation-funded network of broadband seismometers deployed from the Canadian border to the Gulf of Mexico. Because of the high density of instruments (25 in or near the Eagle Ford Shale), he was able to detect earthquakes down to magnitude 1.5, too weak for people to feel at the surface and many of which were not detected by the U.S. Geological Survey's more limited seismic network.

Frohlich identified and located 62 probable earthquakes in the Eagle Ford region, including 58 not reported by the U.S. Geological Survey. The 62 probable earthquakes occur singly or in clusters at 14 sites. Eight of the sites were near wells where extraction of oil and/or water had recently increased, two were near wells where injection of water had recently increased and four were not situated near wells reporting significant injection or extraction increases.

Frohlich suggests one possible explanation for the differences in earthquake triggers in the Barnett and Eagle Ford regions is that in the Eagle Ford, petroleum has been produced by conventional means from various other strata, notably the Edwards formation, for more than 60 years. In contrast, the induced earthquakes in the Barnett have mostly occurred in areas where widespread petroleum production took place only within the past 10 years.

Another possible explanation is that there are more faults in the Eagle Ford region than in the Barnett that can be activated by the movement of fluid in the subsurface.

The largest recorded earthquake to occur in the Eagle Ford region during the two-year study was a magnitude 4.8 quake near the town of Fashing on Oct. 20, 2011. Although relatively large for South Texas, it wasn't without historical precedent. The town experienced a magnitude 3.2 quake in 1973 and a magnitude 3.4 quake in 1983, both associated with an increase in the production of water at nearby wells as a byproduct of petroleum extraction. The 2011 Fashing earthquake also followed an increase in nearby oil and water production.

The second largest quake in the Eagle Ford region during the study was a magnitude 3.9 near Alice, Texas on April 25, 2010. Frohlich and his colleagues published a paper last year in the journal *Bulletin of the Seismological Society of America* that concluded that "it is plausible, although not proven definitively, that production in the Stratton field contributed to the occurrence of the 2010 Alice earthquake."

Financial support for the Eagle Ford study came from the U.S. Geological Survey and from RPSEA (Research Partnership to Secure Energy for America) through the "Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program" authorized by the Energy Policy Act of 2005. ✷

In Barnett Region, It's Injection Wells

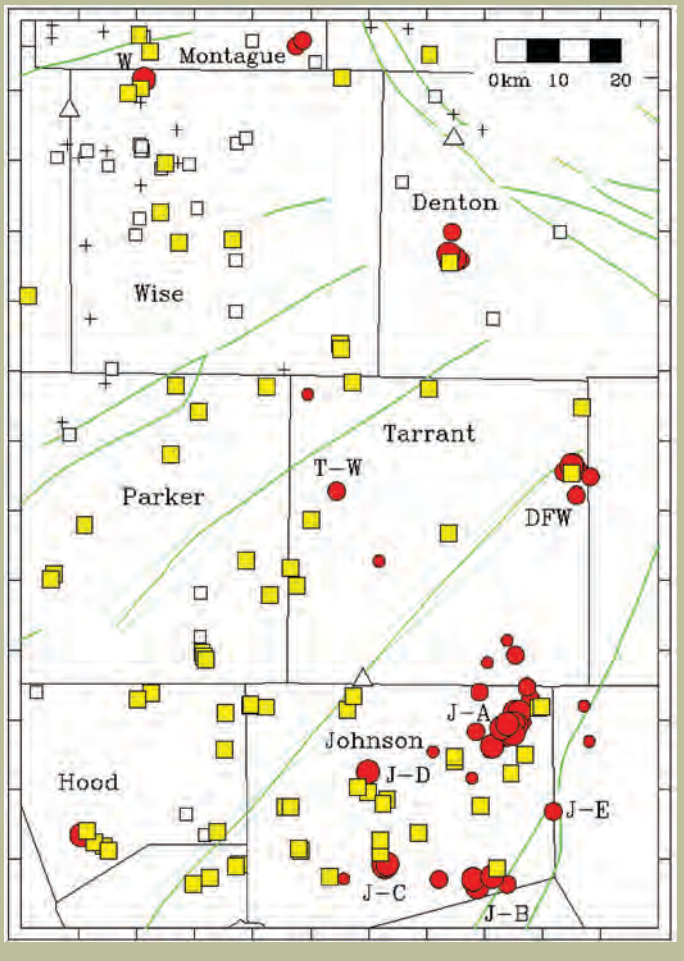
Most earthquakes in the Barnett Shale region of North Texas occur within a few miles of one or more injection wells used to dispose of wastes associated with petroleum production such as hydraulic fracturing fluids, according to Frohlich's August 2012 study in the journal *Proceedings of the National Academy of Sciences*. None of the quakes identified in the two-year study were strong enough to pose a danger to the public.

"You can't prove that any one earthquake was caused by an injection well," says Frohlich. "But it's obvious that wells are enhancing the probability that earthquakes will occur."

For the Barnett Shale study, Frohlich analyzed EarthScope Array data from the same two-year period as the subsequent Eagle Ford study. He found that the most reliably located earthquakes (red circles)— those that are accurate to within about 0.9 miles (1.5 kilometers) — occurred in eight groups, all within 2 miles (3.2 kilometers) of one or more injection wells (squares and symbols). Before this study, the National Earthquake Information Center had only identified two earthquake groups in the area strongly associated with specific injection wells. This suggests injection-triggered earthquakes are far more common than is generally recognized.

All the wells nearest to the eight earthquake groups reported high injection rates (maximum monthly rates exceeding 150,000 barrels of water). Yet in many other areas where wells had similarly high injection rates, there were no earthquakes. Frohlich tried to address those differences.

"It might be that an injection can only trigger an earthquake if injected fluids reach and relieve friction on a nearby fault that is already ready to slip," says Frohlich. "That just isn't the situation in many places." Support for the Barnett Shale study came from the U.S. Geological Survey and the Jackson School of Geosciences.



Uncharted Waters

A Behind the Scenes Look at the Struggle to Kill the Deepwater Horizon Oil Spill by Marc Airhart

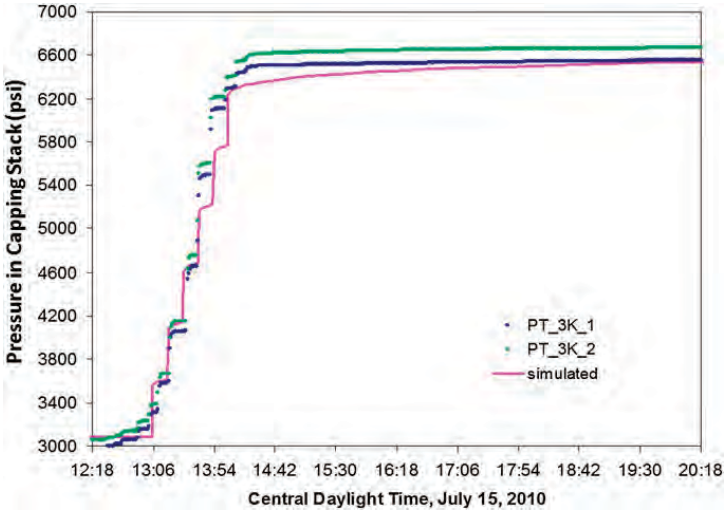
Peter Flemings was on a family vacation hiking in the White Mountains in New Hampshire when his cell phone rang. It was U.S. energy secretary Stephen Chu's assistant. Could he join a web conference with Secretary Chu, and dozens of scientists from government, academia and industry, in a few hours? After packing up and making his way to a coffee shop with wireless access, Flemings found himself on an elite scientific team advising Chu and others in their battle to contain the Deepwater Horizon oil spill.

"That was the end of my vacation," says Flemings, professor and research scientist at The University of Texas at Austin's Jackson School of Geosciences.

Almost immediately, Flemings was swept up in a relentless series of high-level web conferences every few hours. And within a couple of days, he was at the nerve center for an unprecedented combined response from BP, the federal government and academia. The hub of activity, at one of BP's facilities in Houston, was the HIVE—Highly Immersive Visualization Environment—a large space some have compared to NASA's Mission Control. The room had big screen TVs everywhere showing positions of about 20 ships, rigs and remotely operated vehicles (ROVs) working in the vicinity of the well, live views of the gusher from near the seafloor, and media coverage.

In the weeks following the April 20, 2010 blowout, BP had tried two elaborate strategies to bring the Macondo well under control—a massive containment dome and a so-called top kill—but both ended in failure. Tens of thousands of barrels of oil were still spewing into the Gulf of Mexico each day when Flemings joined the Well Integrity Team in mid-July.

BP was anxious to cap the top of the well, but what kept the experts up at night was the possibility that either the pipe had already burst somewhere underground during the initial blowout or that if they now bottled up the gusher at the seafloor, the pipe would burst. Either way, it would be like performing a hydraulic fracture on the surrounding geologic formation, in much the same way that drillers fracture shale formations to liberate oil and gas. If you thought containing a gusher from the top of a wellhead under more than a kilometer of water was hard, try containing it under more than a kilometer of water AND buried deep underground. Some members of the team even feared that an underground blowout could cause the sedi-



Wellhead pressure measured during and immediately after closure of the capping stack on the Macondo Well on July 15, 2010 as measured by pressure gauges installed on the capping stack (PT_3K_1 and PT_3K_2). The pink line denotes pressure simulated by the initial (square) reservoir model assuming a well with no leaks. Figure modified from Hsieh, P.A. (2011).

ments around the wellhead to liquefy and the entire wellhead to disappear into the seafloor.

So this is the dilemma the team had to resolve: could you cap the well and if so, how would you know, as the hours and then days went by, if it was safe to keep it plugged?

The team decided BP could cap the well temporarily—no permanent damage was likely in the first few hours—and then devised a simple little test involving one number to ensure the well was not in danger of an underground blowout—a simple little test that ultimately left them scratching their heads.

Purgatory

Just after noon on July 15, BP workers instructed an ROV to begin closing the valves on a newly installed "capping stack"—essentially a second blowout preventer—atop the original, failed blowout preventer. You might remember from news accounts that the blowout preventer contained sharp teeth designed to automatically shear the metal pipe at the top of the well and clamp it shut in case of a blowout. Had the original blowout preventer worked, there would have been no oil spill. Now, as the valves on the second blowout preventer were shutting, sensors recorded rising pressures inside the wellhead.

To evaluate whether the well was in good enough shape to withstand being plugged up, the team proposed a simple test: If pressures rose above 7,500 pounds per square inch (psi), then the well was probably intact and could be shut in for at least 48 hours. If, on the other hand, the pressures measured inside the wellhead stayed below 6,000 psi, oil and gas was probably leaking into the geologic formation. In that case, the well should be reopened immediately.

After a couple of hours, the valves stopped turning. For the first time in nearly three months, no oil flowed into the Gulf. Soon after, the pressures leveled off at around 6,600 psi, about the most ambiguous number they could have imagined. What on Earth did it mean? The experts found themselves in a kind of purgatory.

"My first reaction was … now what do we do?" recalls Flemings. "It would have been great if it were here or here, it would be obvious. Now we're in the middle. I think that's more or less how everybody felt."

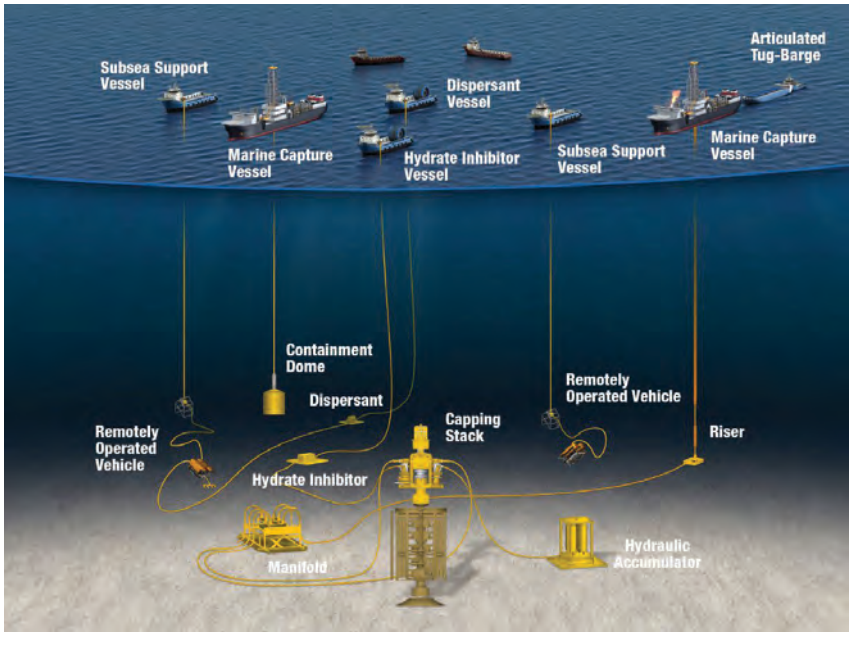
The team agreed that the well could stay safely shut in for 24 hours, but beyond that, if they couldn't be sure the well was sound, they would need to reopen it. Before that deadline, three starkly different interpretations of the anomalous pressures arose.

Paul Hsieh, a hydrologist with the US Geological Survey (USGS), used a hydrologic model to simulate how the pressures should build up in the well for the first six hours after shut in if it had full integrity. The simulated pressure curve was remarkably similar to the actual pressures observed at the wellhead. This suggested the well was in fact sound. Meanwhile, representatives from BP also now believed the well was intact, but that the reservoir, which had disgorged millions of barrels of oil, was more depleted than previously thought. Still others on the team felt the best explanation for the anomalous pressures was an underground leak.

Balancing these different possibilities, Secretary Chu decided the shut in could continue past the initial 24 hours, but with a full review of the latest data every six hours. Several geophysical tests, including a continuous series of seismic profiles and sonar surveys, were begun to monitor the area for signs of underground leakage.

Something Doesn't Square Up

Over the second 24 hours, the experts were faced with a new dilemma. The USGS hydrologic model said pressures should be



The Deepwater Horizon spill spurred development of new technologies for future disasters. This capping stack from the Marine Well Containment Company was developed and constructed by a consortium of oil companies after 2012 with a capacity to daily collect 60,000 barrels of oil from a leaking well in 8,000 feet of water. Image courtesy MWCC.

rising significantly, yet the observed pressures were only creeping up slightly. This growing divergence renewed fears that an underground leak was bleeding off some of the pressure.

Flemings sat down with BP's experts and went back over all of their seismic data, well logs and computer models. He concluded that the way the reservoir was represented in the USGS model, basically a thick square block of sand, was too simplified.

"Their models were based on a square sandbox," he says. "The reservoir is not a sandbox, it's much longer than it is wide and cigar shaped and made up of different sand channels that don't necessarily touch each other."

When the reservoir in the USGS model was revised to reflect this new interpretation, the simulated and observed pressures were again in lockstep. There was also encouraging news from the ongoing geophysical monitoring.

Comparing seismic profiles first taken before shut in and then several times a day thereafter, Flemings and other government and industry scientists could scan for signs that brine in the surrounding sand had been replaced by hydrocarbons. He and Hsieh also made predictions of how small an oil slick would have to be to go undetected in the seismic data. So as each day went by with no sign of a leak, it meant the flow rate of a hypothetical leak would have to be smaller and smaller to "fly under the radar"—or seismic, as it were. After several days of shut in, neither the seismic profiles nor a series of sonar surveys showed signs of leakage.

Within about a week of the shut in, the team was feeling pretty confident that there was in fact no underground blowout, the well was structurally sound, and that BP's alternate explanation for the unusually low pressures—that the reservoir was depleted—was likely correct. Eventually, the entire team came to agree. The well was finally under control.

Flemings' combination of expertise in stratigraphy, pore pressure, drilling and seismic data interpretation might seem a bit esoteric, but it made him a good fit for this particular disaster.

"How many times do you get called up because you have just the right expertise to help with a true crisis in real time?" he asks. "I don't think it will happen again in my lifetime."

Afterlife

On August 3, nearly three weeks after the well was shut in, BP began pumping mud—and then later cement—down the well in a process known as a top kill. BP finished cementing the inner bore of the well the next day. Because the well is essentially a set of pipe inside another set of pipe, there is also an outer bore space between the two sets of pipe. In mid-September, a relief well intercepted the Macondo well much farther down and BP injected cement into the outer bore, permanently sealing off the reservoir.

While it's still too early to assess the full toll of the world's largest marine oil spill—about 5 million barrels of oil were released into the Gulf—it clearly had an impact on fishermen and on coastal communities that rely on tourism, not to mention marine and coastal ecosystems.

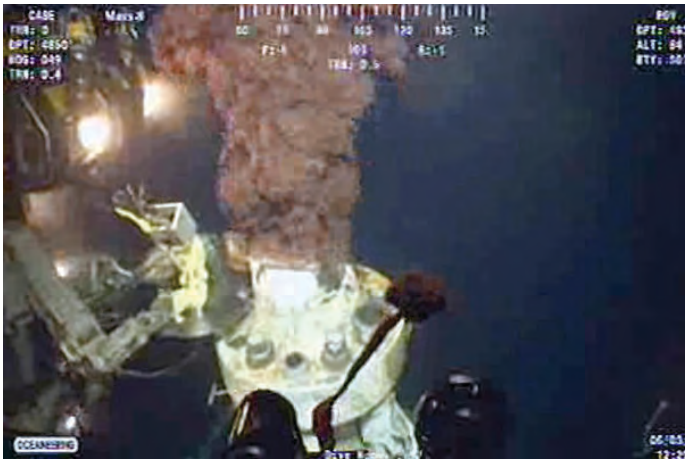
According to the National Oceanic and Atmospheric Administration, 1,100 miles of shoreline were oiled, including coastal wetlands. In a study released last year in the Canadian Journal of Fisheries and Aquatic Sciences, researchers estimated that over the coming seven years, the spill would cost the Gulf fishing industry about $8.7 billion. In October 2010, scientists with the non-profit Ocean Foundation estimated that populations of commercially important juvenile bluefin tuna were reduced by 20 percent in the months following the spill. And in April 2013, the National Wildlife Federation released a study highlighting some of the environmental impacts, including an unusually high number of dolphin and sea turtle strandings, including the endangered Kemp's ridley sea turtle.

Still, the impact might have been much worse if not for naturally-occurring bacteria that broke down some of the oil and gas and favorable winds and currents, all of which kept a significant amount of oil from reaching the shore.

Flemings is grateful that members of the public now understand what's involved in drilling ever deeper for oil.

"The average person came to understand the conditions under which industry goes to get the oil and what can go wrong," he says. "We're drilling 30,000 feet below the seafloor and, in some cases, underneath 10,000 feet of water. Before this accident, the average person had no idea what that meant." ✷

These images taken from a live BP feed show (top) a remotely operated undersea vehicle working on the leaking riser pipe at the site of the spill and (below) a cap placed on top of the plugged well on November 8, 2010, honoring the 11 lives lost on the Deepwater Horizon rig.



Building a Smarter Rock

New Generation of Electronic Smart Rocks Open Underwater Window on Sediment Transport

by Emily Underwood

In April 2011, one of the largest and longest floods on record coursed down Reynolds Creek, a steep mountain stream that runs through sagebrush meadows and aspen groves in southern Idaho. Fed by snowmelt from the Owyhee Mountains, the floodwaters tore down river banks and sent a jumble of rocks tumbling downstream.

Some of them were no ordinary pebbles. More than 200 were brightly painted natural rocks that contained radio tags inserted into specially drilled holes. Four others were "smart rocks" made of sleek brushed aluminum. Researchers had crafted each metal rock to mimic a natural stone's shape and density, and then inserted custom-made electronics that could measure and record movements 512 times per second. It was the smart rocks' first trip down a real river; previously, they'd been coddled in a carefully controlled laboratory river called a flume. Their mission: to help researchers better understand how waterways move tons of rock and other sediment downstream.

It is no small issue. Worldwide, rivers transport an estimated 13 gigatons of sediment each year, more than any other force on Earth besides humans. But predicting where that material will end up has proved difficult. Current models for predicting the movement of coarse sediment in a river—some based on equations developed by Albert Einstein's son Hans in the 1950s—are frequently off by at least an order of magnitude, says Joel Johnson, a geomorphologist at the Jackson School of Geosciences. That's a problem for engineers trying to protect bridges, dams, and levees from shifting flows, and ecologists trying to plan expensive river restoration projects. Researchers, meanwhile, have struggled with the difficult and dangerous task of finding out what's really going on during floods, when rivers do most of their heavy lifting. That's why Johnson and other researchers are pioneering a new approach: building increasingly sophisticated smart rocks that are intelligent enough to take measurements on their own. The devices, Johnson says, are "a killer app" that gives scientists a unique glimpse of river dynamics "from the point of view of the rocks."

Chasing marbles

Deploying objects to track shifting river sediments is not a new idea. In the 1960s, the influential late geomorphologist Gordon "Reds" Wolman of Johns Hopkins University in Baltimore, Maryland, dropped marked marbles into a nearby stream, then noted how far they moved. He continued to find the marbles into the 1980s; he even offered students six beers for every marble recovered, recalls fluvial geomorphologist Peter Wilcock of Johns Hopkins. Decades later, he says, one student found a stash, but "I don't believe they ever received the payout. … The link to immortality was presumably sufficient compensation."

Since then, researchers have tried to make it easier to find such tracers by using rocks embedded with iron magnets or even radiofrequency identification tags similar to those used to identify lost pets and track merchandise. Those tracers, however, can reveal only how far an object travels, not fine-scale information about the forces that set rocks tumbling or what happens along the way. "We know the rocks go downstream—we're not idiots," says Joanna Curran, a hydrologist at the University of Virginia in Charlottesville. But because sediment transport is a nonlinear physical process, small mistakes in input measurements can result in disproportionately large output errors in mathematical model predictions. Improving the models means getting down to nitty-gritty details, including better measurements of dozens of variables ranging from large-scale channel slopes and water velocities to minute interactions between a single grain of sand, the water flowing around it, and the river bed. Sediment scientists, Curran says, want to measure forces down to the level of a rock's "skin."

Now, advances in materials and electronics are making that possible. In one project, Curran is helping undergraduates use a three-dimensional printer to make plastic smart rocks about 7.5 cm across. Each has sensors on six sides and a gyroscope that measures the rock's orientation. The gear is helping Curran gain insight into a key river variable: shear stress, the same side-slipping force that tectonic plates produce as they slide past one another, or if you run your hand along a brick wall. Rocks of different sizes and shapes respond differently to the shear stress created by flowing water, Curran says. It takes more shear stress to move an angular rock than a rounded one, for example. To quantify such differences, Curran has been dropping her fake stones into a flume in her lab. They transmit data to a computer through plastic tubes attached to the rocks. Eventually, she'd love to untether her rocks and release them into a real river, but she's worried about the cost: At roughly $250 apiece, "these are expensive little things," and she's afraid to lose them.

A Rocky Start

Such fears, however, didn't stop the Jackson School's Johnson from leaving his four aluminum rocks—which cost roughly $800 apiece—

Rock 'n' roll. Gray concrete "smart rocks" and colorful radio-tagged "tracer rocks" await a bumpy ride.

at the mercy of a raging Reynolds Creek in early 2011. After putting his creations in the remote stream, he and doctoral student Lindsay Olinde waited for the floodwaters to rise and then fall as the snowpack petered out. Then, in July 2011, Olinde hiked back in with a field assistant and began searching for both the hundreds of radio-tagged stones—which cost only about $5 apiece, not counting labor—and Johnson's four metal mimics. A previous study had suggested that most faux-rocks wouldn't move more than 100 meters downstream. After a week of searching with an antenna that chirped in response to the painted, radio-tagged rocks, Olinde had found only one within the 100-meter reach. "I thought my equipment was broken," she says.

That was just the beginning. Over the next 5 months, she took four more rock hunting trips, sometimes scrambling through the steep canyons. By November, her gloves were freezing to the icy boulders, and she was hearing the chirp of the radio tags in her sleep. Ultimately, she located roughly 150 of the radio-tagged stones. One-half had moved more than 2500 meters downstream, and a few had tumbled more than 6440 meters. "We had fist-sized particles move almost 7 kilometers," Johnson says, in awe.

Olinde had a similar struggle finding the four aluminum rocks. The chirping radio tags do not work in close proximity to aluminum, so Olinde had to use a metal detector instead. But the creek turned out to be full of metal objects such as old ranching equipment, making the detector all but useless. Finally, a rancher's dog found the first smart rock in September, more than 2000 meters downstream from where it had been deposited. Olinde spotted a second by accident in November, where it lay in an icy pool 900 meters downstream, glinting in the sun. The other two are still missing in action.

Back at the laboratory, the researchers were relieved to find that the two survivors had collected data despite their rough rides. But relief turned to disappointment when they discovered that the batteries— supposedly strong enough to survive at least a month—had died after just 40 hours. During that brief period, the smart rocks very accurately recorded no movements whatsoever, Johnson says. "We are certain that those rocks stayed still," he says ruefully.

All was not lost. By combining data on the radio-tagged, natural tracer rocks' unusual distribution with geographic information system data on local topography, Olinde and Johnson are studying how variables such as the steepness and width of the creek channel influenced where the tracers ended up.

Brains vs. brawn

Inspired by last year's experiment, Olinde has been testing a new kind of smart rock along Reynolds Creek. It is somewhat cruder than Johnson's aluminum models, but cheaper and sturdier. She makes them by filling rubber molds of natural rocks with wet concrete, and then inserting a $100 accelerometer about the size of a matchbox. Its penny-sized battery lasts for months, allowing the accelerometer to record the rock's spatial orientation along three axes every 15 minutes. At that rate, Olinde can't see how moment-to-moment forces influence movement, but she can see how the rocks shift in concert with changing water levels. After inserting radio tags into the rocks, she spray-paints them with neon colors. (The results, she jokes, look like artworks created by a cross between British landscape artist Andy Goldsworthy and the American pop-surrealist Andy Warhol.)

In 2012, Olinde released 73 of her new "not-so-smart" rocks into Reynolds Creek, along with 1200 simpler, radio-tagged versions. When the spring floods came, antennae she had installed along the river tracked the rocks as they rolled by. Later, she and a team of assistants searched a 10 km stretch of creek and recovered 33 of the 73 more sophisticated sensors. Unlike Johnson's aluminum rocks, however, the majority of Olinde's concrete versions had continued to collect data throughout their journey. "Joel's rocks are the fine Renaissance gentlemen," she jokes. "My rocks are the burly mountain men."

Olinde is still analyzing the data, but one thing is clear: Current sediment transport models don't do a good job of predicting the rocks' rests and motions. Other researchers agree. The Reynolds Creek work "is a very well done study," Curran says, and "it should add to the body of knowledge on when and why a large cobble moves in a mountain stream." But it also highlights the potential value of scaling up the use of smart rocks to study waterways of all shapes and sizes, from small mountain streams like Reynolds Creek to continent-spanning rivers like the Nile. And it demonstrates the need for even more sophisticated sensors that can reveal the role played by variables like bottom roughness or water depth. "This is the challenge that remains, … moving from smart to genius rocks," Curran says.

That's a goal Johnson says he'll continue to try to reach. He's working on more robust models of his aluminum rocks and is considering a change in strategy to take into account the rocks' limited battery power: waiting until a flood rises and then tossing the rocks in to record the tumult, even if only for a few hours.

In the meantime, Olinde hopes to help other smart rock researchers avoid problems by writing a methods paper that details the obstacles she encountered and how she overcame them. And she is getting ready to mix another batch of concrete for her sturdy, if less talented, rocks. ✷

This article, reprinted with permission, first appeared in the Dec. 24, 2012 issue of Science.

State of the Field

Q&A with Miriam Barquero-Molina, Ph.D 2009

In its August 2013 edition, *Earth* magazine published a round-up on the current state of field camps, "Mapping field camp's past and present," by Timothy Oleson. The article paints a varied but encouraging picture. On the downside, the number of field camps in the U.S. has shrunk dramatically, from 287 in 1995 to 100 today, and quite a few last only three weeks. On the upside, many of the remaining, consolidated camps enjoy solid enrollment and broadening curricula.

The complete article is available at *Earth*'s website. One of the main interview subjects is Jackson School doctoral graduate, Miriam Barquero-Molina (Ph.D. 2009), a former assistant instructor in our GEO 660 field camp who now directs the field camp at the University of Missouri at Columbia. She shared her thoughts with us on her experiences as a field camp veteran.

How did your JSG experiences help at Missouri?

Teaching at the Jackson School field camp really gave me the opportunity to become who I am. I learned about the geology of the Western U.S., with which I was quite unfamiliar when I started (Europe was my undergraduate playground, Chile became my master's focus). I had the opportunity to see world-class geological sites in siliciclastic and carbonate sequence stratigraphy, to get comfy with geologic mapping on top-notch spots along the Sevier fold and thrust belt, gain some insights on the geology of the Yellowstone volcanic system, and even hack at field metamorphic petrology and ore mineralogy in the Pioneer Mountains. But I did not see these places alone. I went there with some of the best of the best: Kerans, Steel, Wood, Marrett, Gardner, and, of course Helper. And I did not do the learning on my own. I worked with our undergraduate students, and with a string of amazingly motivated, and pretty darn bright, graduate students.

Miriam Barquero-Molina

But running a field camp takes a lot more than knowing about the geology. While participating at the Jackson School camp I learned about logistics and careful preparation, about patience and poise. I learned about improvising and going with the flow, to work around the weather and with the weather. I learned about good days and bad days, good years and bad years. I learned that it takes a village. I gained perspective. I learned that I didn't have a clue. And I learned most of it from Mark Helper.

What are the strengths of the best summer field camps?

The UT-JSG field camp and the Missouri field camp are different animals in many aspects. Travelling camp vs. permanent base. UT-only students vs. students from all over the nation. Geological sites from New Mexico to SW Montana vs. Wind River Mountains and Wind River Basin with a brief foray into NW Wyoming. Large emphasis in mapping vs. slightly less mapping and incorporation of hydrogeology, geophysics and geomorphology (both of our camps have a pretty solid sed/strat component). Very different camps, yet both really excellent ones.

The key part of field geology, and thus field camp, is, in my opinion, the ability to comprehend 3D. 3D visualization is not just accomplished through geologic mapping, although obviously mapping is key. All of the projects we did at UT Austin, and the ones we do at MU, challenge students to visualize three-dimensionality in different settings. Good field camps pay attention to the basics. Technology can simplify our lives, even our geological lives. But if technology is incorporated too soon, it could become a crutch rather than an aid, and actually hamper learning of basic field skills. The best way to learn how to locate yourself in a topographic map is, you guessed it, by forcing yourself to look at a topographic map, match what you see around you to what you see on paper, and put your finger on the map. No GPS, tablet, iPhone, iPad, or app will teach you that. Good field camps link their projects on a regional geology context. UT and MU follow slightly different approaches to this, but nevertheless do it, and do it very well. Field camp projects cannot be isolated tasks, cannot feel like busywork. There must be a tether tying them together. Otherwise we are missing the point.

In 1995, there were 287 U.S. field camps. Today, about 100.

In good field camps all involved realize that teaching and learning are 24/7. And teaching and learning can happen around the campfire.

How important is financial support?

While at UT, our students benefited greatly from alumni donations in the form of scholarships to offset their fees. The Missouri camp also counts on the support of an extremely devoted group of alumni who donate their money, and time, to make sure that our camp keeps running, as we move through the first years of our second century of existence. We do have several scholarship funds, that we make available to all comers, MU and non-MU students alike. Scholarships are merit-based (there are GPA requirements). The availability of financial aid makes it easier, and, not uncommonly, possible, for many students to a attend camp.

Last thoughts?

Field geology is an essential skill for any geoscientist. Regardless of where your career as a geologist may take you, whether the lab or the office, a rig or a boat, the classroom or the corporate ladder, a lot of learning comes together and cements during field courses, field excursions, and, of course, field camps. Field camps are the ultimate field learning experience: they are long enough to allow for diverse projects, they encourage instructors to team-teach and students to work in groups (oh, the joy!), they allow students and teachers to work on world-class locales that cannot be reached in any setting other than a long field course. At field camp you get to widen your gastronomic horizons (salad dressed with salsa, power bars and lima beans, anyone?). Field camp will furnish you with enough stories to bore the pants off all your progeny when you are old. Field camp gives you the best tan lines.

In a statistics-frenzied society, the proof is in the poll. Question a random sampling of geologists about the best experience of their undergraduate careers, and a large majority will answer "field camp." There must be a reason this is so, and it can't just be that field camp directors tend to be really good looking people. ✶

Jackson School Formula

Alumni Support + Many Locations + All Major Disciplines = World's Best Field Camps

"We like to think we offer some of the best geoscience field experiences in the world," says Mark Helper, the distinguished senior lecturer who for many years has led the Jackson School's Geo 660 capstone summer field course. To reach that lofty goal, the school combines an outstanding capstone field course for undergraduates with several discipline-specific options in hydrogeology, geophysics, and marine geology and geophysics. Throw in generous support from Jackson School donors, which significantly reduces the expense for many students, and you end up with a world-class suite of field experiences.

Like many large geology field camps, the Jackson School's capstone GEO 660 field course is a six-week long experience that integrates what students have learned for three or four years in the classroom with hands-on activities that prepare them for careers in geosciences. But GEO 660, notes Mark Helper, stands out from many programs in three key areas: geographic range, number of instructors and student financial support.

The GEO 660 class moves almost continuously across nearly 6,000 miles of the western U.S. in a loop from Austin, Texas to Butte, Montana and back, never spending more than six days in one area. At night, the students and instructors bunk down in tents, motels and college dorms. Students on a typical geology field camp stay within a few hour's drive of one or maybe two base camps.

"We can go to the very best places with the best examples to teach those things that we think are important," says Helper. "We don't have to find something that works for a particular spot. And that's a huge advantage."

The GEO 660 trip is also unique in that there are six to ten rotating instructors for the course each summer, whereas a typical program might have two or three. This provides an unusual depth of expertise in sedimentology, stratigraphy, volcanology, structural geology, tectonics and petrology.

Finally, students in GEO 660 receive generous scholarships from the Jackson School that typically cover from half to all of their tuition and fees (including travel, food, lodging and supplies).

All three of these distinctive features—strong financial support, a large and diverse team of instructors and the travelling format—are possible thanks to a healthy field camp endowment that has been built over several years with donations from companies and individuals. These funds also provide additional support to several shorter, more specialized field courses, including the Marine Geology and Geophysics Field Course (MG&G) and Field Methods in Groundwater Hydrology.

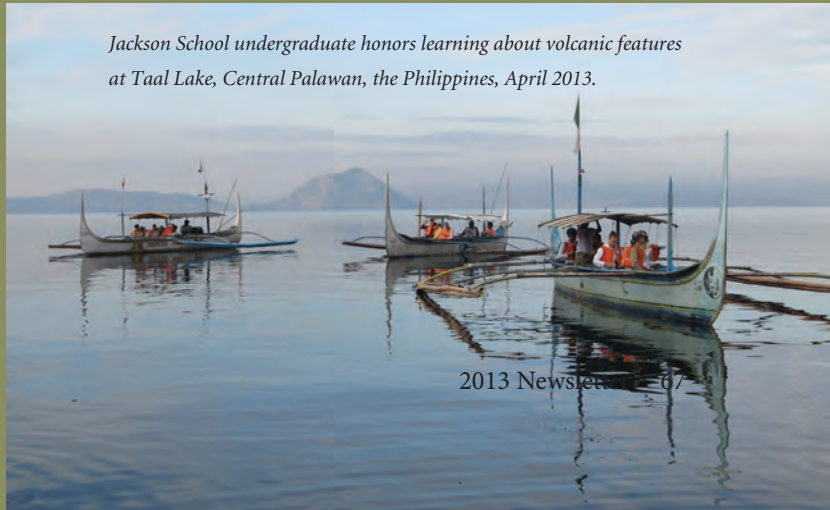
Austin may seem like an incongruous home base for a great marine field course, but thanks to the ocean-going experience of scientists at the Institute for Geophysics, the program has been a major success since its first shipload of students left Port Aransas in 2008. With a combination of at-sea field work in the Gulf of Mexico and on-shore lab work, the MG&G course gives students hands-on instruction they would be hard pressed to obtain at almost any other institution.

According to Sean Gulick, a research scientist at the Institute and research professor at the Jackson School who helped launch the course, "There is no other field course in the U.S. or perhaps in the world that offers such a unique marine geology and geophysics experience."

Back onshore, the Jackson School operates one of the largest field camps focused on hydrogeology, GEO 376, or "Field Methods in Groundwater Hydrology." Located in Texas and New Mexico, the three-week summer program includes geophysics, pump tests, stream gauging, well-logging, water sampling, and mapping.

"Just as 660 offers a peak experience for many general geology students, the hydro field camp is the high-water mark for many of our undergraduate majors," says Professor Jack Sharp, who founded the hydro field camp the mid-1980s. "The camp also helps our students get jobs, since employers find it very useful that our students have this field experience."

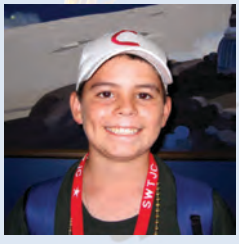
Finally, in addition to these summer courses, the school gets students out into the field through introductory field courses, honors field trips, and industry-sponsored expeditions like Statoil's Svalex field camp (see pages 41-42). Thanks to the generosity of alumni and supporters, the Jackson School continues to be able to offer, year in and year out, some of the best field experiences on planet Earth.



Jackson School undergraduate honors learning about volcanic features at Taal Lake, Central Palawan, the Philippines, April 2013.








First Wave

GeoFORCE Texas Students Graduate from College

Here's a simple math problem: The demand for workers in STEM fields (science, technology, engineering and math) is growing, but the number of students going to college to study these fields is shrinking. On top of this looming workforce shortage, minorities are greatly underrepresented in STEM jobs.

It doesn't take a math degree to see these trends don't add up.

So why aren't more young people going into math and science? A recent survey by the Pew Research Center and Smithsonian Magazine found that nearly half of Americans (46 percent) think it's because science is "too hard." Another 22 percent say these fields aren't useful for their careers and 20 percent say these subjects are "too boring." Ladies and gentlemen, we have an image problem.

GeoFORCE Texas, the four-year program for high school students run by the Jackson School of Geosciences, is showing kids from historically disadvantaged parts of the state that science and math are exciting, societally relevant, and rewarding — plus, they offer phenomenal career opportunities.

The program sends honors students from mostly minority-serving high schools on all-expenses-paid geological field trips across the country to educate and excite them about science. And in 2013 — as many members of the first class graduated from college — GeoFORCE Texas has become the largest geosciences K-12 pipeline program in the nation.

Sparking a Passion for Science

The first class of 69 GeoFORCE students was selected in 2005 from small towns in rural Southwest Texas. They had all completed the eighth grade; about 73 percent are Hispanic. For four summers, they visited sites like the Grand Canyon, the Florida Everglades, Zion National Park and Mount St. Helens, learning about energy, water, volcanoes, plate tectonics and how landscapes evolve.

Students also visit the U.S. Geological Survey (USGS) headquarters in Washington, D.C. to learn about science careers in government. Scientists from industry and universities lead the trips.

"We were talking with a woman who was at the top of her corporation," says Karina Robledo, a student from Pearsall, Texas, (population 9,200) who was in the first cohort of GeoFORCE students. "She told me you could be a very successful scientist, too. That was really inspiring to hear as a high school student from Pearsall."

Robledo just completed a bachelor's degree in chemistry from St. Edward's University in Austin. Next year, she plans to start work on a master's in geochemistry, using chemistry to study the environment — tracking water pollution, for example.

"I probably wouldn't have put it all together — my love for math, science, the environment and being outdoors — learning about all that in GeoFORCE really put it all together for me," says Robledo.

Jeff Sitgreaves (B.S. '13) was part of the second cohort of GeoFORCE students. Thanks to college credits earned in high school, he took only three years to graduate from UT Austin in May with a bachelor's degree in geology. This fall, he begins work on a master's degree in geosciences at UT Austin.

"I wouldn't be in the geosciences if it weren't for that program," he says. "My first year, I thought this is kind of interesting. The second year, this is cool. Then by the third year, yes, this is what I want to do."

Now, four years after completing GeoFORCE and graduating high school, 27 of the 69 students in the first cohort have completed college degrees, with 9 more planning to graduate in December 2013. At least three, including Sitgreaves, are enrolled in graduate school this fall.

The GeoFORCE program has since expanded to include students from urban Houston, who are predominantly Hispanic (46 percent) and African American (32 percent). With classes from all four grades of high school and both regions, GeoFORCE Texas now serves about 640 students each year.

Of the GeoFORCE students who have already received college degrees, 55 percent received them in STEM fields. According to Eleanour Snow, interim director of outreach and diversity programs in the Jackson School, if you include all GeoFORCE students now in college, 64 percent are majoring in STEM fields, more than double the proportion of U.S. college students who earn bachelor's degrees in science and engineering fields (31 percent), according to the National Science Foundation.

GeoFORCE Texas is made possible by the generous support of industry, government and professional organization partners, as well as individuals. The Jackson School also provides general operating support. Partners include Southwest Texas Junior College and the Houston Independent School District.

Building a Foundation for Success

The organizers of GeoFORCE also assist students with the transition from high school to college. They show them how to apply for university admissions and financial aid. They teach students strategies for taking the SAT. They bring them to the university while still in high school to get them comfortable being on a college campus, experience living in a dormitory, and take classes from top faculty.

With four years of college under their belts, the first cohort of GeoFORCE students is demonstrating that the combination of inspiring field trips, interaction with working scientists, and help preparing for college are adding up to success in college.

Compared to a group of similar high school graduates who did not participate in the program, students in the first GeoFORCE cohort were more likely to go to college, more likely to re-enroll for the second year, and if current trends continue, will have been much more likely to complete a degree within six years (see chart).

Doug Ratcliff, former director of outreach and international programs at the Jackson School, launched GeoFORCE with support from members of the school's Advisory Council, industry partners and others (see sidebar). Richard Chuchla (M.S. '81), a geologist and Advisory Council member actively involved with Ratcliff in the early development of GeoFORCE, says everyone was optimistic about the program from the start.

"But we didn't have even the wildest idea that it would be as successful as it has become," says Chuchla, who manages Latin American new business development for ExxonMobil Exploration Company.

In March 2013, the National Research Council issued a report on the looming worker shortage in the energy and mining industries. The report highlighted GeoFORCE as one of four educational programs that "have established excellent pathways to address the

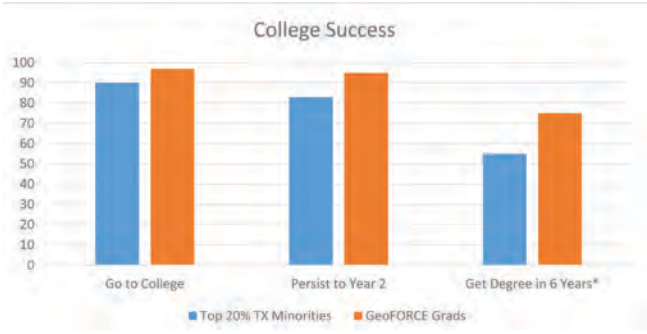
workforce issues."

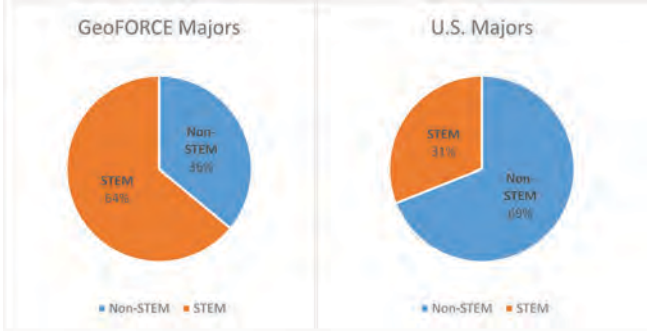
And now GeoFORCE is heading north. With help from industry partners such as Ed Duncan (BS '79, MA '87) and Great Bear Petroleum, the University of Alaska Fairbanks launched GeoFORCE Alaska last summer for students from native villages on the North Slope. Students in this region are historically underrepresented in STEM fields and live in rural communities where schools struggle to provide solid science and math education.

"My favorite part of GeoFORCE was traveling and learning about the surroundings," says Carlos de la Torre, a student from Sabinal, Texas (population 1,700) who graduated from the first GeoFORCE class. "Everything you see around you is either geology, plants or wildlife. That's what I do now. I'm learning about my surroundings."

De la Torre, who graduated this past May with a bachelor's degree in wildlife and fisheries and a minor in earth science, from Texas A&M University, says seeing so many diverse and interesting sites around the country inspired him to study wildlife and pursue a career in education and outreach in the National Park Service (NPS).

"We come from these small towns that no one has heard of, but they believed in us," says Sabrina Cervantez, a student from Del Rio, Texas (population 35,700) who graduated from the first GeoFORCE





class. "I'm very grateful to them for choosing our little area of Texas to hand-select students."

Cervantez, who received a bachelor's in history and English from UT Austin in May, begins a master's program at Louisiana State University this fall, studying the history of geology.

So if you happen to be visiting a national park next summer, and a bus full of Texas or Alaska high schoolers wearing the same brightly colored shirts spills out into the parking lot, don't be alarmed. You're looking at the next generation of scientists and engineers who will help keep our lights on. ✶

Timeline: 1888-2013

125 Years of UT Geosciences

CELEBRATING 125 YEARS OF UT GEOSCIENCES

1888
School of Geology established by Robert T. Hill with first classes held in Old Main.

1909
Bureau of Economic Geology founded under first director, William Battle Phillips

1911
First women enrolled in geology courses

1912
Department of Geology established, B. A. degree program established

1919
First UT Geology field camp

1921
First Departmental field trip to West Texas

1923
Discovery of oil on UT lands spurs expansion of Geology Department

1930
B.S. degree program in geology established, field camp required for degree

1930
Bureau publishes classic stratigraphic study, *The Geology of Texas, v. 1, Stratigraphy*, by E. H. Sellards and others

1933
First Geology Building dedicated

1942
Introductory field course established (now GEO 420K)

1948
Prof. R. K. Deford hired to improve quality of the graduate program

1950
Department of Geology Newsletter started

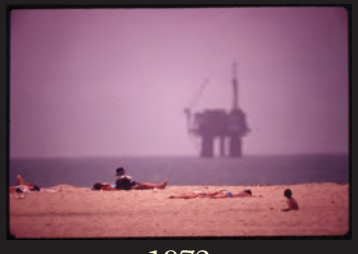
1972
Maurice Ewing founds organization in Galveston that becomes the Institute for Geophysics

1968
Department changes name to Geological Sciences

1941
Peak enrollment from first oil boom: 80 B.A./B.S., 16 M.A.

1949
Vertebrate Paleontology Lab established

1953
Geology Foundation established



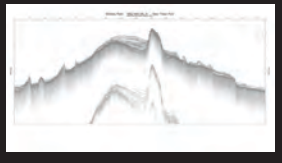
1973
Bureau begins historical monitoring of Texas shoreline

1967
New Geology Building opened

Timeline: 1888-2013

125 Years of UT Geosciences

1973
Scientists on R/V Ida Green collect first marine multichannel seismic reflection profile by a university research group in the Gulf of Mexico

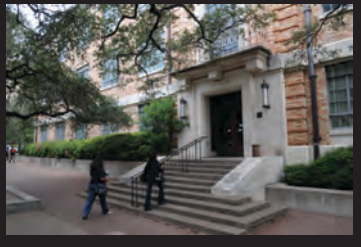


1984
Bureau of Economic Geology moves to Balcones (now Pickle) Research Center

1988
Bureau establishes 1st industrial associates program, now a major component of its sponsored research

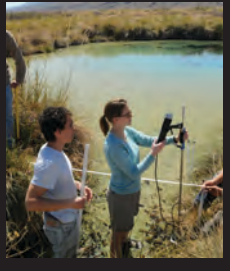
2002
John A. Jackson announces gift that culminates in $242 million (plus previous $25 million) to form Jackson School of Geosciences

2011
Department expands into second building on main campus (E.P. Schoch)



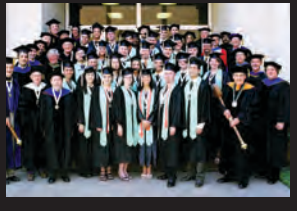
1974
Institute for Geophysics moves to Austin

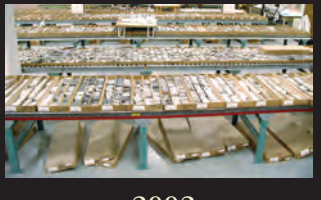
1984
All-time combined peak enrollments: 825 undergraduate, 225 graduate students (there are more graduate students today)



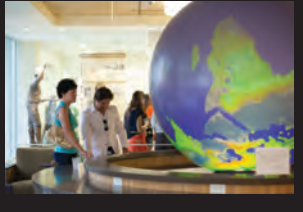
1990
B.S. Hydrogeology/ Environmental Geology degree established

2005
Jackson School approved as separate unit at level of a college





2002
Bureau begins operation of Houston Research Center core facility



2012
School opens Holland Family Student Center

THE UNIVERSITY OF TEXAS AT AUSTIN

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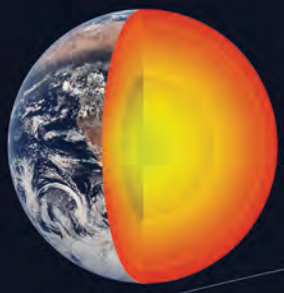
SCHOOL OF GEOSCIENCES

Bureau of Economic Geology
Institute for Geophysics
Department of Geological Sciences

Earth's surface and atmosphere



Earth's interior

Earth's Moon

Europa

Mars

Jackson School Global Research Locations

October 2013

From Texas to the World

ADVANCING EXCELLENCE

Donations to the Jackson School, 09.01.2012-08.31.2013

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Holland Exploration, Inc.

Mr. Stephen C. Jumper, B.S. '84
Dawson Geophysical Company

Mr. David L. Kirchner, B.S. '74
Basin & Range Hydrogeologists, Inc.

Mr. James T. Langham, Jr.
Langham McKay & Company

Mr. Thomas B. Layman, M. A. '87
Chesapeake Energy

Dr. Susan A. Longacre, Ph.D. '68
ChevronTexaco Fellow, Emeritus

Mr. William Maloney
Statoil

Mr. David T. Martinueau, B.S. '92, M.S. '97, Martineau Petroleum, Inc.

Dr. Peter K.M. Megaw, B.A. '76; M.A. '79
Imdex, Inc.

Mr. Forrest W. Pace, Jr., B.S. '85
Talisman Energy

Dr. Donald L. Paul
University of Southern California

Mr. Wagner Peres, Ph.D. '90
Devon Energy

Dr. Andrew I. Quarles, Ph.D. '96
Cuadrilla Resources Ltd.

Dr. David I. Rainey
BHP Billiton Petroleum

Mr. Walter J. Scherr III
Valence Operating Company

Mr. Don B. Sheffield, B.S. '58

Mr. Daniel L. Smith, B.S. '58
Sandalwood Oil & Gas, Inc.

Mr. Richard K. Stoneburner, B.S. '76
Petrohawk (Retired)

Mr. Charles G. Weiner, B.A. '48
Texas Crude, Inc.

Dr. Charles R. Williamson, Ph.D. '78

Members, Ex Officio

Mr. William C. Powers, Jr.
The University of Texas at Austin

Dr. Gregory L. Fenves
The University of Texas at Austin

Dr. Sharon Mosher
Geology Foundation
Jackson School of Geosciences
The University of Texas at Austin

Mrs. Belle German
Geology Foundation
Jackson School of Geosciences
The University of Texas at Austin

ALUMNI NOTES

Jackson School alumni, faculty, and research scientists traveled with GSA members on the joint GSA-JSG expedition to Antarctica in January 2013. *See more photos on pages 86-87.*

1950s

Jim W. Adams (B.S. '51) writes, "Now retired in the middle of the industry's biggest boom. Enjoying the leisure of Manor Park at 505 Lajitas Dr., Midland, Texas, 79707. Come see us."

Walter V. Boyle (B.S. '54; M.A. '55) writes, "First, 'Mucho Thanks' to Dean Sharon Mosher and her Staff for hosting another great Jackson School of Geosciences All Alumni Reunion in April 2013. Vada and I look forward to attending the next one. 2013 was another year to 'Go Cruising' and sight seeing to South America, through the Panama Canal, Central America, and Cabo San Lucas in March and then, another cruise and sight seeing to Ireland, Scotland, and France in July. We continue to enjoy attending the Jackson School of Geosciences Scholarship Luncheons and the Society Dinners in Austin and visiting with 'Old and New' graduates from the

Stay in Touch!

Use the enclosed envelope or our online form (linked to the JSG alumni Web site) to let us know what you've been up to and to update your contact information.

JSG. Vada continues to stay busy with her activities in the Houston Symphony League and the American Association of University Women organization and I stay active in the Houston Computer Investment Group, church organizations, and working in my yard."

Phillip Braithwaite (M.A. '58) writes, "Barbara and I continue living in Dallas during our retirement. We have cut back on our traveling these days. I enjoy gardening and trap shooting. Barbara reads a lot and writes. Once in a while I do some consulting."

Jack Cleveland Cartwright (B.S. '51; M.A. '55) writes, "My wife (Barbara Wells who I met in the Geology Library in 1953 while in grad school) and I continue to live in the Manor Park Community in Midland. We enjoy our retirement living. We now have an accumulated family of thirty three as a result of our marriage in 1955. In the last few years I have devoted effort to writing about our families and various episodes of my life. This has been a very enjoyable enterprise. Best wishes to my classmates in the Class of 1951 and grad school 1953-55."

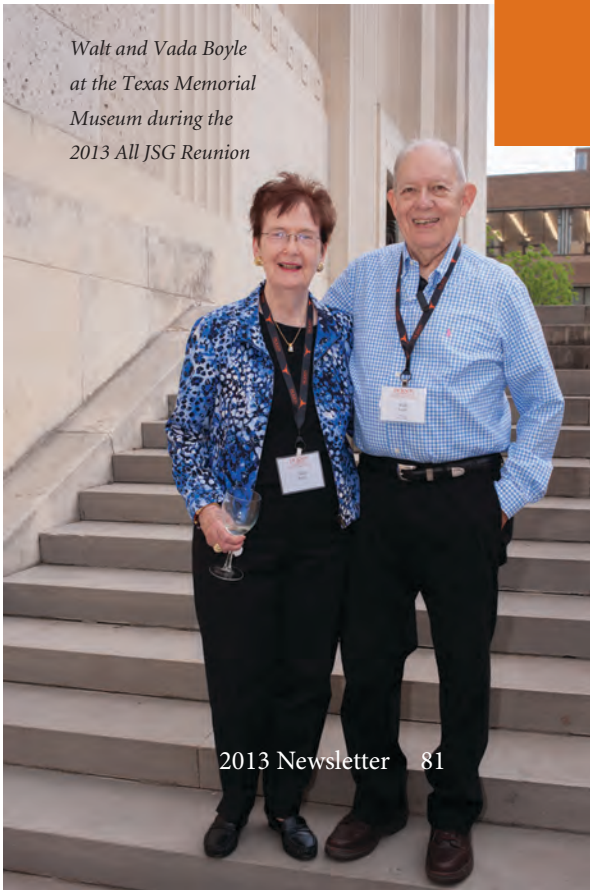
Robert E. Doyle (B.S. '55) writes, "Continuing development drilling programs in Western Siberia, but Russia keeps pulling the welcome mat back! Received approval for a patent to contain large offshore oil spills similar to the BP Macondo of three years ago. The primary area of interest is the Gulf of Mexico where there is a great deal of exploration drilling in the deep-water area some 200 miles from shore. Given BP's current liability of over $62 billion, the majors should have an interest!" Robert can be reached at rbtdoyle1aeig@comcast.net.

Kenneth R. Johnson (B.S. '50) writes, "My wife Kathy and I are enjoying retirement. We have spent the last 10 summers in Lake Oswego, Oregon. We are in pretty good shape but we recently moved to a retirement home –The Hallmark in Houston. I have a monthly meeting with some geologist friends and a monthly meeting with my high school class." Kenneth can be reached at johnson1463@comcast.net.

Roy Dick Miller (B.S. '51) writes, "Still enjoy life with Pat Gillen Miller, my wife of 69 years. Have been retired from Geomap co. as senior geologist and have lived in Georgetown since 1988. Used to do a lot of motorhome travel, but Pat and I stay at our country home now and mostly enjoy the scenery."

James Van (Jim) Richards (B.S. '56) writes, "Retired 20 years U.S. Navy as commander. Consulting for SOLA Oil and Gas in Houston, Texas. Celebrating my 53rd year in the oil and gas exploration business. AAPG Delegate Houston, Texas, SIPES member and past treasurer, Houston Chapter. Past board member Houston Geological Society. Past board member FANS group in Houston, Texas. Continue to march in the Longhorn Alumni Band, 50th anniversary of the band this year, also my 50th wedding anniversary to wife Pam." Jim can be reached at jr1934@aol.com.

Jimmie Norton Russell (B.A. '52; M.A. '54) writes, "I am not the man I once was, maybe I never was! This year I turned 82. Also this year, I retired, again! The physical demands of working as the assistant of teachers of special needs — emotionally disturbed — middle- and high-school students at GOALS Learning Center, Round Rock ISD, became a bit too much for my over-the-hill physique. Thus, my third profession came to a close. The initial one was industry, oil and gas, interrupted by two years in the U.S. Army Infantry, U. S. and Korea. Next was government, the State of Texas water agencies. Lastly was education, which included a semester as a teacher, bilingual Spanish/English. However, I will continue in education, volunteering and substituting at a church school near our home. Regretfully, I did not attend the Jackson School's reunion this year. An impor-



Walt and Vada Boyle at the Texas Memorial Museum during the 2013 All JSG Reunion

London Geological Society Honors Pete Rose

Austin geologist Pete Rose (B.S. '57, M.A. '59, Ph.D. '68) said he was tired of drilling for oil and not finding it when he developed a statistical way to approach the problem. His solution has earned him one of the highest awards in the world for his field. This June, Rose, 78, received the Petroleum Group Medal from the Geological Society of London at the group's annual dinner. He is the first American ever to receive the award, said Jonathan Craig, chairman of the society's petroleum group, in a profile of Rose that appeared in the Austin American-Statesman.

"His process and methods for consistent estimation of risk in exploration have been adopted as 'best practice' by the majority of the world's oil and gas companies and, as such, Peter has probably had a more profound influence on the E&P Business than any other individual in the last 30 years," Craig said.

Rose told the American-Statesman that receiving the award was probably the most "affirming thing that's happened in my life."

Rose grew up in Austin and received his bachelor's and master's degrees in geology from UT Austin. He was working as a geologist for an oil company when he realized in 1978 that half of the wells the company had drilled in two years turned out to be dry, he said.

"It was real underperformance," Rose said. By 1990, he figured out a statistical method to estimate the costs of exploration by analyzing several factors, including the probability of finding oil, the cost of drilling a well, and producing the oil.

Bill Fisher, the Leonidas T. Barrow Centennial Chair in Mineral Resources at the Jackson School and longtime friend of Rose's, told the American-Statesman that the method "had not been done before and certainly not with the rigors he put into it."

Rose started teaching risk analysis to oil companies worldwide and, in 1998, founded his own consulting firm, from which he has since retired.

"Risk analysis does not find oil but it keeps you from drilling wells that shouldn't be drilled," he said.

"I never have accepted there were things I couldn't pursue if I was interested in them," he said. "I used to be a country guitar picker, and I just published a western last year."

tant prior commitment prevented my doing so I would be very pleased hearing from you. Best regards." Jimmie can be reached at ritalrussell@gmail.com.

Floyd F. Sabins (B.S. '52) writes, "Beginning in 2010 my company (Remote Sensing Enterprises, Inc.) has completed 16 projects on Afghanistan under contract to the Department of Defense. The projects identify exploration targets for commodities including copper, gold, pegmatites, lithium, and coal. We have proposed an oil project in north Afghanistan using our alternate exploration model to replace the model used unsuccessfully by the Soviets."

Eugene Patrick Scott (B.S. '57) is a skilled petroleum Geologist consultant in Corpus Christi, TX.

Marriott Wieckhoff Smart (B.S. '57) writes, "My notes have been sparse the past few years. Time passes too quickly. I was sad to hear of Sam Sims passing. Seems to be happening more often these days. John and I are fortunate to continue to be in good health. We have had some nice trips in the past few years to Mexico, Europe, and to South America in 2012. We saw the magnificent Iguazu Falls in Argentina. We are always happy to come back home to beautiful Colorado. I wish the best to the Jackson School and to my classmates from 'half a century' ago." Marriott can be reached at marriott@ix.netcom.com.

Theodore E. Stanzel (B.S. '56) writes, "I have now fully joined the ranks of the retirees, except I remain on as a financial committee chairman for a foundation. Wanda and I will travel to Germany and Italy for the 200th birthday anniversary of Wagner and Verdi musical festivals. We will visit Leipzig, Nuremberg, Weimar, Parma, and Milan."

Leslie P. White (B.S. '56) writes, "The Reunion was a really great time — photos with Bevo, the surprise visit by the Longhorn band in the Red Zone, the visit to The Tower and to Mack Brown's office, the field trip to Pedernales Falls, and best of all, the Grand Finale: the dinner and dance on

the gallery of the majestic Texas Memorial Museum. It was good to see old friends and to make new ones. I am looking forward to the next one. Dianne and I are continuing through the 'enjoy the grandchildren' chapter. What a nice reward."

1960s

Tom Bjorklund (M.A. '62) writes, "I have been a research scientist at the University of Houston and a petroleum geology consultant for the past 10 years. My research interests continue to be the relationships between tectonics and petroleum accumulations in California."

J. Phil Jones (B.S. '64) writes, "My wife and I continue to enjoy retirement and trips to enjoy grandchildren in OK and NY. I was unprepared for a phone call from members of OCAPL (Oklahoma City Assn. Of Professional Landmen) and AAPL (American Assn. of Professional Landmen) that I was being summoned to appear at the AAPL's 59th Annual Meeting in Washington, DC. No reason was provided. I did learn that they were paying expenses for Marilyn and I to appear. It sounded like an offer I could not refuse. I did not learn until Wed, June 5 and then late in the program that I was the 2013 AAPL Lifetime Achievement Award winner. Of course, I was stunned. How they were able to keep the purpose of the event from me, I do not understand, because I spent much time trying to figure out what it was that I had accomplished to merit any such honor. I'm still humbled by the presentation. Many thanks to UT Austin for a great start with a B.S. Degree in Geology in 1964."

Judith A. Schiebout (B.A. '68; M.A. '70; Ph.D. '73) writes, "It's my 40th year of teaching and research since I graduated with the doctorate from UT Austin, and right now I am writing a book on Louisiana vertebrate paleontology and watching with enthusiasm the efforts of some citizens (The Friends of the Louisiana Museum of Natural History Foundation) who are trying to develop a major, accredited museum, based on LSU's 16 collections (www.friends-louisiana-museum-of-natural-history.org). The friends think the outstanding collections, many now in less than suitable spaces like attics and basements, need to be unified in a fine new building on campus with better space for research and space for modern displays and outreach. I hope you will check out the website and Facebook page (www. facebook.com/FriendsOfLousiana NaturalHistoryMuseum?filter=3), 'like' the effort on Facebook, and share the idea with your friends."

Jim Nienaber (Ph.D. '58) and his daughter Ann Paterra.

"Many thanks to UT Austin for a great start with a B.S. Degree in Geology in 1964."
—J. Phil Jones

Rubin A. Schultz Jr. (B.S. '61) writes, "Still enjoying retirement in Corpus Christi, TX — visiting grandkids, travel and growing tropical plants. Not a lot new, spent some time in Utah this spring (Provo and Park City Area) and planning a fall trip to Branson, Mo."

Robert E. Stowers, Sr. (B.S. '61) writes, "In full retirement mode."

Herbert Samuel (Sam) Travis (B.S. '60) writes, "I graduated in the summer of 1960 immediately after completing the Geology 660 field course. Currently I'm retired and investing in real estate projects on or near East Texas Lakes, e.g. Cedar Creek Lake located near Gun Barrel City, Texas and the Granbury Reservoir south of Ft. Worth. When I was active in the geologic world I worked as a geology consultant for large national computing firms such as the Geotechnical Corporation, University Computing Company, and Control Data Corporation. All total I worked 35 years as a geology consultant in the Computing Field." Herbert can be reached at herbert_travis@msn.com.

Don Urbanec (B.S. '60) writes, "After living in Boerne and working in San Antonio for the past 40 years, I retired from the exploration and operations phase of the petroleum business. Last year my wife and I built a house in Fredericksburg, Texas where we grew up. Our daughters also live here. We invite our UT classmates to call and come by." Don can be reached at donurbanec@gmail.com.

Gerald Weber (M.A. '68) writes, "There was an old country/western song that describes my days in Austin: 'Happiness is Texas in the rearview mirror.'"

William Feathergail Wilson (B.S. '60; M.A. '62) writes, "Recently working on a deep experimental desalination well near

Austin and Kyle testing the brackish Hosston and Edwards intervals. Just finished a country wide survey of Paraguay and portions of Bolivia, Argentina, and Brazil. Working on about 30 SWD wells in South and West Texas. Mapping the thickness of the Hosston in the Texas Hill Country. Consulting for a groundwater district in Hays and Caldwell Counties. Working on drilling prospects in South and East Texas and a few other things."

1970s

John Boone (B.S. '73; M.A. '79), is with Arcadis in Houston.

Roger Q. Callaway (B.S. '77) writes, "Still here in North Carolina, sigh. Working, sort of. The state government is taking money from public schools to fund creation charter schools. They almost passed a law forbidding state agencies to plan for sea-level rise. The NC change to public school funding is the most negative of any state in the country. I guess the new motto will be Beating back Science as Best as We Can. Soon, they will be burning geology books. Apparently funded by oil money. Yeah. That makes sense."

Frank G. Cornish (M.A. '75) writes, "I've been consulting with SV Energy/MLP in Corpus Christi now for five years. We continue the hunt for (you guessed it) shallow oil. No success so far, but many leads and upcoming prospects to develop. We are all eager to get back to drilling conventional deep gas. We enjoyed the UT alumni reunion this year and our annual get together at Stanton's in Austin. I gave a talk in Austin at the GCAGS convention and have been invited to re-present it in New Orleans at this years GCAGS convention in the Wilcox: Updip, Downdip, and In between. The paper was published in the South Texas Geol. Soc. Bull. in May. We attended the Pittsburg AAPG as a delegate and visited Niagara Falls and Gettysburg. My photography career is taking off when I won Best of Show (and sold it) in our local Art Center exhibit. Will try again. We are looking forward to my youngest son's marriage in Atlanta this Sept. Hope to see you at the next alumni reunion."

Mike Dildine (Class of '72) (B.S. '72) writes, "Hello to the classes of '70, '71 and '72 (embarrassed to say I 'overlapped' on several). It's been awhile since I've been in touch. My wife and I are enjoying life on the California Central Coast. I'm semi-retired, doing volunteer work for a non-profit I started with some North Coast winemakers called the 'Historic Vineyard Society.' I've talked intermittently with David(dillo) Kirchner on a 660 reunion (1971) in Big Bend. Still a work in progress! Kind thoughts to all!"

Shirley Peterson Dutton (M.A. '77; Ph.D. '86) writes, "I will be doing an AAPG Distinguished Lecture tour this year about reservoir quality of deep Wilcox sandstones in the Gulf of Mexico. The last time I did a DL tour, back in 1987, I was a lot younger."

Heather Wilson Echols (B.S. '79) writes, "Our middle child and the first to marry, John-Mark Echols, 24, a 2011 Graduate of The University of Alabama, married Briana Griffith, on July 20th, 2013, in Midland, TX at The First Baptist Church. They had over 300 guests and a reception at Green Tree Country Club following the ceremony. His younger brother, Wilson Echols, a senior at JSG majoring in geology, was his best man. His older sister, Tarabeth Echols, an interior design major from The University of Arkansas, was the maid of honor. They will reside in Midland where John-Mark is the fluids development project coordinator for Basic Energy Services and Briana is the safety advisor for Titanliner." Heather can be reached heather.echols@gmail.com.

Murray Felsher (Ph.D. '71) writes, "Thoroughly enjoyed my olden days at NASA and EPA in DC, and am still (since 1981) publishing Washington Remote Sensing Letter 4X/month (although print edition has disappeared with the times, and only an email version is available), and still working full time (plus) as a consultant — mainly for our government friends hereabouts. Natalie has retired, and we're doing a bit of traveling — took June 2013 'off' and spent the month touring Iceland and Norway — both geological heavens! Two weeks in New Zealand was also a highlight. Our three 'kiddies' are in middle age (incredible! — where do the years go?) Elyann has her Ph.D. and works for the Fed, Harry is a nuclear engineer and works for the Fed, and Josh is a surgeon. All the kids and their kids (four grandchildren) live here in the DC area, so we're kept extra busy. Best wishes to all."

Keith Haun (B.S. '75) writes, "Still working for Duncan Oil, going on 22 years. Conventional prospects have definitely fallen out of favor, but there are still a few of us 'conventionals' trying to achieve critical mass to get a few wells drilled every so often. Integrating detailed subsurface geology with high quality 3-D data still seems to yield enough good prospects to keep things interesting. We spend as much time as we can down at our place in Jamaica Beach (Galveston), but my fishing expertise is poor enough to keep me from even thinking about going down there full time. Catching a nice trout still can't match the excitement of seeing a good pay zone pop up on the screen in the logging truck. Good hunting (and fishing) to all!"

S. Lance Jackson (B.S. '79) writes, "Working for Argentina, mainly from Houston. Last child is out of the house and attending UT. I still have not found any of the free time you are supposed to have when you are an empty nester." Lance can be reached at lance.jackson@exxonmobil.com.

Ralph S. Kerr (M.A. '76). Ralph continues to work with the energy sector out of Houston, as an executive coach and leadership development consultant. He specializes in helping technical people to improve their leadership skills. His recent work in helping leaders to navigate career choices has expanded into working with college students and military veterans to help them choose career directions and prepare for the job application process. He hopes to make at least one Longhorn football game this fall. Ralph can be reached at ralphkerr@momentumchangesolutions.com.

Charles Edward McKemie, Jr. (B.S. '79). Charles can be reached at cemckemie@dow.com.

Brian Hunt (B.S. '96, and M.S. '00), standing, was one of several alumni who made presentations underground at Natural Bridge Caverns during a special session for the 2013 GSA South Sectional meeting in Austin. The presentations coincided with Hydro Days, an annual gathering focusing on karst hydrogeology, which this year took place at the close of the GSA meeting, with a field trip over the Trinity and Edwards Aquifers. Hunt helped organize the 2013 Hydro Days along with JSG alumni Marcus Gary, Robin Gary, and others. The Jackson School co-sponsored the event.

Armando Otal-Garza (B.A. '71) writes, "After a long career (35 years) in the pharmaceutical sales industry I am now retired and living in the Rio Grande Valley (DELTA, to all my geology colleagues) and in Austin. I enjoy keeping up with my professors and friends through the various mailings from the department. Even though I was not lucky enough to have worked as a geologist, my career was enhanced by the rigorous science background and discipline I learned from being a student of professors Folk, Wilson, Land, Barker, McBride to name just a few. Continued success to all who read this note and, especially, to those who graduated with me." Armando can be reached at aogarza@utexas.edu.

Bren Sidereas (B.S. '74) writes, "I've been very busy working Denbury's Tinsley Field CO_2 flood since 2007 when CO_2 injection began. Since then this prolific World War II field in Mississippi has produced 13.7 MMBO of tertiary CO_2 driven oil. With current production at 10,000 bopd, the field should have a cumulative CO_2 oil production of 15 MMBO by year's end. The last planned development of the 13,000+ acre unit, Phase 8, begins in 2014. I'd like to be finishing up by then too. My wife, Carolyn, and I now have two granddaughters (a 3-year-old and a 1-year-old) and one grandson who just turned 1 month old. My daughter and her husband (w/ the two girls) also live in Rockwall very close by, and my son and his wife (w/ the new baby boy) live in Wylie about 25 minutes from us. We are so lucky to have all grandkids so close — so easy to visit, pick them up for fun, and drop them off when the fun is over! Next up is taking them to the Greek Festival for lots of fun eating and free-style dancing.

"I still enjoy watching college football, and with a couple of my old college roommates, have attended at least one Longhorn game for the past 10 years. My wife and I usually make a couple of Texas Rangers baseball games during that season also. She and I made our first trip to Italy last April and loved that like everyone had told us. We visited Florence, the Cinque Terre coastline, and Milan. I wanted a chunk of their Tuscan Carrara marble (Michelangelo's favorite), but none of the museums were giving it away, and no rock hammers were allowed. With all the pictures of grandchildren and recent travel, I find myself enjoying playing on the computer (iPhoto/iMovie) much more than working on the computer. What does

2013 Alumni Events

Top to bottom, L to R: Enjoying the new Student Center during the fall Jackson School tailgate; a surprise visit from the Longhorn Band during the All-JSG Reunion; Jamie and John Long, Bonnie Weise, and Donna Balin at the tailgate; Karl Warning and Frank Cornish with Bevo at the reunion; Jackson School tailgaters taking a break from the heat; Charlie Kerans leading the alumni field trip to Pedernales Falls State Park during the reunion; Larry Lawver and Laurie Duncan during the reunion.

that mean? And occasionally, when things become a little too quiet, I will still pick up my guitar and 'rock' it out as well as an old guy can. Maybe pretty soon I can prove the sign I have hung in my office wrong that reads: 'Born To Rock - Forced To Work.' I can be reached at bren.sidereas@icloud.com."

David B. Story (B.S. '78) writes, "Just completed 35 years in the petroleum industry and looking forward to new adventures. Always enjoy getting to Austin and hope to move back to the Austin area in the near future." David can be reached at david.b.story@exxonmobil.com.

M. Gary Thompson (B.S. '75; M.A. '77) writes, "Approaching two years of being retired after 34 years with ExxonMobil. Still keeping busy with home improvement projects and visits to our small ranch in South Texas. Hoping the decline on our Eagle Ford production there will plateau soon!"

David Wilkes Vernon (B.S. '79) writes, "Still the appellate chief at the Johnson County D.A.'s Office. Just finished my 231st brief. My youngest daughter graduated from high school this year and will play volleyball for the University of Central Oklahoma. If that doesn't make me feel old, my oldest daughter recently made me a grandpa."

1980s

Walter Ayers (Ph.D. '84) writes, "Still teaching in the Petroleum Engineering Dept. at Texas A&M University. Research is focused on unconventional reservoirs' properties and resources."

Carol Swenumson Baker (B.S. '84) writes, "Our oldest son just graduated from UT. Youngest is a freshman at Texas Tech. Will really miss the frequent trips to Austin. I'm still at ExxonMobil and Rod still with Anadarko."

Ben (Bud) M. Brigham (B.S. '83) can be reached at Bbrigham@anthemventures.net.

Richard Frank Carroll (B.S. '80) writes, "I am still at Sanchez and working the mid-continent, East Texas and the Tuscaloosa Marine Shale. On a personal note, my youngest son just graduated from high school and will be starting at Lone Star College this fall. My oldest son will be a junior at the McCombs School. I spent two weeks with him in Brazil this summer where he had gone for an internship." Richard can be reached at rcarroll16@comcast.net or rcarroll@sanchezog.com.

Michael Clark (B.A. '89) writes, "Just chilling."

David Chow (B.S. '85) writes, "I have been at Marathon Oil in Houston for 18 years supporting geophysical software. I visited Marathon's Aberdeen and Stavanger offices earlier this year. My daughter, Carla, is a senior in marketing at the University of Houston. I participate in senior track & field meets, play pickup soccer, and occasionally cycle to the office."

Roy Ernest Easley (B.S. '80) writes, "Joined the Bass family's oil company (Bopco) last fall and have enjoyed a change of scenery, including working a great deal in the Delaware Basin. Lots of Longhorns in both geology and engineering which is of course fantastic."

Charles A. Goebel (B.S. '80) writes, "Actually spent some time looking at outcrops recently. Nice break from spreadsheets."

Gay Nell Gutierrez (B.S. '81; M.A. '87) is with Aecom in Austin.

Laurie A Haischer (B.A. '85) writes, "I am working in the healthcare industry as a software developer and work in the Texas Medical Center. I graduated from UT with a B.A. in Geology in 1985 but went back to school and graduated from UT computer sciences with a B.S. in computer science in 1997. I have been working in the IT industry since that time. I recently completed an MBA (2011). My geological background and scientific training come in handy when I travel and aid in my appreciation of my surroundings in ways that would not be available to me, otherwise."

Bud Brigham

Brigham Praises Austin's Expanding Energy Sector

In "Oil, Gas Growing into Key Piece of Austin's Economy," the Austin *American-Statesman* reported Aug. 10 on recent developments in the state capital's flourishing energy sector.

Ben "Bud" Brigham, B.S. '83, was one of the main interview subjects. As the *Statesman* reported, "No deal stamped Austin as a potential landing spot for oil and gas firms more than Brigham's sale of the exploration and production company he brought to the city: Brigham Exploration. Statoil, the Norwegian national oil company, paid $4.4 billion for Brigham in 2011.

"That deal added a degree of imprimatur to Austin's oil and gas ecosystem, industry officials say, noting that Statoil could eventually base all its North American onshore operations at its offices overlooking Lake Austin and the Loop 360 bridge."

Brigham underscored that Statoil's presence in Austin could help lift the area's reputation in the oil and gas industry.

"To me, the Statoil transaction might have been an inflection point; it might have been a real step-change," Brigham said. "I'm thinking they may be showing larger companies, 'Hey, this isn't just a community of small independents and promoters. This has become a real oil and gas community.' "

Paul A. Hardwick (B.S. '83) writes, "Continue as vice president of geology for Smith Interests in Houston. We are drilling exploration projects in West Texas. I have one daughter that is a rising sophomore

KXAN Goes With Hauwert Into Austin-Area Caves

In April, KXAN News in Austin followed City of Austin Hydrogeologist Nico Hauwert (B.S. '84; Ph.D. '09) into some underground caves. Hauwert conducted the tour as part of a city-wide effort to make area caves more accessible to the public, a plan that includes helping Bowie High School excavate a cave underneath the school with the goal of turning it into a learning environment. "I think one of the things that really intrigues people about caving is not knowing what's around the next corner," said Hauwert. "You have no idea if it's a large room, a canyon, a stream. The underground world is so unpredictable." And underneath Austin, there are a lot of rooms to discover. "You wouldn't believe how many caves are below the ground here," Hauwert said.

at Trinity University in San Antonio and a daughter that is a rising junior in high school in Houston. Laurie (B.J. '82) and I are getting ready to celebrate our 29th anniversary. We still live in Houston but are beginning to try and figure out where we will go when the kids are gone." Paul can be reached at paulhardwick@earthlink.net or phardwick@smithinterests.com.

Nico Hauwert (B.S. '84; Ph.D. '09) was recently featured on the local evening news showing him caving and discussing the importance of opening up more local caves to the public, especially students.

Jonathan Charles Herwig (M.A. '82) writes, "Still living in the Land of the Morning Calm (Korea), where Bobbie and I have been for the last five years. Kimchi and nukes, it doesn't get any better! Working on the construction of the new U.S. base located 50 miles south of Seoul. Still struggling with the spoken language, but I am proud to inform that I can read at a 3rd grade level or so. If any UTers want a personal introduction to Kim Jong Eun, come on out and we'll take care of you!" Jonathan can be reached at jon.herwig@ch2m.com.

Franz Hiebert (M.A. '88; Ph.D. '94) is with ERM in Austin.

Janie Hopkins (M.A. '82) writes, "I am not a caver manqué. Yet for some reason, the near-treasure-map appeal of the detailed maps and allure of swimming through passages studded with sparkly (in the right light) stalactites and other exotic carbonate manifestations, as served up by the passionate expert Peter Sprouse at a UT Grotto meeting, made me wonder. He was presenting photos and discussing one of his Quintana Roo expeditions—and, perhaps, soliciting the help of fellow experienced troglosouls. But he was not that convinced that a googly-eyed neophyte (in my case antiquoneophyte) with zero cave cred could be a serious help to his mapping efforts. After all, I later learned while listening to another of his presentations at the Centro Ecologico in Akumal, at least one of the systems in Q. Roo is rapidly approaching the length of Mammoth Cave, current title holder as longest in North America. The sooner more survey points could get racked up in these Yucatan caves (especially with connections to ostensibly separated caves), the better."

"However, after a mild suggestion that I do a little caving around the Austin area first (gosh, it seemed that I'd have to pay a few dues) and after a couple more years passed during which he must have begun figuring he needed all the surveying help he could get, he allowed the dilettante to meet up with his summer expedition, headquartered in Paamul and Chemuyil. Aimee Beveridge (1987) and Wes Schumacher (2007) enthusiastically lent me caving gear, certain that I'd love at least a majority of the moments underground, especially as I had finally crawled through, well, one beginner's cave (Whirlpool) and hadn't freaked out. With certainty, I could claim that I liked to crawl.

"As for the real trip—the trip of a lifetime? Hey, I lasted one day. Six hours of my rather inept surveying was almost good-naturedly tolerated by a hard-core cave enthusiast (engineering! professor) from Vegas (this trip also drew in folks from both coasts and Taiwan), who initially mistook me for a scientist despite my avowal that I was simply a geologically trained bureaucrat. Fortunately, my stint below was leavened by the gracious, good-natured, and super patient Terri Sprouse, la esposa bonita del Jefe. And during our casual post-cueva-mortem? Thank God, El Jefe deftly suggested that I might just want to snorkel in Akumal the next day with a few other cavers who were taking a break. What can I say? In the evening I was treated to tales of everybody's encounters with terrifying insects and reptiles and plants that left awful rashes, not to forget tight crawls and special cave lead discoveries, but in the day I could more leisurely partake of the less strenuous Mayan Rivera wonders. Now Walter Mitty has returned to the day job—alas, so fraught with drought—but with a couple of actual memories of the Yucatan groundwater and its hardier explorers."

Jim Immitt (M.A. '81) writes, "There were two things I swore I'd never do while studying minerals geology with Rich Kyle at the Jackson School: live in Houston and work in the oil industry. Well God must have been laughing because here I am! And I love it. Amazing technology, great geology, good company, and I'm learning to see the 'good side' of Houston. Life has many strange twists and I have had one heck of a meandering career. After a long hiatus doing non-geological things for a living, it is

good to be back." Jim can be reached at jim.immitt@yahoo.com.

Charles G. Johnson (B.S. '83) writes, "Some significant acquisitions last year in Texas and South Louisiana. Continuing to focus on vintage fields in those areas. My stars have now lined up with four of five children in college."

Dr. Ralph L. Kugler (Ph.D. '87) writes, "I've been living in Kuala Lumpur for more than six years now. For the past four years, I've been Principal Consultant in the University of Malaya Geology Department, helping out with the Petroleum Geology M.S. programme and supervising several M.S. and Ph.D. students. We just received funding to set up a reservoir characterization and modeling laboratory and are in the process of purchasing a micro-CT, FIB-SEM, LiDAR, and other equipment. I've also been conducting industry training courses and some field trips to Malaysian Borneo, as well as serving on the technical and education committees for several regional and international conferences. Stop by and visit if you happen to be in the area! I can be reached at rlkugler@um.edu.my."

Bill Layton (B.S. '81) writes, "Jessica is getting married in October and my son Jordan and his wife Nikola are expecting a baby girl in September, my first grandchild. What a year! Going to have dinner tonight with Cecil Irby, driver of the famous 1981 Phantom of 660 camp lore. Remember the bear and the Phantom rules!"

David E Lemke (B.S. '82) can be reached at dlemke@lgc.com.

Bruno Maldonado (B.S. '82) writes, "Yes, I am still ticking. After 12 years at Newfield Exploration Co., I recently made a move to Ping Petroleum (Bermuda) Limited, a startup company focused on SE Asia O&G Exploration & Production. I am now a grandfather with a 1 year old granddaughter and I'm loving it. My two boys (Aggies... Ugh!) are now off my payroll with engineering jobs... Yeah! For the past 31 years, I have enjoyed evaluating E&P opportunities worldwide including Brazil, Peru, Barbados, Canada, West Africa, the North Sea, Malaysia, China, Vietnam, Thailand, Indonesia, Gulf of Mexico Shelf, Gulf of Mexico Deep Water, and U.S. Mid-Continent. Thanks to you Jackson School of Geosciences. I can be reached at bxm@pingpetroleum.com."

Linda Ruiz McCall (B.S. '81; M.B.A. '85) writes, "I am happy to report that I have joined the research staff of the Bureau of Economic Geology as the information geologist. A reconnection to the University and the Jackson School that I am finding both exciting and rewarding." Linda can be reached LindaRuizMcCall@gmail.com or Linda.Mccall@beg.utexas.edu.

Katie Joe McDonough (B.S. '80) writes, "Enjoying a thriving consulting business based out of Pine, Colorado. Just graduated second kid from high school. Visitors welcome!"

Jude McMurry (M.A. '82) writes, "Still in San Antonio, where I am a geochemist at Southwest Research Institute. Most of what I do involves review work related to nuclear waste policy or the geologic disposal of radioactive wastes, including recent support for a licensing review for the government of Sweden. My daughter graduated several years ago in geosciences from McGill University, and she now works in the oil sands of Alberta for an environmental engineering company. Christmas gifts are easy, at least — we just exchange rocks! The past year was tempered by the death of my husband of 29 years, from heart failure. Life can change in an instant, but, thankfully, life also goes on."

Charlie Montero (B.S. '84) is with Rosengarten Smith & Associates, Inc. in Austin.

James H. Moore, Jr. (B.S. '81; M.A. '93) writes, "I love my job at Railroad Commission in the Injection-Storage section. Before that I worked as a boundary surveyor, and in mudlogging and geosteering in South Texas. My wife Candice works for Office of Inspector General, Health and Human Services. Daughter Molly graduated from Sarah Lawrence College and resides in Chicago where she is a free-lance writer. Daughter Lydia is a senior at Northwestern University." Jim can be reached at jim.moore@rrc.state.tx.us.

James G. Muncey (Susan) (B.S. '81) writes, "As for professional news... Still happily working with one foot in commercial and other foot in technical. Just joined

ALUMNI NOTES

Bureau Hires Ruiz McCall

The Bureau of Economic Geology recently welcomed Linda Ruiz McCall as its information geologist and Resource Center manager. Ruiz McCall (B.S. '81) comes to the Bureau with her UT Austin geology degree, an MBA in finance, and a master's in secondary science education from Teachers College of Columbia University. She most recently served as program manager and education and outreach specialist for the Texas Water Development Board. At the Bureau, Ruiz McCall will assist the public with general information about Texas geology and will work to create educational opportunities and build and strengthen partnerships with the Bureau's many friends in academia, government, and industry.

Steve Speer passed along this photo of four mid-1980s master's students in the Department of Geological Sciences, all advised by Al Scott. L to R: Dave Noe, Dave Carr, Steve Speer, and Joe Patterson.

Pan Atlantic (from Hess) early this year. Responsible for E&P portfolio planning, portfolio analysis/modeling/optimization, and related business strategy development. Also building integrated project plans for PSC/JOA compliance and management of technical and administrative workflows. PA's exploration focus areas include West Africa and South America. Currently evaluating other areas of Western Hemisphere for strategic fit. On personal front, happily married to Susn 27 years and counting. Eldest daughter Elizabeth lives in LA working in marketing and PR. Her main client is the Red Bull Racing Formula 1 Team. I asked if we could trade jobs but she said no. Youngest daughter Ali will be a freshman Fall 2013 in CalPoly's Architectural Engineering Dept. The weather in San Louis Obispo is tough but someone has to live there. Susn and I are looking forward to lots of vineyard visits! Any classmates living in H-town or elsewhere are welcome to call/visit. Best regards to all! I can be reached at gmuncey@paexploration.com."

David Noe (M.A. '84) is with the Colorado Geological Survey. He reports that the survey has become affiliated with the Colorado School of Mines.

Robert M. Reed (B.S. '85; Ph.D. '99) writes, "I am still in Austin and still working at the Bureau of Economic Geology. My primary research involves microstructures in mudrocks. More results will be forthcoming at the next AAPG meeting."

Paul F. Sagasta (M.A. '84) writes, "After exciting times working in geophysical acquisition, processing and interpretation in faraway place like the Amazon jungle, Burma, Thailand, Ho Chi Minh City, North Sea, offshore Africa, and elsewhere I'm still early retired since 1999 in Bangkok, Thailand."

Stephen W. Speer (M.A. '83) writes, "Had a very enjoyable 30 year class reunion this Spring with the Dirty Dozen et al. in Austin at the All Alumni Jackson School Reunion. Things have changed quite a bit in all those years at the school and it looks all for the better. Strange thing though all of my classmates still act like the same old dorks they were back in the day, but now they all seem to have greyed out a bit (or in the case of Dr. Noe, a distinguished lot!). Dinner/get together at Dave Carr's was icing on the cake. Therese and I are still holding down the fort out here in the Low Country (Charleston, SC), so if anyone feels like chilling out and eating some good southern cooking, feel free to come on out and drop us a line. Cheers!"

Burgess Stengl (B.S. '85) writes, "One more year has flown by as I start my twelfth year with Republic Services. The family continues to grow with our 'newest' grandson, Ethan, arriving just over one year ago. Our daughters Susan and Shara live in Spring and Hutto, both relatively close in Texas terms, so we get to see all three grandkids quite a bit. Angela is still teaching elementary school in the Klein school district, with a change to fourth grade after 20-plus years of teaching second. I've missed the alumni reunions, but Walt Boyle keeps me informed on the happenings in Austin. Sounds like lots of fun, and I hope to make it back to an event this year. Hello to the Class of '85 grads."

Michael L. Sweet (Ph.D. '89) writes, "I am currently working at ExxonMobil Research in Houston. I was elected editor of AAPG Bulletin earlier this year."

Jennifer Thompson (B.S. '86) is a project manager at the Texas Commission on Environmental Quality in Austin.

Peter R. Tauvers (Ph.D. '88) writes, "After postings in Malaysia and The Hague, going back to Shell Ukraine in Kyiv in November as principal exploration geoscientist. My wife, Zinaida, runs our art gallery in Kyiv: www.pit-art.com." Peter may be reached at peter.tauvers@shell.com.

James B. Vanderhill, 1986 and Amy Wharton Vanderhill, 1983 (Ph.D. '86; B.S. '83) write, "Amy continues to enjoy planning and development of the Eagle Ford Shale asset for Freeport-McMoRan Oil & Gas. (PXP and McMoRan Oil & Gas merged with Freeport-McMoRan Copper and Gold and are now part of Freeport-McMoRan Oil & Gas.) Jim also continues to enjoy working as an advisor for ExxonMobil Production Company, U.S. Production. Ceili (TAMU 2011) is currently in Kansas working as a chemical engineer for Mars Chocolate. We often joke she is our ChemE making peanut M&M's! Shannon is our new UT 2013 graduate! She majored in fine arts, design, and is moving to Savannah, GA, to start graduate school at SCAD (Savannah College of Art and Design). Meagan is busy in her Junior year at UT pursuing an advertising degree. She is proud to be participating in the creative sequence. Jim and Amy continue to compete in registered sporting clays tournaments. Jim has achieved an AA class rank and is working towards master class. Amy has achieved a B class rank and hopes to make A class someday. We still have 2 Cavalier King Charles Spaniels and Conneely is doing well in confirmation class. Neither is smart enough for Agility! Amy has taken on a new challenge and agreed to help the Houston Alumnae Club of Pi Beta Phi as treasurer for the next 4 years. You should

see a geologist try her hand at accounting, ha! Email and stay in touch. I can be reached at amy_vanderhill@fmi.com."

Joseph Winfield Versfelt (B.A. '84) writes, "I have been working for the past few years overseas with Apache as exploration manager, first in Argentina and now in Egypt. Very exciting work. Enjoying it greatly. Apache team here also works with Dr. Danny Stockli at UT."

Mark C. Walker (B.A. '81) writes, "I am proud to share with you the news that my son, Lee, enters the Jackson School for the fall semester of 2013. He will also double major in Plan II Honors, and hopes to practice law in the field of energy and natural resources. My wife, Kathleen (J.D. 1985) and I continue to practice law with the Cox Smith Matthews law firm's El Paso office, where she leads a business immigration practice and I continue handling civil trials and appeals, including diverse issues from recall election and campaign finance disputes to ground subsidence due to dewatering for construction. We look forward to spending more time in Austin, including at our Austin office, over the next several years."

Leslie Leland Warren (B.S. '85) writes, "Had great fun with fellow '85 GeoDog Tatiana Frierson at the UT Geology Reunion this past spring! So much fun even without the rest of the group there. I am still working for Schlumberger after all these years, but once again in a new role as the director of curriculum of management and project management studies. It is fun to start traveling again especially since Scott and I are now 'Empty Nesters.' Tatiana and I discussed trying to connect the rest of the '85 GeoDogs so that we can all meet up at the next reunion. Contact one of us if you are interested. I can be reached at warren6@slb.com."

William Barry Wethington (B.S. '85) writes, "Been with BP now for 23 years, in many locations across the globe. Currently I am vice president of our new business in India. I am very pleased that my youngest son is studying geology at the Jackson School."

Matt Wickham (B.S. '85; M.A. '91) is with Pastor, Behling & Wheeler, LLC in Austin.

Clayton H. Wilson (B.S. '83; M.A. '85) writes, "Returned to Houston last May after six years in Melbourne, Australia. Wishing everyone all the best!" Clayton can be reached at chwilson@exxonmobil.com.

William I. Woods (M.A. '81) writes, "It's been a busy and fun year. I am still working half time with IC2 at WPR. Francisco and I spent Christmas in Brazil with our friends Egidio Leitao (a former GS Staff member) and Keith Arrington and got to see all of my adopted Brazilian family at a wedding reception; very nice. This summer we will spend 10 days at Yosemite National Park, and at Christmas we'll go back to El Salvador to visit family there. I visited the Jackson Building in May and was very impressed with the improvements. I was happy to see the Rock Garden in such good shape since I 'saved' it from being thrown away when the addition was added on, but that's another story...."

Susn Young (M.A. '85) is currently a coordinator for our unconventional Reservoirs Knowledge Sharing Network.

"I am very pleased that my youngest son is studying geology at the Jackson School."
—William Wethington

1990s

Kenneth B. (Keg) Alexander (M.A. '90) writes, "I have moved back to New Zealand as the geothermal geology team leader at the Institute of Earth Sciences and Engineering. IESE is a research and development organization at The University of Auckland with a global reputation in geothermal exploration and borehole seismology. Email address is k.alexander@auckland.ac.nz."

Ted Angle (B.A. '93) is a major with the U.S. Army National Guard, responsible for equipping the National Guard units assigned to homeland response missions. These missions focus response to catastrophic events resulting from a chemical, biological radiological, or nuclear event in the United States. He recently returned from Afghanistan where he was assigned as the staff hydrologist for a Texas Agribusiness Development Team. He and 13 fellow Texans worked with Afghan farmers and government officials to create agriculture projects to increase economic development in Ghanzi Province where they were assigned.

Mauro Roberto Becker (Ph.D. '96) writes, "Now with Petrobras America Inc, in Houston, TX, since Aug. 2012."

Bruce K. Darling (Ph.D. '97) writes, "Accepted position as senior consultant with Geosyntec Consultants in Oct.2012. Splitting time between offices in Austin, Texas and Lafayette, Louisiana. Looking forward to retiring in the cooler climate of Bavaria one day." Bruce can be reached at bdarling@geosyntec.com (work) geologist@bkdarling.net (home).

Colby Carl Drechsel (B.S. '94) writes, "Michelle and I welcomed our brand new, spectacular, super awesome son, Owen on January 5th! Born in Casper, WY, he's a hardy one with a Texan's disposition. Life is just blissful now. I am a crude oil marketer now, buying and selling oil in Wyoming and North Dakota capitalizing on years of geology and engineering applications in the field."

Christi Gell & Charlie Gell (B.S. '96; M.A. '96) write, "Christi changed jobs in June to join Expro, a UK-based company, to take on a leadership position leading sales and delivery of an operational well integrity software called SafeWells. Charlie is still working at Halliburton, going on 16 years. The kids, Katherine and Erik, turned 4 and 3, respectively. Christi was in Austin with Erik in December last year and visited Ernie Lundelius at the VP lab where Erik ran around yelling "dinosaur!"

every time he saw a fossil. Perhaps a budding paleontologist?"

Mark Gordon (Ph.D. '90) writes, "I am a structural geologist for Shell. Enjoyed visiting Austin during the regional GSA meeting this spring."

Jubal Grubb (B.S. '97) is back in Austin. Jubal spent quite a bit of time in Afghanistan as a military liaison officer working with villagers on water projects.

Dave Hill (M.A. '93) is with the Railroad Commission in Austin.

Walter Kessinger (M.A. '91) writes, "For the past two years I've been managing the Earth Imaging and Modeling group, which includes seismic processing and depth imaging. Currently we're getting the Houston office up-to-speed in microseismic processing and VSP imaging."

Barb Mahler (M.A. '91; Ph.D. '97) writes, "Was in the pit orchestra for the Gilbert and Sullivan Society's performances of Princess Ida. It got great reviews." Barb is also organizing a session on karst for the fall AGU meeting.

Timothy & Amy (Sapp) McMahon (Ph.D. '94) write, "After a short stint in Houston, Amy and I are back overseas, living in Kuala Lumpur, Malaysia. I am working as the subsurface lead for ConocoPhillips' first operated block in Malaysia, offshore Sabah. We are still adjusting to the change and the girls are still adjusting to wearing uniforms to school. We are all looking forward to exploring another continent (not to mention some tropical islands). I can be reached at timothy.p.mcmahon@gmail.com and Amy at amcmahon@wt.net."

Dianne J. Pavlicek (M.A. '90) began working at the Texas Commission on Environmental Quality in San Antonio, Texas in April 2012 after a hiatus from the geologic profession. She is the staff geoscientist for the Edwards Aquifer Protection Program which regulates construction activities on the karstic Edwards Aquifer recharge zone, contributing zone, and transition zone. In June 2013, she traveled to Italy with her boyfriend, Jesse Mesa, touring Venice, Florence and Rome. It had been 25 years since she was last in Italy working on the Upper Triassic Portoro Limestone in the Northern Apennine Mountains for her master's thesis with Dr. Robert "Luigi" Folk. Dianne can be reached at dpavlicek@satx.rr.com or dianne.pavlicek@tceq.texas.gov.

Sylvia Pope (M.S., CRP '96) is with the City of Austin.

Stacey Tyburski Quarles and Andrew Quarles van Ufford (M.A. '92; Ph.D. '96). Stacey and Andrew are continuing to enjoy living and working in the United Kingdom with their son Ian now 9 years old. Stacey continues her team lead role in West of Shetlands and North Sea Exploration with Nexen and Andrew has joined Cuadrilla Resources as exploration director. The UK provides many opportunities to observe classic geologic outcrops and the offshore and onshore exploration challenges are very stimulating.

Christopher Stephen Swezey (M.A. '91; Ph.D. 97) writes, "I continue to work for the U.S. Geological Survey, mostly mapping in the coastal plain of the southeastern United States. My wife and I have finally rebuilt our roof and chimneys after sustaining severe damage to our house in the August 23, 2011 magnitude 5.8 earthquake near Mineral, Virginia. We have continued to feel many aftershocks more than a year after the initial quake. The last aftershock that we felt was magnitude 2.3 on May 15, 2013."

Sachin Shah (B.S. '97) has taken a position with Shell in Houston, working on their environmental issues.

Mehmet Tanis (M.A. '93; Ph.D. 98) writes, "Greetings to all the friends and faculty at the Jackson school. I am in Houston. Do look me up if you happen to be in the neighborhood. All the best."

Jennifer Winkler Truax (B.S. '92) writes, "I enjoy being a stay-home mom and subbing in the Garland ISD part-time (sub and tutor for kids behind grade level). My children are now 13 and 9 years old. Chip still works in the banking industry in IT. I keep my love for geology going through our vacations like our trip to Yellowstone National Park and by volunteering to teach kids about geology and science on field trips and camps. Last year in October, I volunteered a week of time to teach the geology of Oklahoma to 5th graders from Kimberlin Academy at Camp Goddard. I wrote a 90 question scavenger hunt for Kimberlin Academy kids to use to navigate through the Perot Museum in Dallas and assisted with several school field trips there. Hope to get back to Austin this fall for another Texas game!"

Brad Wolaver (B.S. '95; Ph.D. '08) recently published "Identifying origins and pathways for spring waters in a semiarid basin using He, Sr, and C isotopes: Cuatrociénegas Basin, Mexico," in Geosphere.

2000s

James Bene (M.S. '00) is celebrating his 13 years with Harden & Associates in Austin.

Rebecca Boon (B.S. '08) writes, "Hey everyone, Rebecca here! I'm entering this photoessay competition and part of the scoring is a social media score. If you have time I would love if you could check out my entry (you can login with Facebook, or a simple username and password), and vote for it, as well as leave comments and "like" individual photos. These all contribute towards my score!! Right now I think I have a decent chance of winning, so please check it out and share it with your friends. Thanks a gazillion!"

Joel Le Calvez (Ph.D. '02) writes, "Still in Schlumberger, as the North America microseismic domain expert leading the commercial effort on hydraulic fracture monitoring for the U.S. and Canada. Heavily involved in the research and engineering sides of things for the next generations of processing, visualization, and interpretation codes and platforms."

Melody Cornelius (B.S. '07) is with ERM in Houston.

Kelly (Iacono) Daniel (B.S. '04) is a hydrogeologist with Kleinfelder in Austin.

Emily Marleah Davies (Pangborn) (M.S. '07) writes, "I am entering my second year at the Tuck School of Business at Dartmouth. This past summer I worked at Autodesk in corporate strategy, focusing on the natural resources sector. I am currently looking for opportunities that will allow me, upon graduation from business school, to return to the Austin area." Emily can be reached at emily.m.davies.tu14@tuck.dartmouth.edu.

Jose Delgado (M.S. '03) represented ConocoPhillips Reservoir Engineering Technology/Geologic Modeling team at the 2013 American Association of Petroleum Geologists (AAPG) Annual Convention & Exhibition and was awarded "Top 10 Poster Presentation" with a poster titled, "Reservoir Modeling using Multi-Point Statistics (MPS), Berkine Basin, Algeria." Delgado's poster presentation explained how to utilize effective knowledge sharing to optimize business value. The AAPG technology convention was held in Pittsburgh, Penn. with more than 6,900 geosciences professionals in attendance from 78 countries. Delgado's poster was one of 900 oral and poster presentations submitted, based on 11 technical themes.

Laura DeMott (B.S. '07) writes, "After 5.5 years with ExxonMobil, I have left the industry to return to graduate school. This fall I start my Ph.D. work at the University of Illinois, where I will be studying the geobiology of hot springs at Yellowstone National Park. I look forward to seeing my former classmates and professors at meetings!" Laura can be reached at lmdemott@gmail.com.

Tyler Dickerson (B.S. '07) can be reached at tdickerson@gmail.com.

Rob Dixon (B.S. '02) is with the Anteagroup in Austin and works with Eric Muehlberger.

Katherine Dlubac (B.S. '07) was the lead author on a paper in Water Resources Research entitled "Use of NMR logging to obtain estimates of hydraulic conductivity in the High Plains aquifer, Nebraska, U.S." Katherine is currently in the graduate program at Stanford University.

Dr. Dennis Dunn (Ph.D. '02) is a UTeach lecturer at The University of Texas at Austin.

Bea Garcia-Fresca (M.S. '04; Ph.D. '09) is currently working at Statoil in the unconventional R&D team bridging diagenesis in resource plays between shale and carbonate stratigraphy, and issues of fluid flow and diagenesis in resource plays. She and Ilixo have left California and joined papa in Bergen, Norway.

Elaine Goddard (B.S. '05) writes, "I moved to San Francisco, CA in August 2013 to pursue an MBA in design strategy from California College of the Arts (expected graduation May 2015)."

Sally Holl (M.S. '04) was one of three people chosen to present for the Secretary of the Interior last month about a project she managed. For more information, go to: http://txpub.usgs.gov/snapshot. She is also working to add discrete groundwater level retrieval to this GIS tool.

Dan'l Matthew Lewis (B.S. '09) writes, "I recently completed my M.S. in Oceanography at Texas A&M University in December 2012 after interning with Chevron as a development geologist working on shelf assets in their Covington, LA office. After I graduated, I returned to work in their Covington office full time where I presently work. I can be reached atdanl.lewis@chevron.com."

Astrid Makowitz and Jason Ethan Gumble (Ph.D. '04; Ph.D. '06) write, "My husband whom I met at the Jackson school and I are married 10 years as of November 1st, 2013 and are celebrating with an adventure to Iceland in September without kids!!!"

A. Dax McDavid (B.A. '03; M.A. '06) writes, "New Job — Brigham Resources."

Suzanne Pierce

Kim Nguyen (B.S. '06) has moved to Charlottesville, Virginia.

Suzanne A. Pierce (Ph.D. '06) will be an instructor for the PASI (NSF's Pan-American Advanced Studies Institute) Training Institute on Adaptive Water-Energy Management in the Arid Americas in Chile next summer. Suzanne says that they are going to travel to the Atacama Desert beforehand so that she and a few of the other attendees can see some geothermal and playa lake features in the region.

Wendy Robertson (B.S. '06 and Ph.D. candidate) is returning to Kenya this summer for the fourth time with Well Aware, which is finding water supplies for rural villages.

Sunny Simpkins (B.S. '00) writes, "Chad and I continue to love living in the Pacific Northwest in Portland. We had our first baby last September. I recently changed jobs. I'm the natural resources project manager for the Multnomah County Drainage District. We manage the levee system along the Columbia River in Portland. I can be reached at ssimpkins@mcdd.org."

Eric Swanson (B.S. '04) writes, "I am working in Fresno, CA in the application engineering department for groundwater and irrigation with LAKOS, which is a centrifugal separator filtration company." Eric can be reached at e.swanson@utexas.edu or eswanson@lakos.com.

Thomas J. Wiles (M.S. '07) is a senior geologist at GeoSouthern Energy Corporation, The Woodlands, TX. Thomas can be reached at tjwiles@gmail.com.

Scenes from the JSG-GSA Antarctic Trip

From December 27, 2012 - January 20, 2013, a group of Jackson School alumni, faculty, and staff joined members of the Geological Society of America on an expedition to Antarctica led by world-renowned polar scientists, including Ian Dalziel of the Institute for Geophysics (bottom right) and Richard Alley of Pennsylvania State University (who photographed the two emperor penguins at left).

Other photographers and subjects, clockwise from top left: coastal scene by Ann Laubach, Leon Long by Scott Davis, Deception Island by Margaret Kroehler, Ian Dalziel (foreground) on Living-stone Island by Seva Egorov, wreckage of Shackleton's expedition by Leon Long, emperor penguins by Richard Alley, fur seal on King Haakon Island by Natalie Bursztyn.

Our thanks to the photographers and Cheesemans Ecology Safaris for images.

Alan Andrews (B.S. '10) has taken a position with the Barton Springs Edwards Aquifer Conservation District in Austin.

Ben Bass (B.S. '12) has been accepted for Ph.D. study at Rice University in environmental engineering.

Zoey Beckner (B.A. '12) started as a junior hydrogeologist for URS. She says that she is "sitting in Kim Nyguen's (B.S., 2006) old office. Leaving Sunday for Oregon for three weeks. Lots of field work. Also, office time. Much different than RRC. It's bizarre. And wonderful at the same time. Going to do some water sampling at a local site. First official field work experience outside of school. Excited."

2010s

Ryan Cahalan (B.S. '12) is a Ph.D. student in physical volcanology at Georgia Tech.

Heather Christensen (B.S. '13) is now with the Bureau of Economic Geology where she is working on a handbook/guidebook of Texas geology.

Brian Cowan (M.S. '10) is with Zara Environmental in Austin.

Tian Dong (B.S. '13) writes, "I am currently attending graduate school for geology at Rice University. I couldn't fall in love with geology and make it at Rice without the education I received at the Jackson School."

Tim Eischen (B.S. '12) is a freshwater researcher with the Nature Conservancy of Texas in Austin.

Jessica Cori Errico (M.S. '12) can be reached at Jessica.errico@gmail.com or jess.errico@bhpbilliton.com.

Megan Franks (Ph.D. '12) is a lecturer at UTSA.

Sam Hiebert (B.A. '10) can be reached at samuelhiebert@utexas.edu.

Matt Holiner (B.A. '12) is an M.S. student in broadcast meteorology at Mississippi State University. Matt can be reached at mholiner@yahoo.com.

Noah Kang (B.S. '13) can be reached at noahk90@gmail.com or noah.kang1@samsung.com.

Jennifer Loeffler (B.S. '12) writes, "After graduation, I continued working as a water conservation technical advisor for a sustainability non-profit that I had been interning with during my senior year. Since March 2013, I have been working as an environmental scientist for Energy Renewal Partners, a renewable energy consulting firm in Austin."

Lindsey Lugrin (B.S. '13) has been accepted for graduate study at Rutgers University.

Julia Mechler (B.S. '10) has taken a position at the Texas Commission on Environmental Quality "thus ending my year of being a stay-at-home mom."

Justin Midura (B.S. '12) is with Harden & Associates in Austin.

Kaitlin Moran (B.S. '13) writes, "I graduated in May 2013, worked for Hilcorp Energy Company as a geologic intern during the summer and am beginning my master's at Rice focusing on fluvial sedimentology this fall." Kaitlin can be reached at kaitlin.moran@utexas.edu.

Frank Morgan (B.S. '11) writes, "Currently finishing master's thesis at LSU. Will start work as a geologist for Devon Energy in January, 2014."

Tuong Khanh Nguyen (B.S. '12) writes, "I was fortunate enough to land a job right out of school. It has been a great learning experience for me so far and I am looking forward to my future. I traveled a bit here and there, looking for more challenges and experiences. Wherever my adventures take me, The University of Texas at Austin will always be in my heart and soul. I will never forget my time here at UT." Tuong can be reached at tuong_ng89@yahoo.com or tnguyen@lmkr.com.

John Nowinski (M.S. '10) has accepted a position with PBW in Round Rock.

Evan Z Pearson (B.S. '10) writes, "I graduated in 2010 with a bachelor's in hydrogeol-

View from Mount Tabaro with lava flow deposits in the background between Audrey Eljuri and Ryan Cahalan. March 9, 2013, from the Undergraduate Honors trip to the Phillipines.

Field camp, 1919

ogy and am currently working for Pinnacle Potash International in Austin. My skills in ArcGIS and geology along with the networking that JSG provides got me where I am today. Proud to be a JSG alumni. Hook 'em!" Evan can be reached at ezpearson@gmail.com.

James Pinkard (B.S. '12) is with INTERA where he is working on a report on the hydrogeochemistry of the Gulf Coast Aquifer.

Laura Elizabeth Pommer (M.S. '13), after finishing her M.S. in March, moved to Houston to start as a geologist for Anadarko Petroleum. In July, she and Luke Fidler (another JSG alum) were married in Laura's hometown, Boulder, Colorado. Luke moved to Houston in April to work for Statoil as as geologist. They bought a historic home in Houston, where they live with their three dogs and are looking forward to traveling, exploring, and Jackson School alumni events.

Daniel Reyes (B.S. '12) has taken a position of hydrogeologist I at LBG-Texas Environmental (not LBG-Guyton).

Audrey and Derek Sawyer (Ph.D. '11) announce the birth of Eleanor (Ellie) Jane Sawyer. She arrived April 5, at 9:16pm (7lb, 4oz and 19"). Derek reported that everyone was "healthy, happy, and resting."

Diana Day Schlotter (B.S. '12 writes, "Hired as a staff geologist for SKA Consulting, L.P. SKA is a professional environmental engineering and consulting firm providing timely, innovative solutions to today's environmental challenges. We work together with our clients to identify environmental liabilities, navigate potential regulatory obstacles, and manage and minimize risk." Diana can be reached at diana.schlotter@skaconsulting.com.

John Singleton (Ph.D. '11) can be reached at jssingleton@gmail.com or Jsing@gmu.edu.

Shane Straw (B.A. '12) writes, "Time has moved quite fast since I left Austin. After graduating in May 2012, I began an internship at Pioneer Natural Resources in Irving, Texas. After my internship ended in September, I was hired on full-time as a geoscience systems specialist. It is a very rewarding job in which I get to work with multiple types of mapping and well database software, including ArcGIS, Petra and Kingdom. Pioneer is a great company, and I highly recommend seeking them out for employment! Other than work, life has been pretty good up in Dallas. I miss Austin though, and I try to come back down as often as possible. It's quite awesome walking through the new student center at the Jackson School, although I am a little angry that the only experience I had with it while in school was its power drill-intensive construction. But anyways, I hope to make it back down to Austin soon!" Shane can be reached at shanemstraw@yahoo.com.

Dan Stine (B.S. '14) has taken a position with UT in the Environmental Health and Safety Office as a safety specialist.

Ben Sigrin (M.A. '13) writes, "I am working as an energy analyst at the National Renewable Energy Lab. Loving my new job and making a difference to reduce carbon pollution!"

Matt Uddenberg (M.A. '12) has taken a position with Altarock Energy in Seattle, Washington.

Nathan van Oort (B.S. '13) will begin graduate studies at the University of Guam this fall with an emphasis on karst hydrogeology.

Julianne Wooten (B.S. '12) is with Energy Renewal Partners, LLC, in Austin and is conducting an extensive biological survey in California with fellow alumn Jennifer Loeffler.

Amber Inwood (exchange student from Flinders University in Australia, 2000) writes, "Married a Canadian/Yank of all people, who I met on the park in NZ when I was a park ranger. Quite the romance ensued and we have ended up married with a dog, cat and three chooks in Hawaii for the past 7 years." Amber works as a science educator for the Bishop Museum (www.bishopmuseum.org) and is the senior educator of the department doing grant writing and project management. She states that she much prefers "being on the floor performing, but this way I can always make sure Earth science stays a core piece of the programming. We have a very low rate of students going into the Earth sciences in college despite the amazing laboratory that is Hawaii." She pours "hot liquid lava onto a titanium tray for our 'meet me at the hotspot' daily show."

Jennifer (Doebbler) Strauss worked for Don Blankenship at UTIG as a high school apprentice and then as undergraduate researcher from 1997-2001. She wrote an honors thesis for physics on changes in dielectric absorption of radar through Antarctic ice. ✶

MEMORIALS

Alumni & Friends

Floyd Jones Adcock (B.S. '55), age 84, died Jan. 10, 2013. He was born Jan. 1, 1929 in Coushatta, Louisiana to Aubrey and Amanda Adcock. He is survived by his son, Keith Adcock and wife Melanie of Katy, Texas, daughter Amelia Gacke and her husband Mark of Waco, Texas, and his granddaughters. As a grandfather, Floyd was an example of love and caring for his grandchildren. He set an example of working and helping others. Floyd served in the U.S. Air Force and worked for Marathon Oil Company in Houston for 25 years as a senior geologist. Floyd will be sorely missed, but beautifully remembered.

Gerald Pat Bolden (B.S. '51) died Feb. 19, 2013 in Midland. He was born July 29, 1925, in Naborton, Louisiana. He graduated from Golden Meadow High in Louisiana in 1943, joined the Army Air Corps, and later graduated from UT Austin in 1951 with a B.S. in geology and was employed by Shell Oil Company as an exploration geologist. He took retirement in 1978 and managed Hinkle Exploration as a consultant until 1983 and Hilliard Oil and Gas as exploration manager until 1986. An emeritus member of AAPG, Pat was guest speaker at many geological societies, General Chairman of SIPES National Convention in 1992, received the Monroe G. Cheney Science award in 1993 from SWS AAPG, and was awarded honorary life membership in the West Texas Geological Soceiety. Pat is survived by his wife, Charlene; son Craig and wife, Sylvia; daughter, Kathy Jo Bolden; and Charlene's three children: son, Mark Hutchison and his wife, Cyndi of LaGrange. He also leaves behind a brother, James Roy Bolden of Odessa, Texas.

Cahoon, Frank Kell (B.S. '57) died in Midland on Jan. 30, 2013 at the age of 78. He was born June 20, 1934 in Austin, Texas, to Charles Wilbur Cahoon, Jr. and Sibyl Francis Kell Cahoon. Raised in Wichita Falls, he received early lessons in entrepreneurship and community service through the example set by his grandfather and namesake Frank Kell, one of Wichita Falls' early pioneers. After graduating from Wichita Falls High, Frank enrolled at the Colorado School of Mines. The summer after his freshman year, while working in the Texas oil fields, he was introduced to his future wife, Paula Powers, at a party in Abilene. When Frank learned Paula would attend UT Austin in the fall, he wisely decided to transfer. From that day forward the two were inseparable. They married in 1957 and moved to Killeen, Texas where Frank was a lieutenant in the Army Corps of Engineers. In 1959, Frank, Paula and their baby daughter Corrinne, moved to Midland so Frank could pursue a career in the oil business. Active in the Republican party, he ran and was elected to the Texas House of Representatives in 1964 and moved to Austin.

Frank Cahoon

He was the sole Republican to serve in the 1965 Texas Legislative session. Returning to Midland, Frank found success in the energy business, most notably playing a prominent role in the construction of one of Alaska's first oil refineries, the Kenai oil refinery. Over the next forty plus years, Frank continued his commitment to public service, actively participating as a member of the Midland City Council as well as the boards of the Texas Higher Education Coordinating Board, The Midland Memorial Hospital, the Permian Basin Petroleum Museum, and other organizations. Frank is survived by his wife of 56 years, Paula; his daughter Corrinne Bowers and husband Steve of Austin; his son Frank Kell Cahoon, Jr. and wife Debbie of Austin; his son Joseph Cahoon and wife Christie of Dallas; seven grandchildren; his beloved sister Lula Janet Seydell of Wichita Falls, and numerous wonderful extended family members and friends.

Harry Edward Connors (M.A. '77), 65, of Washington died Feb. 11, 2013. He was born April 14, 1947 in Cleveland, Ohio. He served in the U.S. Navy during the Vietnam Era. Harry graduated from Kent State University with a B.S. and received an M.A. in geology from UT Austin. He married Bethanie Ferris Connors on July 30, 1977 in Aurora, Ohio. He is survived by his beloved wife, Bethanie; beloved daughters, Jennifer Ann (Jason) Kavetsky of Glendale, California; and Laura C. Connors of Hamamatsu, Japan. Also surviving are his mother, Margaret H. Connors; brothers, Robert S. (Victoria) Connors and Brian J. Connors; Mark R. (Renee) Connors of Alpharetta, Georgia; Craig W. (Mary) Connors of Mentor, Ohio; and David S. (Lisa) Connors of La Crescenta, California.

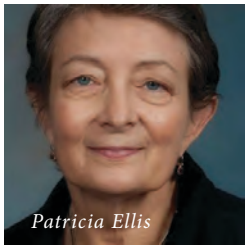
J. Lane Denson (B.A. '49, M.A. '50), an Episcopal clergyman and writer, died Nov. 21, 2012. He was 89 and living in Nashville. The Reverend Denson came to Nashville as a rector of Christ Episcopal Church in 1965 where he initiated a more centered liturgical program. Subsequently he served as a rector of St. John's Episcopal Church, Old Hickory and director of development for the Vanderbilt School of Engineering. Denson served as convener for the Diocese of Tennessee Clericus, chair of the Diocesan Coalition on Alcoholism and Other Drugs, and as a deputy to the 1985 and 1988 General Conventions of the Episcopal Church. He was a lifelong trumpet player and a founding member of the Establishment, a Nashville 1940s-style big jazz band, and of the Monday Night Jazz Band. He

wrote a daily email essay "Out of Nowhere." During World War II, Denson was a naval aviator. He flew PB4Y2 Privateers. He held two degrees in geology from UT Austin and was a geologist with the Texas Highway Department before entering the founding class of the Episcopal Theological Seminary of the Southwest, 1951-1954. He is survived by his wife, Caroline Stark, former director of the Nashville Public Library; his children, Ann Milstead, John Lane IV and Scott Thomas; six grandchildren, Megan, Sarah, Molly, Claire, and Thomas Charles Denson.

John W. Dietrich (M.A. '54), born in Beaumont on April 25, 1925, passed peacefully on Sept. 9, 2012 in Kerrville, Texas. He is survived by his wife, Hazel, their daughters Christine Cragg, Donna Klaiber, Bonnie Dietrich, Carolyn Dietrich, and their families. With a bachelor's from Rice and graduate degrees from UT Austin, his multifarious career spanned newspaper boy to Naval Lieutenant to Texas A&M researcher to staff member at UT's Bureau of Economic Geology (1953-1965) to scientist with the NASA space program (1966-1991). The pinnacle of John's career was his role in the Apollo Space Program ultimately serving as the curator of Lunar Samples. He had a lifelong interest in learning and education with volunteerism being a strong component of his character.

Arthur B. Elliott (B.S. '55, M.A. '58), 79, died Oct. 5, 2012 in Hilton Head Regional Hospital. Born Aug. 31, 1933 in Charleston, West Virginia, his family moved to Texas from New York in 1946 and he graduated from high school in Victoria. Art graduated from UT Austin with degrees in geology and physics and an M.A. in geology in 1958. In 1958 he married Ann Rutledge Bradbury whom he met during graduate school. Art had an interesting, 35 year career as a geologist first with Standard Vacuum Oil Company and later with Mobil Oil International. He lived oversees 15 years in the Philippines, Turkey, Nigeria, Paris, France and London, England. He was an emeritus member of AAPG. In addition to his wife of 54 years, he is survived by a nephew, Kevin D. Kercheville and family of Austin, TX, six deRussy first cousins, and many special Elliot and Huger cousins.

Patricia M. Ellis (Ph.D. '85), beloved spouse, mother, and sister, was born in Rochester, New York on March 6, 1949 and died Feb. 17, 2013. Pat graduated from the University of Rochester in 1970, earned a master's degree from Duke in 1972 and a Ph.D. from UT Austin in 1985. She specialized in the formation and alteration of coral reef deposits, and enjoyed scuba diving in the Bahamas, Indonesia, and the Philippines. She enjoyed flying hot air balloons while she was a student in Texas. Pat spent most of her distinguished career working for the State of Delaware's Department of Natural Resources and Environmental Protection where she rose to the highest technical rank. She specialized in the cleanup of ground water which has been contaminated by leaking underground petroleum storage tanks. She was nationally known for her work on gasoline additives, was a member of the U.S. Blue Ribbon Panel that banned MTBE in favor of ethanol in gasoline, and taught continuing education classes on her skills all around the U.S. Pat was an avid quilter and long-term member of the Ladybugs Quilt Guild who often exhibited her quilts. She loved to travel and spent time in the Caribbean, Europe, India, Tibet, Nepal, Bhutan, and Egypt. Pat is survived by her husband of 33 years, David E. Ellis; her children Katherine A. Ellis of Newark, DE; her children Katherine A. Ellis of Washington, DC and John C. Ellis of Westminster, CO, her brother John W. Mench of Spencerport, NY, and a number of nieces and nephews and their families.

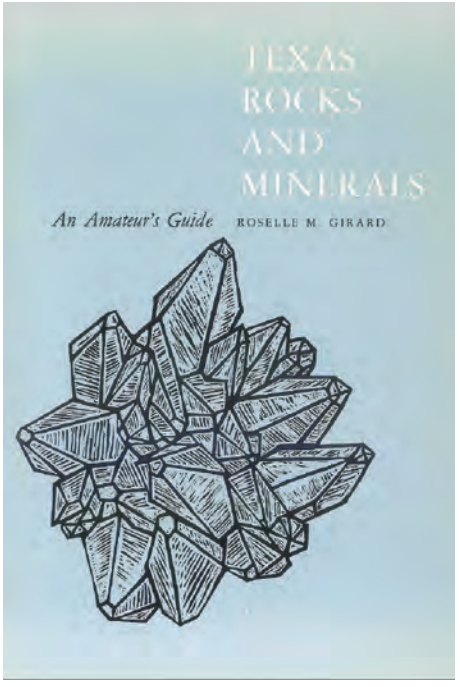

Patricia Ellis

James L. Eppler (B.A. '43), 1921-2012, died peacefully at the age of 91 on Dec. 3, 2012 in Dallas, Texas. Beloved husband, father, grandfather, partner, colleague, and friend, Jim was a U.S. naval war veteran who served in the South Pacific in WWII. He protected his country, raised his family, and lived life to the fullest. He will be remembered as a kind, gentle man who loved golf, traveling, and his work as a petroleum geologist. Jim never knew a stranger and his memory lives on in his loved ones and friends and shall never be forgotten.

Herman Hays Forbes (B.S. '50) died Sept. 24, 2010 at 82. He was born in Mountain Peak Texas March 24, 1928. He is survived by his wife of sixty years, Connie Loney Forbes and their children and grandchildren. Herman graduated from UT Austin in 1950. After a brief stint in the Army he and Connie returned to Texas and remained throughout their life together. He was employed by the State of Texas General Land Office for 37 years. He retired in 1988 as director of the Surveying Division.

Jay M. Frost (B.A. '37, M.A. '38) was born on Aug. 21, 1914 in Houston, where he died on June 20, 2013. A fourth-generation Texan, J.M. attended San Jacinto High, where he met his future wife of 72 years, Mickey Frost. Thereafter, J.M. attended Rice, graduating in 1936. He then attended UT Austin, where he obtained a B.A. (1937) and M.A. (1938) in geology before entering the oil business during the war. J.M.'s interest in oil and gas exploration and production as well as his passions for horses, farming, and ranching endured throughout his life. He was able to go to the ranch every morning and the office every day into his 90s. He was a founding member of The Petroleum Club of Houston and a member of The Colonneh Club. His love of horses came naturally from his ranching family heritage, and began even before he rode his pony "Pinto" to school every day, tying it under the tree that still stands in front of Lanier Middle School. None of J.M's business pursuits could have been accomplished without the support and effort of the numerous, lifelong members of the Frost Ranch family, whose work will endure and to whom he will be eternally grateful. He is survived by his son Ford Jay Frost, his granddaughter Ann Chiles ("Sparky") Frost, his daughter-in-law Claudia Wilson Frost and numerous nieces and nephews and their families.

Roselle M. Girard (B.A. '41, M.A. '52) was born in Austin, Texas Dec. 5, 1918 and died Dec. 17, 2012 at the age of 94. She graduated from Austin High and earned both B.A. and M.A. degrees in geology from UT Austin. She worked for the USGS and Shell Oil before joining the Bureau of Economic Geology in 1952. Most of her career as a geologist was spent at the Bureau where she authored Texas Rocks and Minerals, an Amateur's Guide. First published in 1964 and currently in its ninth printing, it is still among the Bureau's best-selling publications. As part of the Bureau's cooperative program with the U.S. Bureau of Mines, Roselle collected mineral statistics for Texas; from 1960 to 1977 she was coauthor of annual reports on the mineral industry of Texas. She



Texas Rocks and Minerals *by Roselle Girard.*

also played a major role in developing the Bureau's annual report and was at the center of the BEG's public outreach. Roselle retired in 1983 after 32 years of service to the Bureau, for which she will be long remembered.

John C. Gries (Ph.D. '70), professor of geology at Wichita State University for over 40 years, died Jan. 18, 2013. A teacher known to thousands through his popular Introductory GEO 300 class, he will be particularly remembered by the many geology majors he mentored and encouraged in their careers.

John was born and raised in Rapid City South Dakota where his father, Paul Gries, was a highly-regarded professor of geology at the South Dakota School of Mines. He was introduced to well site geology at the age of five and accompanied many of his dad's field classes.


John Gries

Gries's education included a B.S. in engineering and a master's degree in geology from the University of Wyoming and a Ph.D. from UT Austin. He joined the faculty at Wichita State in 1971.

At WSU he taught in a variety of fields, but virtually all WSU geology grads will best remember their five weeks at field camp in Colorado which he led for most all of that 40 years. Known for his expertise with a Dutch oven and his seemingly unlimited delicious menus produced over the campfire, he got to know field camp students on a personal level. He served multiple terms as department chairman. His teaching and research have been recognized by numerous awards including the recent 2013 Teacher of the Year award from the Kansas Geological Society. He also took second place in the highly coveted GSA National Meeting Campfire Cook-off competition. John's work and interests have taken him at one time or another to all of the Rocky Mountain states, many of the other states, and the occasional jaunt to Morocco, Ethiopia and the East African Rift, often in the company of his long-term companion and wife of 13 years Toni Willis-Jackman, a former diplomat and now lecturer in environmental geology at WSU. He had no immediate plans for retirement and was actively planning the next year's field season.

John is survived by his wife Toni, his daughter Lynn Gries who practices and teaches trauma surgery at the University of Arizona School of Medicine in Tucson; his first wife and friend Robbie Gries; his sister-in-law Nella Gries and two nephews Nathan and Mark. Memorials have been established at the Great Plains Transportation Museum and the Wichita State University Foundation. *—Toni Willis Jackman, Wichita State University*

John L. Hamilton (B.A. '51), age 88, passed away on the Aug. 19, 2013. John was born in Fort Worth, Texas on the Aug. 8, 1925 and attended Paschal High. John served in the U.S. Navy during World War II, receiving the the Navy Commendation Medal for Service. He graduated from UT Austin and returned to Fort Worth to marry his childhood classmate Ann Lowden. They settled in Houston where John worked in the mortgage business before starting his own real estate investment company, which he operated for over 50 years. Active in historic building preservation John worked to renovate historic homes in Houston, Galveston, and New Orleans. In philantropy John provided housing to Vietnamese displaced from their homes after the Vietnam War, received the Paul Daugherty Award from Casa de Esperanza for service to that organization, and along with Ann, created an endowed scholarship for the UTMB School of Nursing. John is survived by his wife of 63 years, Ann Lowdon Hamilton, daughter and son-in-law Anna Beth and Doug Hill, son Caleb Hamilton, and two grandchildren.

Paul M. Hardwick (B.S. '55) of Horseshoe Bay, died March 31, 2013. Hardwick is survived by his wife Patsy Cox Hardwick of Horseshoe Bay and five sons: Michael S. Hardwick and wife Terry of Canyon Lake, Mark P. Hardwick of Midland, Patrick C. Hardwick and wife Roxane of the woodlands, Paul A. Hardwick and wife Laurie of Houston and Charles F. Hardwick and wife Stephanie of The Woodlands. He is also survived by 15 grandchildren and 2 great-grandchildren. A retired geologist, he also served his country as a naval aviator during the Korean War, flying from the USS Lexington.

Charles H. Harris (B.S. '56) of Harahan, Louisiana died June 2, 2013 of Alzheimer's disease. He was born on Jan. 16, 1929 in Beckville Texas. He graduated from Lutcher High in Orange and attended Lamar Junior College prior to enlisting in the U.S. Army, serving during the Korean War. Following his military service he attended UT Austin and graduated with a degree in geology. He began working with Chevron, geoprospecting in Montana and Wyoming, prior to returning to Texas. Charley began his career as an engineer in the dredging industry with Bauer Dredging in Port Lavaca in 1959. In 1969, he moved his family to New Orleans to become the chief estimator of the newly formed T.L. James and Company's Dredging Division. Charley retired in 2004 after 45 years in the industry. He enjoyed cooking Wednesday night dinners for the family, long talks and bourbon on Friday nights with his dear friend Adrian Cordes, and spoiling his grandkids. He was a devoted husband, father, and "Papa." Survivors include: his daughter, Cindy Harris Horchoff (Pat); sons, Kevin Harris and Wayne Harris (Eileen Crowe); and a large extened family.

David Scott "Scotty" Holland (B.S. '57), 81, died Jan. 5, 2013, in Houston. Scotty was born March 26, 1931 in Havana, Arkansas. His family moved to Abilene, Texas in 1946 where

he met his high school sweetheart, Jacque Nell Hunter, the love of his life, soul mate and best friend, uniting in marriage in 1952. Scotty and Jacque Nell had the first of their two sons, David Scott Jr., in 1953 while stationed in Biloxi, Mississippi. Their second son, Terrence Hunter, was born while Scotty was attending UT Austin.

Together, the two traversed life's passages. Many evenings and weekends were shared as volunteer, supervisor/leader of cub scouts, boy scouts, PTA suppers, coaching of Pee Wee sport programs, bible school teachers, and most of all ensuring the nurturing of their two children in ethics, integrity, and perseverance. Christian principles were taught and practiced with not only their children but friends and associates. Scotty always had a strong commitment to excellence and never tired from achieving self-imposed goals. After graduating from Abilene High in 1949, where he was the first recipient of the Thornton Award, presented to the school's best athlete, Holland enrolled at Hardin-Simmons lettering in football. He credits the development of his competitive nature to having played football under Coach Warren Woodson and has been known to say "teams are made up of players and leaders, and in most cases, unless a player is able to follow, he will never lead."

In 1951, Scotty enlisted in the U.S. Air Force to serve his country after North Korean hostilities began. He served as an airborne radio operator aboard a B-25 Mitchell aircraft. Following his military service, he entered UT Austin, obtaining a B.S. in geology in 1957. Scotty's early professional career, as an exploration geologist, was spent in Midland with Marathon Oil Company and Pennzoil Company. Eventually, Scotty guided Pennzoil Exploration and Production Company in the worldwide search for hydrocarbons as president and CEO, also serving as group vice president of the parent, Pennzoil Company, before retiring in 1990.

Scotty was a recipient, from Hardin Simmons University, of the Distinguished Alumni Award (1983) and an Honorary Doctor of Laws degree (1990). Additionally at Hardin Simmons University, Scotty helped fund the Holland School of Sciences and Mathematics, Holland Medical High School, and the future establishment of the Holland School of Health Sciences.

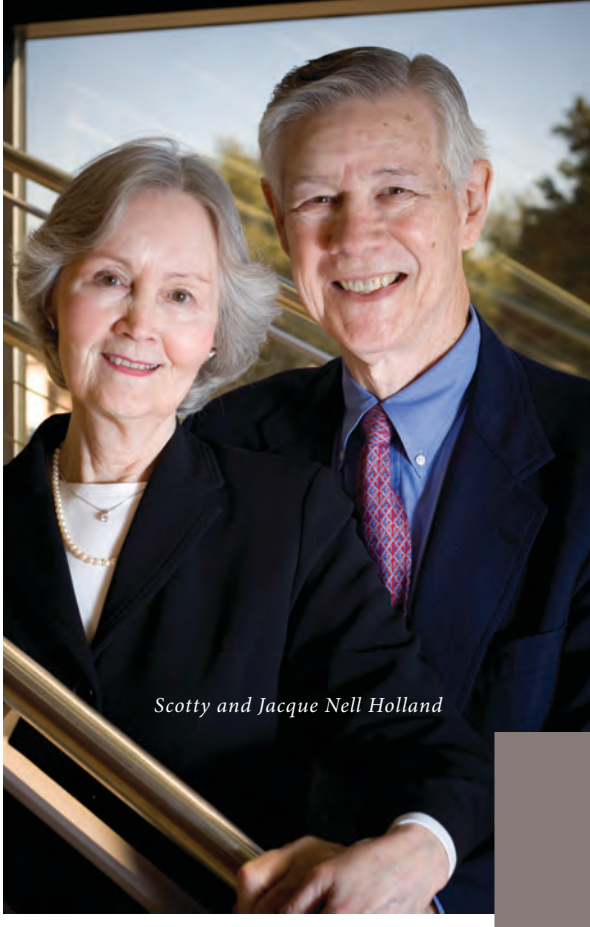
He established the Hunter-Holland Scholarship at McMurry University in Abilene as an endowment for history majors. An endowment at Abilene Christian University, supporting music education, was also established by Scotty and his wife, Jacque Nell.

Most recently, Scotty's support of UT Austin, his alma mater, cumulated in the construction of the Holland Family Student Center, located at the Jackson School of Geosciences, where he was a major contributor. He served on the boards of the Houston Museum of Natural Science, the Geology Foundation of the Jackson School at UT Austin, and the Geology Foundation of AAPG.

Scotty was a devoted father, grandfather and great grandfather to his children, who always came first in his life. He is survived by his sister Mae Rue Hazard of Arlington, Texas; his loving wife of 61 years, Jacque Nell; sons, David Scott Holland and wife Dashika of San Antonio, Texas, Terrence Hunter Holland and wife Nita of Midland, Texas; and Scotty's pride and joy, grandchildren Sara Michele Holland, Katie Dyan Holland, both of Ft. Worth, Texas, and Travis Jared Holland and wife Krystal Cathleen; and great-grandchildren, Lyla Grace and Cayson Scott Holland of San Antonio, Texas.

James W. Hood (B.S. '48), beloved husband, father, grandfather, great grandfather, and friend passed away Aug. 12, 2011, due to an aggressive brain tumor. He enjoyed a variety of activities from stamp collecting to home remodeling. After an honorable discharge from the U.S. Army in 1945, he graduated from UT Austin, then he went to work for the USGS as a hydrologist. He is survived by daughter Jean (George) McGee, son James Jr. (Michelle) Hood, son Richard (Mary) Hood, 15 grandchildren, and four great grandchildren. Earth has no sorrows that heaven cannot heal.

Edward R. Kennedy (BS '48, M.A. '49), 89, of Midland, died March 11, 2013. Edward was born Aug. 19, 1923 in Sentinel Butte, North Dakota. He served in the U.S. Army in World War II and received a purple heart for service in the European Theatre. He graduated from UT Austin with an M.A. in geology. He worked as an independent geologist, specializing in the Permian Basin from 1950 until his death. Edward was a member of the West Texas Geological Society and Sipes & Midland Archeological Society. He and his wife, Margaret were former members of two local dance clubs. Survivors include wife, Margaret; daughter, Blix Ann Masterson and husband Richard; two granddaughters and three great grandsons. He was preceded in death by his parents, two stepdaughters, Kathy Smith and Bonnie Fox, and brother, Bernerd Kennedy.



Scotty and Jacque Nell Holland

Wilton Hays Killam (BS '49) was born near Ballinger, Runnels County, Texas on Feb. 27, 1929. He graduated from Polytechnic High School in Fort Worth in 1944 and earned a B.S. in geology from UT Austin in 1949, an M.A. in geography from UT, and a guidance and counseling certification from Stephen F. Austin State University. At UT he was in the Army ROTC and was commissioned upon graduation as 2nd Lieutenant, serving in the Korean Conflict. After the war he returned to teach science at Lufkin Jr. High until he became director of the counseling program for LISD and counselor at Lufkin High School. Wilton served a number of years as tennis coach. In 1968 he joined the original faculty of Angelina College and served as dean of students and the first tennis coach. In 1993 he was awarded the Angelina Award by the Angelina County Chamber of Commerce for his service to the community. Wilton married Bonnie Sue Bain on June 6, 1955 and was the father of three sons, Bob and wife Scottie of Austin, Bil and wife Wendy of Lufkin and Steve and wife Joy of Lufkin. He is survived by his immediate family, as well as his brother and sister-in-law, Dr. Allen and Ruth Killam of

Durham, North Carolina; brother-in-law and sister-in-law, Ted and Jean Bain of Centerville; numerous Killam and Hays cousins; and many friends and former students. He is preceded in death by his grandson, Patrick Scott.

J. David Krause (B.S. '53), owner of several former Denton car dealerships, died Oct. 21, 2012 at his home in San Jose, Costa Rica. After a short career in the oil and gas industry, Krause became a beer distributor for Bee County in southeast Texas. In 1965, he began selling cars, eventually becoming a general sales manager for Menger Oldsmobile in Corpus Christi, according to his son, Kurt Krause of Denton. In 1975, he and his family moved to Denton, where he bought a Pontiac dealership from Monk King in 1975. The dealership, which was located downtown near where the former Wells Fargo bank drive-through, is where he first became known as "Krazy Krause." A year later, he bought the Toyota dealership on University Drive. In 1992, he sold the dealerships and retired.

Howard Emil Kringel (B.S. '50), 88, passed away on Aug. 3, 2012. A 1943 graduate of Thomas Jefferson High in Port Arthur, Howard had degrees in geology (UT Austin) and education (Lamar College-Beaumont). His teaching career began in Port Arthur and he retired after teaching many years at Hogg Junior High in Houston. Howard's church family was an important part of his life. Survivors include: brother Dr. Roland Kringel, cousin Merrill Lott, nieces Barbara Stringer, Elizabeth Nixon, Mary Mitchell, Robin Caldwell, nephews David Skaggs, Michael Kringel, Kirk Kringel, and 15 great nieces and nephews.

Anna Marietta Evans Langston, 88, of Austin, died Dec. 29, 2012, surrounded by her loving family. Marietta was born in 1924 in a two-room house on a farm near Lindsay, Oklahoma, to Albert and Lydia Graham Evans. As a child, during the depths of the Great Depression, Marietta worked alongside her family on their farm, located near the edge of the Dust Bowl in central Oklahoma. She helped with everything from harvesting broom-corn to plowing with a team of mules, as well as walking many miles to a two-room schoolhouse. Later, she taught school herself, before attending the University of Oklahoma, where she graduated with a minor in Latin and a degree in English Literature. At OU she also met her future husband, Wann Langston Jr. They married in 1946. In a few years the couple moved to Berkeley, California, where Wann worked on his Ph.D. and Marietta was a loan supervisor in the UC Library. In 1953 their first child, Karen, was born. Soon the family moved to Canada, where Wann became vertebrate paleontologist for the National Museum of Canada. Another child, Sandra, followed shortly thereafter. The family moved to Austin in 1962. Marietta was a lifelong gardener, growing beautiful flowers as well as wonderful tomatoes and other vegetables. Also a passionate reader, she studied many subjects widely and deeply. Marietta was a loving wife, mother and grandmother, and a wonderful friend. She is survived by her daughters, Karen Langston and Sandra Langston; her son-in-law, Francesco Alianelli; her grandchildren, Stefano and Roberto Alianelli, also of Bernalda; and her sister, Irene Broadman and brother, Charles (Chuck) Evans.

Charles J. "Charlie" Mankin (B.S. '54, PHD '58), 80, died Nov. 13, 2012, in Norman, Oklahoma. He was born on Jan. 15, 1932, in Dallas, Texas. He was united in marriage on Oct. 12, 2007, in Maui to Betty Bellis. Charlie was raised in West Texas and graduated from high school in 1949 in Ozona. He received three degrees in geology from UT Austin and held a postdoctoral position at Cal Tech. Mankin came to the University of Oklahoma in 1959 as an assistant professor and became director of the School of Geology and Geophysics in 1963. In 1967, Mankin became director of the Oklahoma Geological Survey, maintaining this role until his retirement in 2007. He is believed to be the longest-serving director of any state geological survey in the country. Upon his induction into the Oklahoma Higher Education Hall of Fame, The Oklahoma Higher Education Heritage Society called Mankin an "enrichment to the state and nation." In addition to his leadership in Oklahoma, Mankin served as president or vice president of several national organizations, including the Association of American State Geologists and the American Geological Institute. Charlie is survived by his wife, Betty Bellis Mankin, of Norman; daughters: Sally Geyer, of Atlanta; Helen Volak, of Tulsa, and her children; and Laura Veal and husband Larry and their children; and Betty's children: Doug Bellis and wife Tina, of Norman, and their daughters; and Karen Powers and husband Mark, of Cedar Park, Texas; and sister, Carolyn Thompson and husband Sam, of Austin, Texas. He was preceded in death by his parents; and his first wife, Mildred Helen (Hahn) Mankin.

Charles "Chick" William Charles (B.S. '49) died peacefully on June 27, 2013, surrounded by his family. He was born in Cuero, Texas, Jan. 4, 1926. Upon graduation from Cuero High in 1943, he entered the U.S. Navy Officer's Training School, graduating with a B.S. in naval science and tactics from UT Austin in 1946. After one year of duty in Hawaii, he returned to Austin, graduating with a B.S. in geology in 1949. That same year, he was employed by Core Labs, Inc. in Houston. His 36-year career took him to various states and countries, finally to Dallas in 1959. At the time of his retirement, he was director of technical services for special core analysis. Upon retirement, he found refuge from the big city life at his Cedar Creek Lake home. "Chick" is survived by his wife of 60 years, Mary Louise "Lou" Marquis, son Charles, daughter Laura (Steve Entz), daughter Leslie (Mike Sirek), five granddaughters, five great-grandchildren, and one sister Jeannine (Elmo Sample), two nieces and one nephew. "Chick" donated his body to U.T. Southwestern Medical School in Dallas.

Robert Louis (Bob) McBroom, Sr. (B.A. '51) died July 17, 2013. Bob was born May 19, 1928, grew up in Wichita Falls and graduated from Wichita Falls Senior High in 1945. He earned a B.S. in geology at UT Austin in 1951. Bob married Mary Louella Kendrick, his college sweetheart, Dec. 26, 1960. After serving in the army at Fort Sill, McBroom began his career in Wichita Falls becoming a certified independent geologist in 1961. He was a member of AAPG and past president of the Southwest Sectional. He was a member of the first faculty of John Hirsch' High School teaching general science and later English and journalism. McBroom earned his master's degree in English in 1966 at Midwestern State University. He taught at Estacado High in Lubbock while working toward a Ph.D. from Texas Tech (1970). Upon returning to Wichita Falls, McBroom was part of Midwestern State University's English department and retired as an associate professor in 1976 before returning to the oil business. For several years, he wrote a column on the oil and gas industry of North Texas for the Times Record News. Inspired by the beauty of the blue lights lining the buildings at Texas Tech University at Christmas, McBroom was instru-

mental in bringing the idea to MSU inaugurating the Fantasy of Lights.

Donald Elmer Outlaw (B.A. '40, M.A. '47) was born on Sept. 1, 1919 and passed away on Friday, April 30, 2010. Donald was a resident of Newark, Delaware.

John L. Proctor (B.A. '50) left this world on April 13, 2012; he had a full and exceptional life. A son of San Antonio, he graduated from high school at the age of sixteen and answered the call to duty during World War II. Postwar he graduated from UT Austin in geology, where he was part of Air Force ROTC. He received his commission into the Air Force in 1950 and served in support of the Korean conflict, later entering the Air Force Reserve which he eventually retired from as a Lieutenant Colonel. He returned to UT majoring in petroleum engineering, residing for a brief time in Dean Nowotny's garage apartment, and rough-necking in the summer to pay for school. While at Texas, he met Pozelle Proctor, who was also a student, and invited her to meet him at the Jefferson Davis statue on campus to get coffee. Realizing neither of them liked coffee, they drank tea instead, and thus began their long relationship. They married upon graduation in 1955. John worked in the petrochemical industry after that for such notables at Dow Chemical before taking a position at the IRS as a petroleum engineer in Dallas in 1966 where he remained until his retirement in 1991. Upon retirement and the graduation of both his daughters from UT, he and Pozelle moved to New Braunfels where he published three books. John is survived by his wife, Pozelle (Pozy) and their daughters, Heidi and Erika. He is pre-deceased by his mother, Leonie Nowotny Reeves, father, Le Roy Proctor, and his sister, Marie Garner.

Cecil C. Rix (BS '49, MA '51, PHD '53) was born Nov. 12, 1924 in Port Arthur, Texas, and he passed from this life to be with his Lord on Dec. 9, 2012, at the age of 88. He married Martha Ruth Keller of Dublin, Texas in 1953, and they had two children, Charles Meredith Rix and Jane Elixabeth Rix, He was preceded in death by his parents, his daughter, Jane, in 2002, and by his daughter-in-law, Jenny, in 2005. He is survived by his wife, Martha of 59 years, his son Dr. Charles Rix of Edmond, Oklahoma,his grandson, grandaughter, sister-in-law, and numerous nieces and nephews. Cecil attended high school in Port Arthur, then Reed College as a member of the Air Corps' Pre-Meteorology Program, and served in World War II on Saipan and Guam. After the war, he studied geology at UT Austin, receiving his B.S. (1949), M.A. (1951), and Ph.D. (1953). In 1953, Cecil began his career as a research geologist with the Carter Oil Company Research Department in Tulsa. In the early 1960s, he was a member of the new venture staff of Standard Oil, New Jersey (SONJ) responsible for the exploration and discovery of the first major gas field in the UK North Sea. Later assignments with SONJ, now ExxonMobil, included supervisory and management positions in research, production and management. Prior to his retirement from Exxon in 1986, Cecil formed and managed the company's E&P Training Division. He was a member of AAPG and several societies, including the Geological Society of London. He and his family lived in Tulsa, Houston, New York City, London, England, Bordeaux, France, and Bangkok, Thailand and traveled extensively. Cecil will be sorely missed but beautifully remembered.

Harlan Hugh "Hal" Roepke (Ph.D. '70), 82, died Nov. 9, 2012 at Ball Memorial Hospital after a fall. Hal was born in 1930, in Rochester, Minnesota. He graduated from high school in St. Paul and earned his B.A. in geology at the University of Minnesota. He entered the U.S. Army in 1954, reaching the rank of second lieutenant. Back in Minnesota earning his masters in geology, he met and married a lovely girl who had danced her way into his life, Judith Lomer (Bole) Roepke, "Judy." After working for the USGS, he obtained his Ph.D. in geology from UT Austin. After the birth of his first child, Janet Elizabeth Roepke, the family moved to Muncie, Indiana in 1965, where Hal started teaching geology, and soon his second child, Douglas Andrew Roepke, was born. Hal taught geology from 1965 to 1997, initiating the Ball State Geology field camp in 1966, with which he made an annual trek to the gorgeous landscapes of the Badlands, Black Hills and the Tetons. Hal earned great respect and admiration from many students, and helped lead many to wonderful careers in geology. Hal is known for his dry sense of humor, quick wit, great gift of an open heart and mind, a twinkle in his eye when sharing the joy of rocks and landscapes, and his ability to make all feel included. He was self-effacing about his value to others, but for those who know him, they know how amazing of a man he was.

Robert Brooks Ross (B.S. '50), 87, died at his home in Houston Jan. 1, 2012. Born Jan. 19, 1924 in Palo Pinto, Texas, he grew up in Austin. In World War II , he served in the 71st Infantry Division and was awarded the Bronze Star. After the war, he graduated from UT Austin and became a geologist. He married Velma Hilliard on July 29, 1950; the couple settled in Houston. In 1958, the family moved to Jackson, Mississippi. A distinguished oil explorationist, he served as president of the Mississippi Geological Society and the Mississippi Landmen's Association. In 1971, Bob returned to Texas and worked for several oil companies before his retirement. He was preceded in death by his father, Robert Burgher Ross; his mother, Myrtle Watson Ross; his aunt Beulah Watson, and his sister Corinna Ross Martin. He is survived by his wife of 62 years, Velma ; his son Cecil (Peggy); his daughter Corinna Verret; grandchildren, great-granddaughter, and numerous nieces, nephews, grand-nieces and -nephews. He was a wise, loving, and unselfish husband and father, and the most faithful of friends.

Chester C. Sadler (B.S. '53), 81, of Gatesville, passed away Jan. 7, 2013, at a Temple hospital. Chester is survived by his wife, Gaye Sadler; children, Homoiselle Sadler Bujosa and husband, Carlos, Chester Calhoun Sadler III and Sallie Justiss Sadler; sisters, Suzanne Sadler Wilson and Cynthia Sadler Vaughan and husband, Bill; brother, Stanley J. Sadler; stepchildren, Dillon J. Martin and wife, Shannon, and Katie Brook Doyle and husband, Jack; his grandchildren and one great-grandchild; and loving nieces and nephews. He was loved and admired by his mother-in-law, Mrs. Laverne Pitts of Temple.

Frederick E. Schultz (B.S. '47), 90, of Ojai, died Tuesday May 21, 2013 at home with his loving family. Schultz was born Oct. 20, 1922 in Taylor, Texas and was a Ventura County resident for the past 29 years coming from Houston, Texas. He was an exploration manager for Exxon Mobil Oil for 37 years. He contributed to the discovery and naming of the i-londo Platform offshore California. After his retirement he held positions with SOHIO and Pauley Petroleum. Fred graduated from UT Austin obtaining his B.S. in geology. During WWII Fred served in the U.S. Army

in Germany and was awarded the Bronze Star and Rifleman's Award. Fred was an avid fisherman and enjoyed building model trains and railroads. He and his beloved wife Lois traveled all over Europe and especially enjoyed the time they spent in Denmark. Schultz recorded and was the executive producer of a children's album based on Christian principles.

Sims, Samuel J. (M.A. '57), 79, died May 13, 2013 at home. Prior to his treatment for soft tissue sarcoma, Sam was actively engaged in his geology consulting, playing tennis, and traveling regularly with Myrna. Sam was born Feb. 20, 1934 in Los Angeles, the son of Roxey and Oscar Sims. He graduated from Coachella Valley Union High School near his hometown of Indio in 1951. He earned a B.S. from Caltech in 1955, an M.A. from UT Austin in 1957, and a Ph.D. from Stanford in 1960, all in geology. Sam worked for Bethlehem Steel as a geologist from 1960 to 1985, with assignments in Gabon, Brazil, and Mexico. He and Myrna were married in Gabon in 1961. From 1985 to 2012, he worked as an independent consulting geologist. He was a fellow of the Geological Society of America and the Society of Economic Geologists. Besides Myrna, his wife of 51 years, he is survived by his daughters, Janet L. Patterson, wife of Brad Patterson of Morristown, NJ, and Sandra J. Sims, companion of Ron Fischer, of Golden, CO. He was the beloved Sampa to Deolan and Ada Patterson. Sam was predeceased by three sisters: Jocelyn Pickens, Vanda Mayfield, and Donna Martin.

Thomas F. Taylor (B.A. '42) died Dec. 23, 2012, in Houston, at the age of 95. He was born Oct. 2, 1917, in Jacksboro, Texas. He grew up in Tulsa, Oklahoma, and graduated from UT Austin where he was member of the golf team and a Life Member of the Ex-Students Association. Tommy proudly served in the U.S. Army. He is preceded in death by his brother, Robert H. Taylor; and son, Thomas F. Taylor, Jr. He is survived by his loving wife of 69 years, Sara Cave Taylor; two children, Judy Taylor Ewing and her husband Lee, and Don Cave Taylor of Houston, three grandchildren, and two great grandchildren.

A geologist by training, Bill Tipton became known as a painter of western scenes, including popular images of the Wells Fargo stagecoach that the company purchased.

William E. "Bill" Tipton (B.S. '49, M.A. '51) died Feb. 11, 2013, at his Querencia home in Austin. Bill had an insatiable love of God and now is with Him. He was 92 years young. Bill loved to draw, especially horses. He completed his first oil painting at 9 years old, winning blue ribbons at the State Fair of Texas. His western paintings have hung in business offices and bank collections throughout Texas, Colorado, and the Wells Fargo Museum in San Francisco. His portraits of chancellors and deans grace university collections in Texas and Kentucky. His works are represented in private collections throughout the U.S. and internationally. Bill cared genuinely about everyone around him. With never a raised voice, he was quick with kindness and encouragement. His overflowing sense of humor and warm smile always brightened your day. Bill would want to be remembered as an artist, but he was also a geologist by training with a B.S. and M.A. from UT Austin. He was a WWII veteran, serving in the Navy. He grew up in Dallas, raised a family in Houston, retired to Colorado to paint, and then he and his loving wife, Julie, returned to Austin to be closer to family. Bill leaves behind his wife, Julie, of 63 years and the love of his life; his son, William Tipton, Jr. (his wife Donna Tipton, their son Jonathan and their grandson, Bryson) and his daughter, Diane Tipton Land (her husband Stew Adler and their daughters Karen (with fiance Justin Short), Susan and Sarah). He is also survived by his brother, Dr. George W. Tipton, 99 years young (son Buddyand wife Brenda, daughter Ellen), his brother-in-law, L. Henry Gissel, Jr. (his wife, Jo Claire and their children, Lewis and wife Amy, Virginia and husband Stephan, and Scottie), and many nieces and nephews whom he loved.

Virgil Wal

Virgil A. Walston (B.S. '60), an international oilman and loving husband and father, died at home in Moulton, Texas May 15 after a short battle with an aggressive cancer. He is survived by his devoted wife of 55 years, Suzanne Porter Walston, and three sons: Bruce Burleson Walston, Andrew Ellington Walston, and Robert Glenn Walston, his two sisters, Dorothy Walston Alcorn and Sally Walston Doehring, and many nieces, nephews and friends. Virgil was born in Tyler on Aug. 23, 1934. After graduating from Lamar High in Houston, he attended Virginia Military Institute and graduated from UT Austin with a B.S. in geology. He later attended Texas Tech for graduate studies in geology. He served honorably in the U.S. Army from 1955-57. A well respected international oil explorationist, Virgil began his career with Esso in Tripoli, Libya in 1963 followed by various managerial positions with PT Stanvac in Jakarta, Cities Service in Singapore, Jakarta, and Houston, and Occidental Petroleum in California. After retiring from Occidental in 1985, Virgil co-founded Alcorn International, Inc and VAALCO Energy, Inc. and served as vice chairman, president and COO until his retirement in 2003. In this capacity, Virgil oversaw successful operations in the Philippines with Alcorn International and in Gabon, West Africa where VAALCO still operates today. Besides hunting and fishing on his ranch, his passions included UT sports, golf, gardening, travelling, reading, crossword puzzles, and breeding and raising Rhodesian Ridgeback dogs.

Lewis Coy Warren (B.S. '48) died Aug. 9, 2013 in Abilene. He was born Dec. 10, 1922, in Canyon, Texas and grew up in Cisco. From the time Coy was a young boy, he was fascinated with his father's work in geology. He attended UT Austin on a football scholarship, but his studies were interrupted by World War II. Coy volunteered for the Army Air Corps and became a pilot on a B-25 Bomber with five members. He flew weather reconnaissance in the China-Burma-India Theater and earned the rank of First Lieutenant. When the war was over, he returned to his studies at UT Austin and earned his B.S. in geology. In 1944, Coy married Alice Slicker. They had one daughter, Connie, before Alice's death in 1959 due to

cancer. In the early 1950s, Coy moved his family to Abilene where he and his father, L.A., formed LACO Oil Company. They continued to work together until L.A.'s death in 1971. In 1968, Coy met Elizabeth Gene King on a blind date. After dating barely four months, they married July 1, 1968. They were married for over 42 years until Elizabeth Gene's death in Dec., 2010. Coy continued a lifetime of work in the oil and gas industry and was joined in the business by Elizabeth Gene's son, Greg King, in 1979. Coy was active in the community by serving on the board of Citizens National Bank and being a member of the Abilene Geological Society. He created and presented many slide-show presentations promoting geology. One of the accomplishments Coy was most proud of was his writing and publishing of three devotional books cherished by Sunday School teachers and family members. Coy is survived by his daughter and her husband, Connie Warren Stansell and Russ Stansell from Fort Worth; his two sons, Dr. Austin I. King and wife, Susan Lewis King; and Greg N. King and wife, Leigh Jacobs King; his nephew, Randy Randolph; and niece, Cathy Randolph, all from Abilene; six grandchildren and four great-grandchildren.

Frank A. Welder (B.S. '49) died Sept. 4, 2012. Frank was born in Victoria, Texas. He served in the Air Force during WWII and then earned his B.S. in geology at UT Austin in 1949 and his Ph.D. in geology at LSU in 1955. He worked on the Edwards Aquifer in Southwest Texas 1954-1958, and taught geology at NE Louisiana State University 1958-1964. He also worked with the USGS in northwest Colorado, mostly in the Piceance Basin. After retirement in 1983 he spent a year in the Sultanate of Oman supervising a groundwater investigation program. He is the author of more than 25 geoscience publications. Frank and his wife Jean have been residents of Meeker since 1975. Married Dec. 31. 1955, they shared many great adventures in their 57 years together. Frank is survived by Jean, daughter Maureen Mabrey (Rick); sons Brian (Carla) and Shawn Welder, seven grandchildren and five great-grandchildren, nieces, nephews, and many extended family and friends.

Ralph H. Warner (M.S. '61), 80, of Kingwood, died April 7, 2013, after a long, courageous battle with Parkinson's Disease. Ralph graduated from Austin High in 1950. He went on to earn his undergraduate degree from Texas Lutheran University in 1954. Ralph was then drafted into the U.S. Navy, where he served for two years. Following his service, Ralph earned M.S. in geology from UT Austin in 1961. Ralph was a loving husband, father, grandfather and great-grandfather. He was preceded in death by his parents, Carl and Erna Warner; brother-in-law, Raymond Flachmeier. He is survived by his loving wife of 58 years, Marilyn Warner; children, Kimberly Lenzi (Larry), Brian Warner (Virginia) and Julie Warner; grandchildren and great-grandchildren, and sisters, Patricia Ruser (John) and Charlotte Miller (Lonnie).

Helen Elder White (B.A. '56) died April 28, 2012, at her home in Ozona, Texas. She was born on the April 16, 1934. Educated in San Angelo, Texas, she graduated from Central High in 1952. She majored in geology at UT Austin. Helen is survived by her beloved husband of 56 years, Frank C. White; their two daughters, Laura Anne White of Houston, Texas, and Susan Michelle White McNeill of New Market, Md.; her son in-law, Scott K. McNeill; and her two granddaughters. Helen was a beautiful loving person who cared for her family and friends with love, understanding and tenderness. She brought out the best in all who loved her and she will be deeply missed.

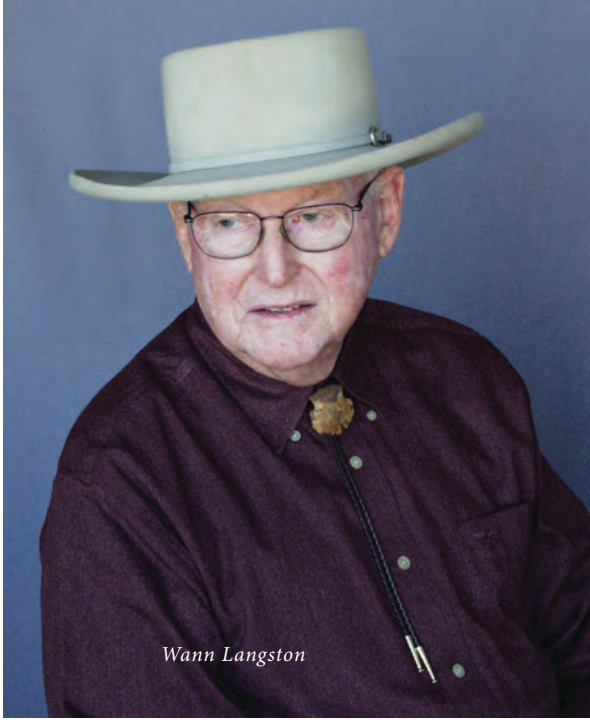
James C. Whitten (B.S. '56), 82, of Midland, died Sept. 11, 2011. He was born May 7, 1929. He attended St. Thomas High School. He graduated from UT Austin with a B.S. in Geology in 1956 and came to work in West Texas with Humble. He married Patricia Brophy on Nov. 16, 1957. Pat and Jim lived in Lubbock, Midland, Hobbs, Snyder, and Monahans until settling in Midland where Jim became an independent Geologist. He is survived by his wife of 53 years and their four devoted children: Dawn Howard and husband, Randy, Aileen Lands, Natalie (Whitten) Schwarz, and Chris Whitten and wife, Julie. Also mourning his passing are twelve grandchildren and two great grandchildren.

Faculty & Staff

John W. Dietrich, see alumni obituary.

Roselle M. Girard, see alumni obituary.

Wann Langston, Jr. died April 7, 2013, following a protracted battle with cancer, surrounded by his children and very much at peace in his last months. Wann's lifelong



Wann Langston

fascination with fossils spans nearly nine decades of tangible, uninterrupted accomplishment, leaving an example that few of us can even hope to approach. His influence on the field of vertebrate paleontology undoubtedly will be felt keenly by generations to come. Two-dozen fossil vertebrate species have been named in his honor.

From the age of four, Wann was captivated by ancient life, and he spent his childhood in the pursuit of bones, by sketching exhibits and by reconstructing vertebrate skeletons in clay. At that time his father, Wann Langston, Sr., was Dean of the University of Oklahoma Medical School. As Wann Jr. later explained, "I became a fixture in that gross anatomy lab at such an early age that my behavior would surely have discomfited both my father and his superiors had they known what was going on. But it was to my everlasting benefit that I got away with it. And I often reflect on how lucky I was that I didn't get my father into trouble." He spent his formative years visiting natural history museums across the country and while still in his teens he met many of the most influential paleontologists of the century.

As a volunteer in the University of Oklahoma paleontology laboratory, Wann quickly became an unsurpassed expert in all things associated with preparing fossils. His natural gifts and talent in preparation earned him an invitation to participate in his first scientific collecting trip. At the age of 17, Wann joined a team from OU, led by Donald Savage, into the rugged deserts of the Big Bend of the Rio Grande, now home to Big Bend National Park. On this trip, Wann also met Barnum

Brown whose crew was representing the American Museum in this early bone-rush into Trans-Pecos Texas. It was the trip on which Barnum Brown discovered the first scraps of the giant crocodilian Deinosuchus. And for his efforts, Wann found the better part of a ceratopsian skeleton. Late in life, in his dry cadence and utterly characteristic intonation he reflected, "not a bad first field trip."

After graduating with a B.S. in geology from the University of Oklahoma, he served in the United States Navy, returning to the University of Oklahoma at the end of World War II for an M.S. supervised by Dr. J. Willis Stovall. After teaching for a few years at Texas Technological College, in Lubbock, Texas, Wann entered the Ph.D. program at the University of California, Berkeley to study the Early Permian amphibians of northern New Mexico under the supervision of Dr. Charles Camp, completing his degree in 1952. Wann remained there as a lecturer and Chief Preparator for two years, working closely with his life-long friend Samuel P. Welles on such projects as the first reconstruction of Dilophosaurus. While at Berkeley, Wann also married his wife Marietta Evans and started a family along with his career. The two had met back at the University of Oklahoma where she was teaching freshman geology labs. Their marriage lasted 60 years, until Marietta's death just a few weeks ago. Wann and Marietta are survived by daughters Karen and Sandra, and two grandchildren.

In 1954, Dr. and Mrs. Langston, with infant daughter Karen in tow, then moved to Ottawa where Wann assumed the position of Curator of Vertebrate Paleontology at the National Museum of Canada. Three years later, daughter Sandra was born. He spent the summer months collecting specimens in the western Canadian plains and on Prince Edward Island.

In 1963, the family trekked to UT Austin, where Prof. Langston spent the next 50 years contributing to the world's knowledge of fossil reptiles. He served as director of the Vertebrate Paleontology Laboratory at UT from 1969 to 1986. His research spanned many groups of animals, and he is widely known for his work on North American dinosaurs, Permian amphibians, and North and South American crocodilians. Dr. Langston's fieldwork continued to expand the collections at UT far past his retirement in 1986. After his retirement, he was responsible for reconstructing the skeleton of the giant pterosaur Quetzalcoatlus. His final work was a masterful and accurate reconstruction of the 6-foot long skull of Deinosuchus, which brought his career into full circle.

Among his many honors is the Romer-Simpson Medal, which was awarded to him by the Society of Vertebrate Paleontology in 2007. For those of you who missed that event, Wann read aloud an email from one of his daughters who asked if perhaps her father had made a typographical error in his note to her regarding yet another accolade, and if he was instead being awarded the Homer Simpson Medal. In true form, Wann then told the audience that having personally known Al Romer and George Simpson, a Homer Simpson medal was more fitting to his particular accomplishments. Of course, nothing could be further from the truth.

Prof. Langston's paleontological legacy is vast and diverse. It consists of field collections, skeletal reconstructions, an unparalleled personal library, and over 100 publications, as well as innumerable students and colleagues that have been touched by his knowledge and skills. Specimens that he collected or mounted can be viewed at the Texas Memorial Museum in Austin, the Perot Museum of Nature and Science in Dallas, the Houston Museum of Natural Science, the Museum of Texas Tech University, Big Bend National Park, among many others institutions around the United States and around the world.

Dr. Langston also masqueraded as a tightwad, while donating among the most significant gifts made by any single individual to endowments in the SVP, the Webb School, and to UT Austin. The fruits of his mind and labor and the exceptional measure of his philanthropy ensure that Wann Langston Jr. will be known and remembered so long as the enterprise of paleontology carries on. *—Tim Rowe, director of the Vertebrate Paleontology Laboratory at UT Austin*

Editor's Note: Another excellent biography, "Wann Langston, Jr. – A Life Amongst Bones," by Chris Bell, Matthew Brown, Mary Dawson and Ernest Lundelius, Jr. was published this fall as part of a special edition of the journal *Earth and Environmental Science Transactions of the Royal Society of Edinburgh* honoring Langston's legacy. The biography is available online at: http://bit.ly/15utPwe.

Above, Quetzalcoatlus northropi, the largest flying creature ever discovered, was found in 1971 by Douglas Lawson, who was working under the supervision of Wann Langston (pictured below).

The staff and members of the Jackson School of Geosciences would like to convey our respects to the families of the following alumni:
Roy L. Beckelhymer (B.S. '52)
Ralph H. Warner (M.A. '61)
J. Wayne Word (B.S. '51)
John C. Yeager (M.A. '60)

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2013 Jackson School of Geosciences Alumni News Update/Submission Form

Or enter news online at http://www.jsg.utexas.edu/alumni

All information submitted is confidential and will not be shared outside of The University of Texas at Austin. All fields are optional but we appreciate your effort to help us keep your information accurate and current.

All alumni, including former researchers and staff affiliated with the school's organized research units, are encouraged to submit. If you are not receiving the newsletter in the mail, this form will ensure that you receive future copies.

Your Name and Home Address:

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E-mail:

Preferred Mailing Address

❍ Home ❍ Work ❍ Please do not send me mail.

Preferred E-mail Address

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Print Preferred E-mail Address in Alumni News:

❍ Yes ❍ No

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❍ BEG ❍ UTIG ❍ Other

Additional Details on UT or JSG Experience:

Enter Your Class Notes for the 2013 Newsletter:

Attach separate sheet or use online form at www.jsg.utexas.edu/alumni for longer entries.

Check if you would like more information on:

❍ Alumni events in your area or at upcoming geoscience meetings

❍ Mentoring and recruiting students

❍ K-12 outreach programs

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